A Review of the Range of Impacts and Benefits of the Columbia River Treaty on Basin Communities, the Region and the Province

Prepared for:

Ministry of Energy, Mines and Natural Gas

Columbia River Treaty Review

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Executive Summary

This report provides an overview of the impacts and benefits of the Columbia River Treaty (the Treaty) to the Columbia Basin (drainages into the main stem of the Columbia River north of the 49th parallel) in Canada and to the Province of B.C. It has been prepared in response to input received from Basin residents during provincial consultation sessions in the spring of 2012. At these sessions the public requested that a summary be created that documented what is known about the range of impacts and benefits in the Basin resulting from the creation and operation of the Treaty Dams and associated reservoirs.

Information in this report is drawn from existing reports, publications and web sources. The information provided is included as it was presented in those reports. No additional research was undertaken to either verify information or to provide an analysis of net benefits either to the Basin or to the communities most affected, or to define the current scope or scale of unaddressed or partially addressed impacts, other than how they have been addressed in other reports.

Impacts on First Nations and related communities are not addressed in this report. A separate information gathering and consultation process is being conducted with First Nations by the Province and Canada.

- **Treaty Background**

The Columbia River Treaty was signed by Canada and the United States in 1961 and was ratified in 1964. BC Hydro and the Province (for the purposes of the disposal of the Canadian Entitlement) are appointed as the Canadian Entity under the Treaty while Bonneville Power Administration and the U.S. Army Corps of Engineers jointly provide these functions in the U.S. Under the terms of the Treaty, BC Hydro built and now operates 15.5 million acre-feet (MAF) of storage at the Mica (7.0 MAF), Hugh Keenleyside (7.1 MAF), and Duncan (1.4 MAF) projects, in co-ordination with the United States, to maximize power generation and flood control benefits in both countries. The Treaty also authorized the construction of the Libby Dam in the United States, which created the Koocanusa Reservoir (5.0 MAF) that floods back 67 kilometres into Canada.

Under the Treaty, each party (Canada or the U.S.) accepts that any local or sub-regional impacts that occur as a result of the Treaty are the responsibility of the government within whose jurisdiction these impacts occur, in this case the Province and BC Hydro. Further information on the Treaty can be found at http://gov.bc.ca/columbiarivertreaty/.

- **General Benefits and Impacts**

Canada (B.C.) received an up-front lump sum pre-payment for the annual flood control benefits in the U.S. in the amount of US$64 million. That payment covered the benefits of an assured annual flood control plan for the first 60 years of the Treaty (i.e. to September 2024). In addition, the Province of B.C. receives one-half of the potential annual additional power generation benefits at the downstream U.S. projects resulting from the water flow regulation provided by Canadian storage under the Treaty

(Canadian Entitlement). The first 30 years of those Canadian Entitlement benefits were sold to the U.S. for a lump sum of US$254 million payable in 1964. After the 30 year sale period expired, the benefits began to return to the Province of B.C. beginning in 1998, and reverted to full provincial ownership in April 2003. Other general benefits of the Treaty to Canada (B.C.) include:

- Flood damage mitigation, particularly around Trail, Castlegar, Revelstoke, Creston and Kootenay Lake;
- At-site electricity generation at Mica Dam;
- Provision for an additional 5 MAF of Non-Treaty storage in Kinbasket Reservoir;
- Ability to develop additional generating facilities that benefit from flow regulation provided by upstream Treaty storage including: Kootenay Canal (1975), Revelstoke Dam (1984), Arrow Lakes Generating Station (2002), Brilliant Expansion project (2007);
- Generating facilities provide employment, and create spin off industries and services from construction, ongoing operations and periodic upgrades;
- Columbia Power Corporation and Columbia Basin Trust regional investment and related employment;
- Since the full return of the Canadian Entitlement benefit between 1998 and 2003, annual delivery of at least 1,176 megawatts (MW) capacity and 4,073 GWh[1] of energy to the British Columbia border over the last 10 years, worth $100-300 million annually; and,
- Power generation at Columbia Basin facilities helps to provide approximately 44% of the low-cost electricity BC Hydro delivers to B.C. residents and businesses.

The general impacts (footprint and operational) of Treaty dams and subsequent additional development include:

- Inadequate consultation with the Columbia River basin residents and First Nations when the Treaty was negotiated and initially implemented;
- The reservoirs created by the Duncan, Keenleyside, Mica and Libby dams, and the Non-Treaty Revelstoke Dam inundated approximately 60,000 hectares (231 square miles) of valley land;
- Over 50,000 hectares of lakes, rivers, wetlands, ponds streams and riparian areas and related habitat for fish, wildlife, waterfowl, bird and other species was impacted;
- Approximately 2,300 people were displaced and more than a dozen small communities were inundated primarily in the Arrow Lakes and Koocanusa Reservoirs;
- From an economic perspective, these areas were fertile and productive valley bottom lands;
- Economic activities and potential related to forestry, agriculture, forestry, recreation and tourism were also diminished;
- Flooding also impacted traditional First Nations' cultural sites;
- The rise and fall of reservoir water levels as a result of current operations continue to affect the surrounding ecosystems, tourism, forestry and recreation and cultural interests; and

[1] A gigawatt hour, abbreviated as GWh, is a unit of energy representing one billion (1,000,000,000) watt hours and is equivalent to one million kilowatt hours.

- Lack of understanding of how the system is operated, and lack of knowledge of how decisions are made have resulted in a feeling that regional interests are not adequately accommodated in on-going operations.

- **Specific Impacts**

The three Canadian Treaty dams and reservoirs were all constructed between 1964 and 1973. The Libby Dam was completed in 1975. The Revelstoke Dam and generation complex was completed in 1985. The areas affected by the reservoir inundation at full pool reservoir in are shown in Table 1.

Table 1: Area of Pre-Dam Aquatic and Terrestrial Ecosystems inundated by the Treaty and Revelstoke Reservoirs (ha)

	Mica/ Kinbasket	**Revelstoke**	**Keenleyside/ Arrow**	**Libby/ Koocanusa (B.C.)**	**Duncan**	**Total**
Lakes	2,343.0	0	34,992.3	0	2,583.9	39,919.2
Rivers	4,896.6	2,654.4	2,021.9	1,490.1	424.5	11,487.5
Streams	192.1	53.4	50.6	10.3	17.7	324.1
Shallow ponds	555.1	26.9	102.9	210.6	172.3	1067.8
Gravel Bars	235.6	56.9	3,262.8	80.4	22	3,657.7
Wetlands	5,862.6	456	3,431.6	1,071.9	1,824.5	12,646.6
Floodplains, Riparian Forests	15,526.5	4,004.7	3,563.5	2,173.1	1,396.6	26,664.4
Upland Ecosystems	13,035.7	4,199.1	3,844.3	1,646.8	860	23,585.9
Total	**42,647.2**	**11,451.4**	**51,269.9**	**6,683.2**	**7,301.5**	**119,353.2**

The Kinbasket and Arrow Lakes Reservoirs inundated the largest areas of both water and land. In reviewing the impacts and benefits, all reservoirs had similar types of impacts, although at different scales.

The impacts reported here are drawn mainly from the 1994 Arrow Lakes, Revelstoke, Golden and Valemount community reports that were developed by local government organizations as part of an effort to gain compensation for the Treaty related development impacts.

The lack of prior consultation in development of the Treaty, and the frustration with the inadequate mitigation or compensation measures for the impacts of Treaty and related dams and hydroelectric projects by the Provincial Government and BC Hydro, the people of the Basin came together in the early 1990's to press the Province for recognition of the injustice of this situation. Local governments in the Basin coordinated their efforts at the regional district and tribal council level under the Columbia River Treaty Committee, which first met in 1992. Over the following 2 years, 4 community impact reports were developed for Valemount, Golden, Revelstoke and Nakusp. The Committee, in partnership with elected officials from the region, used those reports in the negotiations with the Province that led to the

establishment of the Columbia Basin Trust. The social and economic impacts are drawn largely from those community reports.

Other documents including reports from the Columbia Basin Fish and Wildlife Compensation Program, and People in the Way by J.W. Wilson (1973) were also considered. There were no community reports developed for the Duncan Dam or Koocanusa Reservoir. However, many of the reported impacts can be assumed to also apply to those areas.

Biophysical Impacts

The main reported biophysical impacts include:

- The loss of rivers, lakes, streams and riparian areas affected the fisheries in each of the reservoirs;
- The loss of wetlands, riparian areas, and upland areas affected the habitat of mammals, waterfowl, and other birds, and other species types. Entire ecosystems were removed;
- Other natural features such as hot springs were lost;
- At low water, the drawdown areas create mud and silt flats that are both unsightly and ecologically unproductive;
- In reservoirs with higher drawdowns such as Kinbasket, Arrow Lakes and Koocanusa, high winds create dust storms at low water levels;
- There are reported localized reservoir related weather impacts including higher winds, less snow and more rain, and winter fog; and
- There are reported higher levels of insect infestations at certain times of the year.

Social Impacts

The main reported social impacts include:

- Lack of consultation leading up to the Treaty left people feeling that their views, concerns and needs were not adequately addressed;
- Commitments made about future development of infrastructure and economic development opportunities were not delivered by the Province and/or BC Hydro;
- There are ongoing concerns that both the process of reaching acquisition settlements for the private lands, and the amount of compensation received, were inadequate;
- Residents' perception that there has been a lack of adequate measures to address the social, environmental and economic impacts remain as a source of hurt, anger and mistrust;
- Communities lost access to "unspoiled wilderness", with forests, wildlife and fish, and related recreation experiences;
- Over 2,300 people were displaced and over a dozen small communities, their homes, infrastructure, public spaces and way of life were lost primarily in the Arrow Lakes and Koocanusa Reservoirs; and
- Archeological sites were also inundated.

Economic Impacts

The main reported economic impacts include:

- Loss of tourism and recreation activities and future tourism potential;
- Lack of development of suitable water and land based recreation infrastructure and access after development;
- Fluctuating water levels, floating debris, and visual impacts at lower water levels place constraints on tourism and recreation opportunities;
- Loss of rail and road infrastructure;
- Significant reduction in Hamber Provincial Park;
- Loss of wildlife, waterfowl and fisheries resulted in both consumptive and non-consumptive hunting and recreation impacts;
- Loss of productive forest land and related economic opportunities, and reductions in annual allowable cut;
- Loss of opportunities to generate more local benefits by not fully harvesting the reservoirs prior to flooding;
- Increased costs to forestry operations due to limitations in access, increased need for water based access and transport and more extensive and difficult to access harvest areas and terrain;
- Loss of arable farmland and orchards, especially in the Arrow Lakes and Koocanusa reservoirs;
- Loss of tax revenue related to the loss of private lands affected both educational and municipal funding;
- Grants in lieu of taxes are not related to either municipal impacts or expenditures;
- Employment benefits of the construction of Treaty and related facilities and related permanent employment have not significantly benefited some of the most affected communities; and
- Small communities had little capacity to adapt to these changes and develop economic alternatives.

- **Mitigation and Benefits to the Region**

Development Mitigation

During the process of project development, the Province and BC Hydro did make some investments to mitigate impacts. Some of those investments include:

- Relocation of the communities of Edgewood, Fauquier and Burton and creation of residential lots in other locations for resettlement;
- Development of new water supply systems in the Trail and Castlegar areas;
- Hospital expansions in Castlegar and Mica Creek;
- Development or improvement of some public roads and logging roads;
- New ferry infrastructure on Arrow Lakes;
- Development of a construction camp at Mica Creek;
- Diking and bank stabilization in Revelstoke and Nakusp;
- Development of some boat launch and marina facilities; and
- Development of infrastructure and community facilities in Revelstoke.

Environmental Compensation Programs

The BC Hydro Columbia Basin Fish and Wildlife Compensation Program (FWCP-Columbia) was established in 1995 to sustain and enhance fish and wildlife populations by undertaking projects with the potential to mitigate footprint impacts resulting from BC Hydro projects, and to meet water licence obligations. The program covers all of the BC Hydro facilities in the Basin. It started with an annual budget of $3.2 million per year, tied to inflation. The current budget is $4.5 million. Since 1995, FWCP-Columbia has invested more than $65 million in approximately 750 projects related to fish and wildlife in the Columbia region.

Columbia Power Corporation (CPC) has a similar Environmental Program which has been in place since 2002 to address the impacts of the Arrow Lakes Generating Station, the Brilliant Dam and Brilliant Expansion Project, and the Waneta Expansion Project. Over the last 3 years, CPC has invested $486,600 annually in this initiative.

Water Use Planning

To address issues of declining fish stocks and aquatic habitat, and consequently water management, as well as the relationship between fish, flood protection, recreation, other water uses and power generation at hydroelectric facilities the Province initiated the requirement to develop Water Use Plans for BC Hydro water control structures. The Columbia River water use planning process started in 2000, and an initial plan was developed in 2004. An update to that plan was completed in 2007. As a result of that process, approximately $115 million will be invested between 2008 and 2020 to address issues such as flow management for various interests including navigation, recreation, fisheries, flood control, habitat, nutrient enhancement, migration, stranding and other issues related to fish, waterfowl habitat, ongoing dust and debris concerns, ongoing reservoir access and access maintenance concerns, wetland protection, riparian and wildlife habitat and heritage protection. A similar process was undertaken for the Duncan Dam. The Duncan Dam estimated budget is $13.5 million for the 2008 to 2018 period. To date, approximately $53 million has been invested from these two programs.

Columbia Basin Trust

Columbia Basin Trust (CBT) was created in 1995 to support efforts by the people of the Basin to create social, economic and environmental well-being in the Canadian portion of the Columbia River Basin - the region most affected by the Columbia River Treaty. During the creation of the Treaty, Basin residents weren't adequately consulted for their views, concerns or solutions. In the early 1990s, the people of the Basin seized the opportunity to get involved. Residents, local officials and representatives from regional districts and tribal councils joined together to coordinate efforts, forming the Columbia River Treaty Committee. Reflecting the desires of the people of the Basin, the committee approached the Province of B.C. in order to negotiate:

- that funds be allocated to the region, representing a fair share of the ongoing benefits being realized outside of the Basin as a result of the Treaty; and
- that a regional organization, governed by a board of Basin residents, be created to manage those funds.

Negotiations were successful on both counts, and, in 1995 the *Columbia Basin Trust Act* was passed through the B.C. legislature and CBT was established. A binding Financial Agreement was also established which resulted in the following for the residents of the Basin through CBT:

- $276 million over ten years to finance power project construction in partnership with Columbia Power Corporation;
- $45 million up front, which CBT used as an endowment; and
- $2 million per year from 1995 to 2010 for operations.

Using the income earned from its power projects and other investments, CBT has a Delivery of Benefits program that supports initiatives focusing on fostering quality of life and addressing critical issues in the Basin. In 2011/12, CBT disbursements to communities were over $18 million. CBT initiatives include Community Development, Water, Environment, Economic, Social and Youth. Since 1996, CBT total delivery of benefits to communities has been approximately $90 million.

Current levels of benefits are expected to continue at about the same level, until 2015/16, when Waneta Expansion begins to produce power. Those additional revenues and increased revenues from a new sales agreement for the Arrow Lakes Generating Station will mean that by 2017/18 projected annual benefits to communities are expected to be double the current levels.

Columbia Power Corporation

The province also established Columbia Power Corporation in 1995 and endowed it with $250 million to act as a joint venture partner with CBT. Together they have purchased the Brilliant Dam, constructed the Arrow Lakes Generating Station and the Brilliant Expansion Project. The Waneta Expansion project is currently under construction. Net income from these power projects is shared based on each organization's ownership proportion of the specific project.

Regional Flood Mitigation

The water management benefits of the dams and reservoirs have significantly reduced the risk of flooding, especially in Revelstoke, Castlegar, Trail, Creston and Kootenay Lake. Water flows this summer, for example, were similar to 1948 and 1961 when there was extensive flooding.

Grants in Lieu of Taxes (GILT)

Although publicly-owned power facilities in the Columbia Basin generally do not pay municipal property taxes and school taxes, they do pay municipalities and regional districts grants in lieu of taxes. The exception is the Brilliant Dam, which continued to pay property taxes after it was acquired by CPC and CBT from Cominco in 1996. The grants-in-lieu formulas provide funds to local governments impacted by reservoirs, in addition to the local jurisdiction in which a dam and powerhouse is located.

In 2012, for the Treaty dams (Mica, Keenleyside and Duncan) grants in the amount of $1,961,530 were paid to Columbia-Shuswap Regional District (RD), Fraser-Fort George RD, Village of Valemount, Central Kootenay RD, City of Castlegar and the Village of Nakusp. The GILT for the Revelstoke Dam in 2012 was $2,340,686 paid to Columbia-Shuswap RD and the City of Revelstoke and the GILT for the Kootenay Canal was $ 832,132 paid to Central Kootenay RD and the City of Nelson. Columbia Power Corporation

paid a total GILT of $473,890 for the Arrow Lakes Generating Station and the Brilliant Expansion project to the Regional District of Central Kootenay, the Village of Nakusp, and the City of Castlegar.

Construction Employment

For the nine year construction period of the three Treaty dams, actual employment was estimated to be 17,850 person-years. The Revelstoke Dam created a further 11,055 direct person-year jobs, and the Kootenay Canal Generating Station produced additional 2,000 person-years of construction employment. Subsequent projects such as the Arrow Lakes Generating Station, the Brilliant Expansion project as well as Revelstoke Unit 5 and the Duncan Dam spillway improvements have added approximately 2,000 person-years of employment. There is currently construction underway at Mica Dam, the Keenleyside Dam and at the Waneta Expansion Project. Future projects include Revelstoke Unit 6 and improvements to the Kootenay Canal facility. Since the Treaty was established, there have been approximately 33,000 person-years of employment, or an average of over 685 construction jobs per year since 1964.

Permanent Employment

To manage the Treaty and related facilities, BC Hydro employs permanent staff at the dam sites. For the 2012/13 fiscal year, BC Hydro has a total of 109 permanent and 11 temporary employees, and has an additional $4.3 million budgeted for contracted work. This total does not include transmission line crews. There is one permanent employee with the Fish and Wildlife Compensation Program.

In addition, Columbia Power Corporation has 40 permanent employees, and the Columbia Basin Trust has 42 permanent employees. Annual Employment budgets in 2012 for BC Hydro, Columbia Power Corporation and Columbia Basin Trust for these positions is approximately $24 million. It is not clear how much additional employment is generated from contracted services provided to these organizations and programs, but the total value of contracted services is approximately $16 to $18 million per year.

Tourism and Recreation

The reservoir system in the region created opportunities for new recreational and tourism benefits. Private facilities and services, and BC Parks and Forestry Recreation Sites and Ecological Reserves that support tourism and recreation activities, have been developed in association with the dam facilities and reservoirs.

BC Hydro has a Visitors Centre at the Revelstoke Dam, a trail at the Kootenay Canal, and a lock in the Keenleyside Dam provides both commercial and recreational services. BC Parks has developed Cummins Lake Provincial Park and Foster Arm Protected area on the Kinbasket Reservoir, and the Cummins River Protected area and Goosegrass Creek Ecological Reserve have been established. There are also several Forestry Recreation Sites on the Kinbasket Reservoir including Canoe Reach Marina.

Martha Creek Provincial Park has been established on the Revelstoke Reservoir as well as the Five Mile boat launch. Syringa, Blanket Creek, McDonald Creek and Shelter Bay Parks have been established on

the Arrow Lakes Reservoir. Duncan Reservoir has two Forestry Recreation sites with boat launches. Kikomon Creek Provincial Park and Wardner Provincial Park (day use) have been established on the Koocanusa Reservoir. Total 2010/11 visitation to Provincial Parks noted above was 364,654.

- **Provincial Benefits**

Power Generation

One of the goals of the Treaty was to increase the opportunities to generate electricity. The large BC Hydro projects in the Columbia Basin (Mica, Revelstoke, and Kootenay Canal) have a total installed capacity of 4,620 MW. Actual generation depends on water flow, and has varied between 16,000 and 20,000 GWh annually in recent years. That capacity, along with other smaller BC Hydro and Columbia Power Corporation facilities in the region, now constitutes approximately 44% of BC Hydro's total generation capacity. The flexibility of large hydroelectric projects with storage also supports electricity trade with Alberta and the US.

Canadian Entitlement

Under the Treaty terms, Canada is entitled to half of the additional potential power generation in the U.S. resulting from improved water regulation. These rights were transferred to the Province in 1963, and Canada pre-sold the first 30 years of those benefits in 1964. Between 1998 and 2003, those benefits began to be returned to B.C. in various amounts, and as of April 2003 are now fully returning. The Canadian Entitlement is currently worth about $100-$300 million annually (varies with market prices). That power is marketed on behalf of the Province by Powerex, a BC Hydro subsidiary. Over the last 10 years, annual revenue from the sale of the Canadian Entitlement has averaged approximately $202 million and goes into the Province's Consolidated Revenue Fund.

Water License/Rental Payments

Under the *Water Act* and Water Regulation, the Province requires users of publically owned water to pay annual fees known as water rentals. Water rentals are based on the size of the generating facility, the volume of storage and annual power output. Over the last 10 years, those annual fees have been, on average, $46.7 million for Mica, $53.4 million for Revelstoke and $19.2 million for the Kootenay Canal Facility.

In addition over the last 2 years, Columbia Power Corporation has paid an average of $4.47 million for the Arrow Lakes Generating Station and $2.33 million for the Brilliant Expansion Project. Water rentals go into the Province's Consolidated Revenue Fund.

Provincial Crown Land Occupation Fees

There is also a Provincial fee for the use of the Crown land that the facilities and storage occupy. Those annual fees are currently $266,700 for Mica/Kinbasket, $54,223 for Revelstoke, $27,316 for Arrow Lakes and $18,681 for Duncan, and also go into the Province's Consolidated Revenue Fund.

BC Hydro and CPC Payments to the Province

Generation capacity in the Columbia Basin contributes to the net income of BC Hydro. Although there is no facility-specific link to income, if the share of Basin capacity is used to estimate a share of net income, over the last three years, these facilities have generated approximately $179 million (2009/10), $236 million (2010/11), and $246 million (2011/12) of net income for BC Hydro.

BC Hydro is required to make an annual payment to the Province, on or before June 30 of each year, equal to 85 per cent of BC Hydro's net income for the most recently completed fiscal year, assuming that the debt to equity ratio, as defined by the Province, after deducting the Payment, is not greater than 80:20. The dividend in 2010/2011 was $463 million and for the year to date at March 31, 2012 is $230 million. Over the last ten years, that approximate Basin component has averaged $105.7 million per year. These payments go into the Province's Consolidated Revenue Fund.

The net income for Columbia Power Corporation for the last 3 years was $14.9 million, $17.3 million and $14.7 million respectively. Columbia Power Corporation pays an annual dividend to the Province of B.C. of $2 million. This dividend goes into the Province's Consolidated Revenue Fund.

Non-Treaty Storage Agreement (NTSA)

BC Hydro designed and built the Treaty storage projects (Mica, Arrow and Duncan) with more than 5 Million Acre Feet (MAF) of additional usable storage than the 15.5 MAF required under the Treaty. Most of this extra volume is physically located at Mica but is contractually not attached to any specific project or location. This additional water storage space is referred to as Non-Treaty Storage, and is utilized under a long term commercial agreement between BC Hydro and the Bonneville Power Administration (BPA). The NTSA essentially allows BC Hydro and BPA to fine-tune the Treaty-specified releases of water across the B.C. – U.S. border in response to prevailing loads, market prices and non-power interests such as ecosystem and fisheries protection. BC Hydro estimates the average hydroelectric generation value of the regulation improvement provided by non-Treaty storage to be approximately $12 million annually. This benefit is part of BC Hydro's power sales revenue, and helps to minimize customer rates.

Kootenay River Power Generation Benefits

The ability to better manage flows due to the Duncan Dam and the Libby Dam greatly enhanced the power generation potential of the lower Kootenay River. That potential has subsequently been utilized through construction of the Kootenay Canal and Brilliant Expansion projects. With those facilities and other system improvements, the additional power generated is estimated at 3,250 GWh annually. The revenues from those projects are included in the income for BC Hydro and Columbia Power Corporation.

Other Provincial Benefits

The Province also gains tax revenues for wages for permanent employees of by BC Hydro, Columbia Power and the Columbia Basin Trust, and for contracted employees, or project labour income from those organizations, the Fish and Wildlife Compensation Program and the Water Use Planning

programs. There are also provincial tax benefits on the wages paid to contracted employees working on capital projects, such as the current Mica Dam Units #5 and #6 and Columbia Power Corporation project at Waneta. The Province also receives tax benefits on the materials used in construction and maintenance. Fees paid at Provincial Parks also become part of provincial revenue, as do fees paid for fishing licences for recreational fishing on the reservoirs. No estimate of the total value of these benefits is documented.

A Review of the Range of Impacts and Benefits of the Columbia River Treaty on Basin Communities, the Region and the Province

A. Introduction and Purpose of this Report

The Province of B.C. has initiated a Columbia River Treaty (Treaty) Review process to evaluate future decision options, including possible continuation, amendment or termination of the Columbia River Treaty. The review process will also provide recommendations to government on any potential new arrangements should the Treaty be continued, amended or terminated.

In response to Basin residents desire to further understand the range impacts and benefits of the Columbia River Treaty, this report was commissioned by the Ministry of Energy, Mines and Natural Gas and provides an overview of the Treaty and its associated dams and reservoirs in the drainages and the main stem of the Columbia River north of the 49th parallel. It does not necessarily reflect the position or opinion of the Province.

The Columbia River Treaty Review process is intended to provide an opportunity for the Province to engage with Columbia Basin residents on the future of the Treaty. This engagement will increase the Province's understanding of local interests, values and concerns. An additional objective of the consultation is to ensure that Columbia Basin residents understand the full range of impacts and benefits of the Treaty on Basin communities, the region and the Province.

B. Scope

First Nations

This report does not examine specific impacts on First Nations and related communities but the report recognizes the environmental, social and economic impacts resulting from the Treaty also apply to First Nations members and their communities. A more comprehensive discussion of interests to specific First Nations, including those related to s. 35 of the *Constitution Act* (1982) is being implemented through a separate CRT 2014 Review First Nation Engagement Process.

Geographic Scope

To help further an understanding of the range impacts and benefits stemming from the Columbia River Treaty, this report provides an overview of the Treaty and its associated dams and reservoirs in the drainages and the main stem of the Columbia River north of the 49th parallel. The main focus of the report is on the Columbia River main stem Treaty facilities including the Mica Dam (Kinbasket Reservoir), and Hugh Keenleyside Dam (Arrow Lakes Reservoir), the Canadian portion of Koocanusa Reservoir (Libby Dam) and the Duncan Dam and Reservoir. Although it is not a Treaty facility, the Revelstoke Dam and Reservoir are included because of their impact on the Columbia River, and because that facility is a significant benefit of the improved water management resulting from the Mica Dam. Because of the water management benefits of the Duncan and Libby Dams on the Kootenay River, the benefits of

subsequent Kootenay Canal and Brilliant Expansion hydroelectric developments on the Kootenay River are also discussed. Also, because the Columbia Power Corporation was established to develop generation capacity and to act as a joint venture partner with the Columbia Basin Trust, their facilities, including the Waneta Expansion Project are also described.

Literature Review

The content of the report is based on a review of readily available information including: reports, books, web sources and other publications related to development of the Treaty, impacts of development of the reservoirs and dams, mitigation of direct impacts of the reservoirs and dams, and benefits that have been returned to the Columbia Basin region, to BC Hydro, and to the Province of B.C. Selkirk College analyzed existing GIS datasets (see Appendix 1 for a summary of this information) to provide a summary of the biophysical impacts resulting from inundation of land associated with the construction of the Treaty-related dams (Arrow, Duncan, Mica, Libby) along with data that has been collected through the Fish and Wildlife Compensation Program's *Dam Footprint Impact Study*.

Limitations and Challenges

A significant challenge in trying to understand the impacts and benefits from a social and economic standpoint is that the impacts and benefits flow over time. Many of the impacts happened at one point in time. The impacts on residents of having to relocate, for example, were immediate when the dams were developed. Many of the individuals who experienced those direct impacts have now passed on, although the memories and some of the reality of those impacts are still very real to family members and communities.

Some of the impacts of the dam and reservoir development are ongoing such as fluctuating reservoir water levels. These impacts continue to affect people, communities, ecosystems and the economy in the Basin.

Many of the benefits of flood control and hydroelectric generation are also ongoing, and in some cases, such as hydroelectric generation capacity and funding to communities and organizations available through the Columbia Basin Trust, will continue to grow in the future.

Another challenge is that some of the reported impacts are lost opportunities because of inundation of lands that did, and could still be supporting agriculture, forestry and tourism activities. These are "opportunity costs" associated with development possibilities that were lost.

The perspective on impacts or benefits also depends significantly on the point of view from which the question is asked. The Treaty structure creates a set of downstream benefits, largely in the United States (U.S.), in the form of flood control and hydro-electrical generation potential, with few U.S. impacts other than the inundation of the U.S. portion of Koocanusa Reservoir and the financial obligations to Canada created by the Treaty. In British Columbia (B.C.), the Treaty and related development provides electrical generation that serves all residents of the Province. A portion of both the costs of generation, such a licence fees, and of net incomes resulting from that generation also flows to the Provincial government.

Many of the economic benefits related to the construction of the dams and the ongoing maintenance and upgrading of the facilities contribute to those areas of the Columbia Basin where the dams are located. However, virtually all of the impacts related to U.S. and B.C. benefits are felt within the Columbia Basin. Even within the Basin, impacts vary. Some communities such as Renata, no longer exist, while others such as Nakusp, Golden and Revelstoke were, and still are directly affected, while still others experience only indirect effects, or even benefits.

When considering Treaty impacts and benefits, the benefits that are a direct result of the Columbia River Treaty, such as downstream benefits payments, and power generation at the Mica Dam should be distinguished from those benefits that have been created incidental to the Treaty, such as Non Treaty Storage Agreement benefits and increased generation capacity resulting from improved water management on both the Columbia and Kootenay Rivers (e.g. Revelstoke, Arrow Lakes, Kootenay Canal, and Brilliant Expansion generating stations).

There is also regional compensation and benefits created as a result of provincial policies, programs and regulatory requirements, for example requirements resulting from conditions of water licensing (e.g. Fish and Wildlife Compensation, Water Use Plans) and development of BC Parks and Forestry Recreation Sites. These programs and benefits also apply to, and generate similar benefits in other areas of B.C. that have non-Treaty hydroelectric generation and reservoir facilities. In addition, through provincial legislation, the Columbia Basin Trust was created by the Province, not as a Treaty requirement or benefit, but in recognition of the regional impacts of the Columbia River Treaty dam and reservoir development that were not addressed by the Treaty or other government policies, programs or requirements. [1]

Because this report is based on web sites, reports and documents reporting the findings of others, it may also contain any errors or gaps in those documents. The report was developed within a relatively short time frame, and information that may have been useful to include may have been missed. In some cases, issues identified in the 1994 Community Impacts Reports or in subsequent statements of impacts have either been in whole or in part addressed, or plans are in place to address those issues in the future. Some of those mitigation actions and plans may have been missed in this review. If further published reports are identified as a result of the consultation, those documents will be added to the bibliography of this document.

There was little gathering of new data undertaken as part of this report. The description of impacts and benefits is therefore presented in various forms and measures that range from general descriptions, to specific measures such as areas affected, or dollar values, as they were presented in the reports and publications reviewed. No attempt has been made to convert and analyze those measures in a way that would allow an overall assessment of "net" impacts, in other words, to answer the question, "Have the benefits exceeded the impacts to the Basin, or to the most directly affected communities?" Wherever dollar values are used, the related date is referenced. No updates or present values of reported estimates or values based on current costs, wages or other data is provided.

[1] http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_96053_01

Many of the web sites and documents provided good summaries of issues, initiatives and programs, and those summaries are included in this report verbatim from the references provided.

Finally, a separate analysis of impacts on First Nations and related communities are not addressed in this report. A separate information gathering and consultation is being conducted with First Nations by the Province and Canada.

C. THE COLUMBIA RIVER TREATY (TREATY)

The Columbia River is the fourth largest river in North America as measured by average annual flow, and is the most powerful river in North America in terms of energy generation. Only about 15 per cent of the 259,500 square miles (697,000 square kms) of the Columbia River Basin is in Canada. About 38 per cent of the average annual flow, however, and up to 50 per cent of the peak flood flows at The Dalles, Oregon come from Canada. Prior to the Treaty, variations in flows caused significant flood and hydropower generation problems, especially in the U.S.

Development of the Treaty

The following brief description of the Columbia River Treaty is excerpted from a Ministry of Energy, Mines and Natural Gas web site. [2, 3] A full copy of the Treaty is also available on-line,[4] as well as a legal history and interpretation.[5]

> "In 1944, Canada and the United States asked the International Joint Commission, an organization formed by both countries under the 1909 Boundary Waters Treaty, to investigate and report on the feasibility of cooperative development of the Columbia River system. The Commission established the International Columbia River Engineering Board whose mandate was to support the investigation and conduct technical studies. Detailed studies began after a 1948 flood devastated communities along the Columbia River, killing several dozen people, and making thousands homeless.
>
> Studies in both countries recommended the development of upriver storage in Canada on the Columbia River and its tributaries for the economic and flood benefit of both Canada and the United States. On February 11, 1960, negotiations began between Canadian and United States representatives regarding the site selection, dam construction and joint use of specific projects. Talks proceeded rapidly. On January 17, 1961, the Treaty was signed by Prime Minister John Diefenbaker and President Dwight Eisenhower."

[2] http://blog.gov.bc.ca/columbiarivertreaty/
[3] http://blog.gov.bc.ca/columbiarivertreaty/history/
[4] http://blog.gov.bc.ca/columbiarivertreaty/files/2012/04/Columbia-River-Treaty-Protocol-and-Documents.pdf
[5] http://munkschool.utoronto.ca/wp-content/uploads/2012/07/Bankes_and_Cosens_POWI_2012.pdf

To enable the Columbia River Treaty to go ahead, and in recognition of the costs of developing the dams, the Canadian government and British Columbia signed an agreement in 1963 addressing the issues of authority, benefits and responsibility (1963 Canada-British Columbia Agreement). Starting in the early 1990's, other agreements under the Columbia River Treaty between the Canadian and U.S. Entities have been put in place to serve additional values such as managing water flow for fish and for recreation.

Either Canada or the U.S. can unilaterally terminate most of the provisions of the Columbia River Treaty any time after September 16, 2024, providing at least ten years' notice is given. The latest date to provide termination notice for September 2024 is September 2014. Regardless of termination, Assured Annual Flood Control expires automatically in 2024 and converts on 16 September 2024 to a "Called Upon" operation of Canadian storage space as may be needed by the United States for flood risk management. "Called Upon" flood control continues for as long as the dams that provide it are in place, even if the Columbia River Treaty is terminated.

The responsibility for dealing with impacts in Canada is addressed in the Treaty. Treaty Article XVIII (Liability for Damage) states that neither country is liable to each other for any damages resulting from acts undertaken under the Treaty, and that each "shall exercise due diligence to remove the cause and to mitigate the effect of any injury, damage or loss" resulting from the Treaty.[6] Under the 1963 Canada-British Columbia Agreement the responsibility for impacts in Canada rest with the Province and BC Hydro.

As an International treaty, the Columbia River Treaty is within the jurisdiction of the federal government. However, the Canada-British Columbia Agreement (1963) allocated most Columbia River Treaty rights, benefits and obligations to the Province. The Canada – British Columbia Agreement requires Canada to obtain the concurrence of the Province before amending or terminating the Treaty. The Federal government is participating in the current Review through a number of Federal/Provincial Working Groups and through a First Nations Coordinated Consultation Process.

Columbia River Treaty Requirements

The Treaty required Canada to provide 15.5 million acre-feet of water storage by building three dams: Duncan, Arrow (later renamed Hugh Keenleyside) and Mica. The Columbia River Treaty also allowed the United States the option to build Libby Dam in Montana. In exchange for providing and operating the Columbia River Treaty water storage projects, Canada received an upfront payment of US$64 million for 60 years (to 2024) of future flood control benefits (Assured Annual Flood Control) in the United States.

Canada also received an entitlement to one-half of the estimated additional hydroelectric generation capability at power plants on the Columbia River in the United States that resulted

[6] http://blog.gov.bc.ca/columbiarivertreaty/files/2012/04/Columbia-River-Treaty-Protocol-and-Documents.pdf pg.12

directly from the operation of Columbia River Treaty dams in Canada (the Canadian Entitlement). British Columbia sold the first 30 years of the Canadian Entitlement to a consortium of utilities in the United States for US$254 million, and used the money to finance the construction of the three Columbia River Treaty dams in the Province.

General Scope of Benefits and Impacts of the Treaty

The Columbia River Treaty has brought flood control and significant power generation benefits to British Columbia. Those benefits include:

- Flood damage mitigation, particularly around Trail, Castlegar, Revelstoke, Kootenay Lake and Creston;
- At-site electricity generation at Mica Dam;
- Ability to develop additional generating facilities that benefit from flow regulation provided by upstream Treaty storage including: Kootenay Canal (1975), Revelstoke Dam (1984), Arrow Lakes Generating Station (2002), Brilliant Expansion Project (2007);
- Generating facilities provide jobs as well as spin off industries and services from construction, ongoing operations and periodic upgrades;
- Columbia Power Corporation and Columbia Basin Trust regional investment and related employment;
- Up-front cash payments of US$64 million for flood control and US$254 million for the first 30 years of the Canadian Entitlement power;
- Since the full return of the Canadian Entitlement benefit between 1998 and 2003, annual delivery of at least 1,176 megawatts (MW) capacity and potential for up to 4,073 GWh[7] of energy to the British Columbia border over the last 10 years, worth $100-300 million annually; and
- Power generation at Columbia Basin facilities helps to provide approximately 44% of the low-cost electricity that BC Hydro delivers to B.C. residents, businesses and industries.

Impacts began with the negotiation of the Treaty itself. By today's standards, there was a lack of consultation with Columbia River Basin residents and First Nations when the Columbia River Treaty was negotiated in the early 1960s. In September 1961, a series of Water Storage License hearings were held by the Province throughout the region that would be impacted by the flooding. These hearings were, however, limited to water licence issues rather than the Columbia River Treaty itself.

Flooding caused by the filling of the four Columbia River Treaty reservoirs created by the Duncan, Arrow (now named Hugh Keenleyside), Mica and Libby dams, and the non-Treaty Revelstoke Dam covered large sections of valley bottom land. Approximately 65,000 hectares (231 square miles) of valley land, and over 50,000 hectares of lakes, rivers, ponds streams and related fish, wildlife, waterfowl, bird and other species habitat were flooded. Approximately 2,300 people were displaced and more than a dozen small communities were inundated. Related economic activities and

[7] Gigawatt hours, abbreviated as GWh, is a unit of energy representing one billion (1,000,000,000) watt hours and is equivalent to one million kilowatt hours.

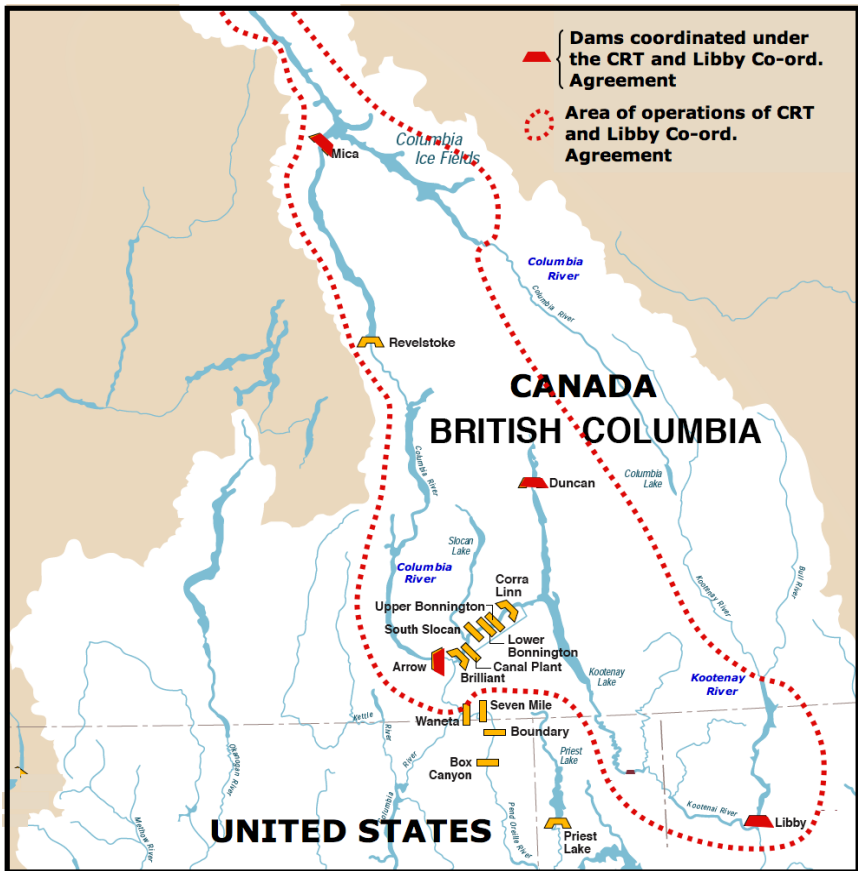
potential related to forestry, agriculture, recreation and tourism were also lost. Flooding also impacted traditional First Nations' sites. The rise and fall of reservoir levels continue to affect the surrounding ecosystems, cultural, economic and recreation interests.

Since the early 1990s, British Columbia has taken a number of steps to recognize the long term impacts in the region most directly affected by the creation of the Columbia River Treaty dams. In 1995 the Province created the Columbia Basin Trust, to support social, economic and environmental well-being in the Columbia River Basin. Furthermore, Water Use Plans and implementation programs and ongoing conservation and enhancement projects through the Fish and Wildlife Compensation Program have also been developed.

D. Columbia River and Treaty Dam and Reservoir Development

The following sections provide a more detailed review of the impacts and mitigation actions for each of the three main Treaty dams and associated reservoirs in the Columbia Basin as well as the portion of the Koocanusa Reservoir in Canada (See Figure 1). The Revelstoke Dam and Reservoir are also included. Although not a Treaty facility, the Revelstoke Dam is on the main stem of the Columbia River and does impact water management and has similar impacts and benefits to the region and Province.

Figure 1: Columbia River Treaty Dams and Reservoirs[8]



[8] Hearns, Glen (2008)

The focus on impacts relates mainly to the immediate impacts, mitigation and benefits, at the time of development. The scale of development impacts and their short and long term consequences were, and in some cases are, still difficult for the most affected communities in the region to understand and to accept.

In the areas most directly affected, the "measurable" losses related to the flooding of the reservoirs such as inundated forestry and agricultural land constitute one component of impacts. However, the emotional and psychological impacts of the process and of losing personal and family history, economic value in farms, homes, gardens, memories and dreams associated with the displacement of households and communities, and of losing access to publicly owned wilderness is non-quantifiable and no amount of compensation can offset the personal, family and community impact of those losses. Also, an ongoing lack of understanding of how the system is operated, and lack of knowledge of how decisions are made have resulted in a feeling that regional interests are not adequately accommodated in on-going operations.[9]

Similarly, the river, floodplain, wetland and upland ecosystems that existed prior to the development of dams and reservoirs have been replaced by reservoir aquatic systems whose water levels fluctuate significantly over the course of a year. The economic, recreational and ecological value of those former systems is gone, and again compensation cannot replace them. The understanding of the ecological processes in these reservoirs is still evolving, as are the regional economic and ecological values of the new reservoir system. Ecological changes are evolving both naturally, and as a result of continuing mitigation and enhancement efforts. See Table 1 for a general summary of the areas impacted by the five major reservoirs. [10]

Table 1: Area of Pre-Dam Aquatic and Terrestrial Ecosystems inundated by the Treaty and Revelstoke Reservoirs (ha)

	Mica/ Kinbasket	**Revelstoke**	**Keenleyside/ Arrow**	**Libby/ Koocanusa (B.C.)**	**Duncan**	**Total**
Lakes	2,343.0	0	34,992.3	0	2,583.9	39,919.2
Rivers	4,896.6	2,654.4	2,021.9	1,490.1	424.5	11,487.5
Streams	192.1	53.4	50.6	10.3	17.7	324.1
Shallow ponds	555.1	26.9	102.9	210.6	172.3	1067.8
Gravel Bars	235.6	56.9	3,262.8	80.4	22	3,657.7
Wetlands	5,862.6	456	3,431.6	1,071.9	1,824.5	12,646.6
Floodplains, Riparian Forests	15,526.5	4,004.7	3,563.5	2,173.1	1,396.6	26,664.4
Upland Ecosystems	13,035.7	4,199.1	3,844.3	1,646.8	860	23,585.9
Total	**42,647.2**	**11,451.4**	**51,269.9**	**6,683.2**	**7,301.5**	**119,353.2**

[9] Personal communication, Kindy Gosal, Columbia Basin Trust
[10] http://fwcpcolumbia.ca/version2/reports/pdfs/FWCP-CB_Impacts_Summary.pdf

In this section, impacts, mitigation and benefits are presented in the context of each of the three Treaty dams and four Treaty reservoirs, and the Revelstoke Dam and Reservoir so that the local impacts can be better understood in the context within which they happened.

1. Mica Dam and Reservoir

a) Description

The Mica Dam, completed in 1973, is the largest of the Treaty projects, and at the time, the only one in Canada to generate power. The Dam is located about 135 kilometres by road north of Revelstoke. It is the tallest dam in the Province at 243 metres in height.

The underground powerhouse, designed for 6 generating units, is 54 metres (177 ft.) high, 24 metres (79 ft.) wide and 237 metres (778 ft.) long. The reservoir contains approximately 7 million acre feet of Treaty storage, 5 million area feet of non-Treaty storage and 8 million acre feet of dead storage.[11] In 1976, the first two electrical generators were commissioned and in 1977 two more were completed bringing the total capacity of the powerhouse to 1,736 MW.[12] Current capacity is 1,805 MW.

BC Hydro is currently installing two additional generating units of approximately 500 MW each into existing turbine bays at Mica Generating Station. The project will cost approximately $1 billion and is expected to create 800 person-years of direct employment over the next five years. To reliably deliver the additional electrical generation at Mica, this project will also require construction of a new series capacitor station near Seymour Arm, North Shuswap Lake, on the existing Mica to Nicola 500 kV transmission line. The target in-service date for Mica Unit 5 is October 2014, and the target in-service date for Mica Unit 6 is October 2015.[13]

The Mica Dam has a maximum reservoir depth in Kinbasket Reservoir (formerly McNaughton Lake, renamed in 1980) of approximately 170 metres. The maximum reservoir area is approximately 425 km^2, with a drawdown area of approximately 220 km^2. The water license maximum and minimum operating ranges are 2,475 feet and 2,320 feet (155 feet), however, in a typical year Kinbasket Reservoir levels fluctuate by about 80 feet, although larger annual fluctuations have occurred in the past and will occur under some circumstances in the future. As the upper reaches of the reservoir between Golden and Valemount are in the relatively flat Rocky Mountain Trench, the drawdown reduces the reservoir area by 50%.

b) Biophysical Impacts

The areas affected by the reservoir inundation at full pool reservoir are shown in Table 2.[14]

[11] Dead storage refers to water in a reservoir that cannot be drained by gravity through a dam's outlet works, spillway or power plant intake and can only be pumped out. Dead storage allows sediments to settle which improves water quality and also creates hydraulic head along with an area for fish during low levels.
[12] http://en.wikipedia.org/wiki/Mica_Dam
[13] http://www.bchydro.com/energy_in_bc/projects/mica_generating_station_upgrade.html
[14] http://fwcpcolumbia.ca/version2/reports/pdfs/FWCP-CB_Impacts_Summary.pdf

Table 2: Area of Pre-Dam Aquatic and Terrestrial **Ecosystems Inundated** ***by the Mica Dam Reservoir (ha)***	
Lakes	2,343
Rivers	4,897
Streams	192
Shallow ponds	555
Gravel Bars	236
Wetlands	5,863
Floodplains, Riparian Forests	15,526
Upland Ecosystems	13,036
Total	**42,647 ha**

The approximate upland, riparian and floodplain areas inundated by community area were estimated to be 11,491 ha for the Golden area and 17,125 ha for the Valemount area for a total of 28,616 ha.

A recent GIS analysis undertaken by Selkirk College identified one cultivated field of approximately 30 hectares in the inundated area.

The Town of Golden and Area Report (1994)[15] and the Valemount Community Report (1994)[16] reported the following impacts, including:

- Approximately 450 km of streams and some 110 km of tributaries capable of supporting fish were inundated, along with about 400 ha of permanent wetlands and 1,100 ha of seasonal wetlands and 385 ha of gravel deposits (subject to flooding);
- Diverse small lakes (Ptarmigan, Hot Springs, Yellow Jacket and another unnamed lake), fish bearing streams and spawning areas, as well as entire unique ecosystems were destroyed. Fish populations have been reduced;
- Approximately 28,500 ha of forest cover was lost as well as other areas of slides, rock outcrops and talus;
- Fish, wildlife, bird habitat related to all the above were inundated;
- Other natural resources such as hot springs in the Canoe Valley were lost;
- Higher insect infestations, a warmer climate with less snow and more rain, and winds have increased; and
- At low water (47 metres or 150 feet below full pool) there are “miles of silt mud flats” and winds that seem higher than prior to development create blowing dust as a result.[17]

At the time, impacts on birds and wildlife were estimated as shown in Table 3.[18]

Table 3: Estimated Wildlife Changes due to the Mica Reservoir			
Species	**Estimated Population**	**Anticipated Losses**	**Remnant Population**
Moose	2000	70%	600
Elk	300	40%	180

[15] Hambruch, Paul (1994)
[16] Townsend, Mayor Jeanette (1994)
[17] Townsend, Mayor Jeanette (1994)
[18] Hambruch, Paul (1994)

Deer	800	50%	400
Caribou	500	10%	450
Goat	1000	0	1000
Black Bear	3000	70%	900
Grizzly Bear	100	30%	70
Wolf	100	70%	30
Cougar	25	50%	12
Snowshoe Hare	?	50%	?
Coyote	?	70%	?
Lynx	?	40%	?
Bobcat	?	10%	?
Ruffed grouse	?	70%	?
Franklin grouse	?	30%	?
Blue grouse	?	10%	?
Ptarmigan	?	0%	?
Squirrel	?	20%	?
Marten	?	20%	?
Weasel	?	50%	?
Muskrat	4000	100%	Nil
Beaver	3000	90%	300
Mink	2000	80%	400
Fisher	1000	20%	800
Otter	300	80%	60
Wolverine	1000	10%	900
Osprey	14	90%	2
Bald Eagle	?	70%	?
Peregrine Falcon	?	100%	Nil

Based on subsequent consulting reports, it was not possible to confirm the claimed pre-dam species population as well as the anticipated loss of different species population. A recent study of dam footprint impacts noted that a lack of pre-dam information related to what species were present, and related population sizes made it impractical and imprecise to assess quantitative losses by species. However, that Fish and Wildlife Compensation Program consulting project studied those losses in qualitative terms by estimating habitat loss for 289 different species.[19] The Mica Reservoir had the highest Wildlife Impact Rating (WSIR) of all Treaty reservoirs with a mean rating of 2.96 on a scale of 0 (nil) to 5 (very high). Several species had ratings over 4, including moose, caribou, beaver, martin, mink, several bat species and many shore, water and upland songbird species. The Duncan and Arrow Dam Units also had relatively high species/habitat impacts, with mean WSIRs of 2.49 and 2.37 respectively.

[19] Janmaat , Dr. John M. and Islam, Shafiqul (2011)

c) Social and Economic Impacts

The social and economic impacts are drawn primarily from the Town of Golden and Area Report (1994)[20] the Valemount Community Report (1994),[21] and a more recent submission by the Mica 5 and 6 Core Committee (2008)[22] to BC Hydro. Many of the statements below are taken directly from these reports.

The context for much of the Kinbasket Reservoir area (Canoe Valley) pre-dam development as described in the Valemount Report was "unspoiled wilderness" with forests, wildlife and fish, which was the appeal of the area for residents of Valemount and Golden. The Valemount Report notes that both historically and today, residents of the Columbia River Valley live in closer connection to the land and environment than most British Columbians and Canadians who live in large urban centres, and that residents living nearby tend to think of the public lands as "ours" just as someone in the city would think of public open space near their property.

Prior to development, residents were told that the reservoir would be a "beautiful mountain resort lake," with a proposed 40 foot drawdown. Ultimately, with both Treaty and Non-Treaty storage, the reservoir has water levels fluctuating as much as 47 metres or 150 feet from high to low water, although it has reached "full pool" only a few times since the dam was constructed. The "mountain lake" is a reality only at high water.

A significant impact on the forest sector was reported. In 1968 the B.C. Forest Service Inventory Branch set the total area of Crown land to be flooded in the Kinbasket Public Sustained Yield Unit (PSYU) at 25,765 ha out of the total area of 132,080 ha with 11,491ha of productive forest land. Thus the forest land area in the PSYU was reduced by 8.7%. The total annual wood loss to the Kinbasket PSYU was estimated at 75,390m^3.[23]

i. Social Impacts

The following impacts are noted in the three reports noted above:

- A natural hot springs area approximately 15 miles from Valemount that had been improved for use by local residents, and cottages that had been established in the valley were inundated.
- Local residents used the Canoe Valley for fishing, and enjoyed the quiet serene grandeur of the Valley.
- The un-harvested forest has created debris in the reservoir and along the shoreline and make the area "unusable" for recreation.
- To people in the area, the social, environmental and economic impacts remain as a source of hurt, anger and mistrust.
- By not properly addressing the long-term, legitimate and durable past grievances, a new round of resentment is developing in the minds and hearts of Columbia Basin residents.

[20] Hambruch, Paul (1994)
[21] Townsend, Mayor Jeanette (1994)
[22] Mica 5 and 6 Core Committee (2008)
[23] Hambruch, Paul (1994)

ii. Economic Impacts

The following impacts are described in the reports noted above.

Forestry

There are some inconsistencies in the reported impacts on forestry.

- In 1994, 60% of the economy of Valemount was forestry related. The Valemount report noted the area of productive forest land lost was 17,125 ha.
- The Golden report noted:
  - 11,300 ha felled
  - 8,900 ha felled and burned
  - 8,095 ha standing forest
  - 28,325 ha total

- The Mica 5, 6 Committee states: Lower elevation forest stands – those that have the highest growth and productivity rates – have been lost in perpetuity. The 42,492 ha (105,000 acres) of productive forest land near Golden would have provided a consistent timber supply to local mills, which have struggled over the recent decades. Conservative estimates are that the economies of Golden and Revelstoke forego roughly $6-8 million per year (2008) due to lost forestry opportunities.
- In 1968 the B.C. Forest Service Inventory Branch set the total area of Crown land to be flooded in the Kinbasket Public Sustained Yield Unit (PSYU -forestry management) at 25,765 ha, with 11,491ha of productive forest land. The total annual wood loss to the Kinbasket PSYU was estimated at 75,390m^3. When the Big Bend highway was inundated in 1973, access to wood harvest from the north end of the reservoir area went to Revelstoke. The PSYU boundaries were subsequently changed with 11,728 ha and 33,000 m^3 of annual allowable cut (AAC) shifting from Kinbasket to Revelstoke. In a subsequent report in 1973, the BC Forest Service estimated the AAC loss in the Kinbasket PSYU at 42,302 m^3. [24]
- The Valemount report noted that only 20% of the 4,750,000 m^3 inventory was harvested pre inundation. The remaining area could have supported an ongoing annual allowable cut of 66,500 m^3. Provincial stumpage fee losses were estimated at $881,125 at that time.[25]
- BC Hydro estimated the pre inundation harvest as 2,800,000 m^3, and wood not harvested at 5,784,800 m^3 with 2.31 million m^3 of that from the Golden area.[26] The total volume of pre inundation wood in the reservoir was estimated at 8,585,000 m^3.[27]
- The Valemount report (60% Kinbasket PSYU) estimates resulting direct job losses in forestry to be 60, with an additional 90 induced jobs and approximately $4.5 million annually in wages. The Golden and Area report (40% of the PSYU) estimated annual job losses at 72 direct and 60

[24] Hambruch, Paul (1994)
[25] Townsend, Mayor Jeanette (1994)
[26] Janmaat , Dr. John M. and Islam, Shafiqul (2011)
[27] Hambruch, Paul (1994)

indirect and approximately $3.38 million annually in wages. If the entire area had been harvested prior to inundation, the equivalent of 3,420 temporary forestry jobs and 5,130 induced jobs would have resulted, with approximately $255 million in wages. The Golden and Area report notes that at $100 per m^3, the value of wood not harvested would have been $578,480,000, with $242 million of that proportioned to the Golden area.
Note: These would have been "one-time" gains.

- Private salvage operations were successful in removing salvageable timber, especially cedar, starting in 1976, but that practice was stopped by BC Hydro in the early 1980's.
- Forest harvest costs increased due to the need to continually adjust access points to water (log dumps) due to fluctuating water levels, de-watering sites and related haulage costs. High water does reduce costs of booming and water transport.
- Forestry pest management costs increased as a result of reduced road access.
- The reservoir resulted in the creation of a more complicated forestry road system on both sides. Access roads to timber areas had to be rebuilt at much higher cost in steeper terrain. That road system further reduces total remaining forest area and adds to operating costs. For example, Evans Forest Products spent $2.88 million to construct 45 km of road on the east side of Kinbasket Reservoir between 1985 and 1988. Although mainlines were replaced by either BC Hydro or through Forest Service funding, maintenance costs for the new 200 km system fell mainly to Evans Forest Products and were estimated to be $1.37 per m^3 for the Sullivan Bend mainline and $2.40 per m^3 for the West Columbia mainline. In addition forest activities had to move to steeper terrain, which also added costs.
- Approximately $2.9 million was spent by forest companies on new access roads and infrastructure to utilize the reservoir for water transport of logs, exclusive of grants. The additional costs of strapping, dumping, towing, dewatering and reloading were estimated to be $7.00 per m^3 (1989).
- Evans Forest Products estimated that in 1989-1990, 80,000 m^3 in cutting proposals were deferred to accommodate habitat requirements. Habitat protection requirements on remaining forest lands appear to have increased as a result of loss of habitat in the inundated area.
- The need to access areas by water rather than road increased pre-harvest development and tree planting costs to Evans Forest Products by $2.00 per m^3
- Loss of the Big Bend Highway translated into the loss of $6.4 million in infrastructure loss to the Town of Golden, and increased the road-building burden for local forestry operators at a cost of $2.40 / cubic meter of timber harvested.
  Note: The current AAC in the Golden TSA is 485,000 m^3. The forestry services and logging labour force was estimated to be an average of 153 for the 2005 to 2007 period. The average harvest for that period was 85% of AAC. Average harvest employee annual income was estimated at $53,827 for that period. Average actual cut between 1998 and 2007 was 74.6% of AAC. The indirect and induced employment multiplier was 1.27. [28] The current allowable annual cut (AAC) for the Robson Valley TSA is 536,000 cubic metres per year. For the 1995 to 1999 period, the average annual cut was 458,174 m^3 on an AAC of 602,377 m^3. Harvest employment for the 1996

[28] http://www.for.gov.bc.ca/hts/tsa/tsa07/2008_tsr/Golden_TSR4_Analysis_Report_Feb20_09.pdf

to 1998 period was 125 per year. The average annual employee income in the forestry sector was estimated at $46,390 for that period. The indirect and induced employment multiplier for that period was 1.39.[29]

Tourism and Recreation

- The Canoe River forest road was not replaced and road access to Valemount changed significantly. The road distance to Revelstoke and Golden increased from 282 km, to 805 km and 443 miles respectively. The opportunity for a north-south route from Valemount down to the Revelstoke and Golden areas along the Canoe Valley has been lost forever.
  Note: The current southern Yellowhead route to Revelstoke is approximately 480 km (300 miles).
- Recreation and tourism opportunities in the Canoe River Valley and Hamber Provincial Park have been lost.
- Future tourism development opportunities at Canoe Hot Springs were lost.
- Recreational and commercial canoeing, kayaking and hunting were adversely affected. Loss of wildlife resulted in hunting and recreation impacts, tourism impacts, and lost opportunity costs. The estimated potential of recreational hunting was 38,610 man-days and the "non-consumptive" use of the resource was estimated to be about equal.
- The consumptive value of wildlife losses were estimated at $437,000 annually (1973) for the Mica basin.
- Waterfowl losses in the Mica basin resulted in an estimated loss of 38,000 hunting days, with an annual value of $175,000 and non-consumptive losses of $80,000 per year (1973)
- Recreational fishing losses were estimated to be 5,000 person days annually, valued at $5.00 per day (1973) or $25,000. The amount inflated to 1994 values was estimated to be $91,000 annually.
- Total annualized losses to Golden and Area were estimated to be $5,525,000, not inclusive of timber lost during flooding, poorly utilized timber during flooding, losses due to the expanded road network, emotional impacts, trapping losses, potential tourism losses, loss of biodiversity, and loss of connectivity between National Parks.
- A more recent study for Golden and Area Initiatives updated the 1994 loss estimates using a 5% inflation factor to a 2009 estimate of $91,550,590.[30] That study also identified several major constraints on the recreational use and potential of the Kinbasket Reservoir including:
  - Significant fluctuations in water levels,
  - Extensive debris throughout much of the Reservoir – in the water and along the shores,
  - Considerable industrial waste (old tugboats, abandoned buildings, abandoned tanker trucks and other waste) at some locations like Bush Harbour,
  - Road access to shoreline areas is inadequate for recreational use,
  - Insufficient year-round maintenance of existing roads,

[29] http://www.for.gov.bc.ca/hts/tsa/tsa17/tsr2/analysis.pdf
[30] Economic Growth Solutions (2009)

- High winds on Kinbasket Reservoir reduces the potential for recreational boating and sport fishing activity,
- Limited development of trails, compounded by the access problem,
- Lack of suitable infrastructure to facilitate water-based recreational activities (e.g. boat ramps, docks).

Other Impacts

- There was "lots" of arable land in the valley from Valemount to beyond David Henry Creek. **Note:** the Golden and Area Report notes that there was no commercial farming in the valley.
- Due to low water in 1993, Mica generating station was shut down, with resulting loss of revenue to BC Hydro.
- Although BC Hydro invested in infrastructure and other improvements in other communities (Castlegar, Revelstoke, Mica Creek), there was no investment in Valemount.
- The addition of Non-Treaty Storage was a significant factor in exacerbating water level elevation and management impacts. There is also a perception that non treaty uses in the U.S., such as irrigation, impact Kinbasket Lake water levels detrimentally.
- The former development potential in Valemount related to tourism and forestry was lost and the community could not afford to replace it. The community had few professional resources to help plan for economic or community development.
- A recent Socio-Economic Study for Valemount identified the Kinbasket Reservoir and its cyclical flooding, and disturbed riparian areas as weaknesses in terms of development opportunities.[31]
- Easy and safe access to areas with tourism potential was lost with the inundation of the Big Bend highway.
- Loss of the Big Bend Highway translated into the loss of $6.4 M in infrastructure value to the Town of Golden.[32]

iii. Hamber Provincial Park

The Golden and Area Report (1994) and the Mica Unit 5 and 6 Core Committee submission both describe the reduction in area of Hamber Provincial Park and an impact. The following is a brief history of Hamber Provincial Park.

The former area of Hamber Provincial Park included the Kinbasket Reservoir. Hamber Provincial Park was established in 1941 as a Class A Provincial Park (protected area). The original area of the park was 1,009,112 hectares.[33] Within four years, as a result of pressure by the resources industries, the Class A designation was changed to Class B to permit some logging and mining, and the park area was reduced to an area of approximately 303,000 ha.[34,35] (**Note:** The Golden and Area community report refers to the Park area as 203,000 ha).

[31] Brent Harley and Associates (2004)
[32] Mica 5 and 6 Core Committee (2008)
[33] http://en.wikipedia.org/wiki/Hamber_Provincial_Park
[34] Janmaat , Dr. John M. and Islam, Shafiqul (2011)
[35] Anderson, James D. (2011)

The reservoir inundation would have affected both the park area and reduced vehicle access to the park, and therefore significantly reduced its tourism potential as a rationale for retention. In addition, there were still regional pressures to make the area accessible to logging. Those two factors led to a redrawing of the boundaries in 1961/1962 to the current area of 25,137 hectares. The former park area on the south side of the current park is now part of the Golden Timber Supply Area, and of the Robson Timber Supply Area to the north. With its connection to the National Parks to the east, the remaining area of Hamber Provincial Park currently comprises a portion of one of the world's largest blocks of protected areas. The park was designated as part of the Canadian Rocky Mountains World Heritage Site by UNESCO in 1990.

d) Property Acquisition and Compensation

BC Hydro acquired approximately 25 privately owned properties, primarily near Valemount, Beavermouth and Boat Encampment. Four property owners were displaced.[36] Private land was purchased at "market values" with no consideration of the "value to the owner", or "sentimental values."[37] Assistance was provided for home relocation. In 1981, when it was discovered that some of the land that had been acquired was not in the inundation area, it was offered back to the owners, at over 3 times the purchase price, and with restrictions on its use and management. [38]

Most of the property affected by the inundation was Crown lands. Approximately 15 trap lines, about a dozen mineral claims and numerous timber sales were affected.[39]

e) Construction Related Benefits

The Mica Dam and powerhouse development had a construction cost of approximately $780 million[40]. Overall the dam construction project created approximately 8,750 person-years of employment on the dam[41], and approximately 4,200 person-years of employment on the powerhouse[42]. The main benefit to Valemount and Golden was related to the clearing of the inundation area.

f) Development Mitigation[43]

- A construction work camp that housed approximately 4,000 people was constructed at Mica Creek. It included a 2 bed hospital, a public swimming pool and a public trailer court. A second 1,200 single man construction camp was built at Potlatch Creek.

[36] BC Hydro and Power Authority (circa 1974) Columbia Construction Progress: Mica Project
[37] Townsend, Mayor Jeanette (1994)
[38] Townsend, Mayor Jeanette (1994)
[39] BC Hydro and Power Authority (circa 1974) Columbia Construction Progress: Mica Project
[40] BC Hydro Corporate Affairs (1988)
[41] BC Hydro and Power Authority (circa 1974) Columbia Construction Progress: Mica Project
[42] BC Hydro and Power Authority, Construction Progress Reports-Mica (1973-75)
[43] BC Hydro and Power Authority (circa 1974) Columbia Construction Progress: Mica Project

- Reservoir cleanup was undertaken by BC Hydro. Shoreline debris, floating debris and "mats of dead wood" were initially an issue. The 1994 Valemount Community Report noted that although initially poor, cleanup had "considerably improved over the last 5 years." BC Hydro continues to remove floating woody debris from Kinbasket Reservoir and regularly meets with Debris Management Committees in Golden and Valemount. Since 2007, BC Hydro has funded over $3 million of debris removal work on Kinbasket Reservoir.[44]
- A marina facility was developed on the Reservoir approximately 15 km from Valemount. It offers a limited service marina as well as campsites. Every year in September, the marina hosts the annual Valemount Fishing Derby.[45] BC Hydro completed planned improvements to Valemount marina in 2011 and installed the floating walkway at the new boat ramp built at Bush Harbour in 2010.
- The Golden and Area report notes that over $1 million was spent during 1992-93 on wildlife projects in the Mica Compensation Area on research, planning and enhancement, but that enhancement opportunities are limited by the nature of the reservoir.
- Sullivan Bend mainline and the West Columbia mainline were reconstructed.
- Approximately 12.3km (7.7 miles) of CPR rail line was relocated
- Big Bend Highway between Revelstoke and Mica Creek was reconstructed and paved.
- Boat ramp constructed and extended at Sprague Bay.[46]

g) Ongoing Impacts and Operational Concerns

- Tightening environmental restrictions over time (e.g. for Mountain Caribou habitat) are compounding the impacts of the diminished forest harvest land base due to the area lost permanently to flooding.[47]
- Forestry operations have been forced into higher elevation, steeper sloped areas where tree productivity is lower, operating costs higher and the risks of environmental impacts greater. Costs of accessing timber have increased substantially and the continuity of timber supply has been lost due to the challenges of barging across Kinbasket Reservoir.
- Suitable access to both the east and west side of the Columbia Reach from the south has been reduced to under-maintained industrial grade logging roads that suffer the inherent risks associated with private industry funding.
- Creation of the reservoirs resulted in a significant loss of wilderness, which has significant existence value to all British Columbians. Specifically, there was a significant loss of riparian zones, wetlands and small lakes. These areas are especially important as winter habitat for mammals and as nesting and foraging grounds for resident and migratory birds. While the Fish and Wildlife Compensation Program and Water Use Plan Programs are beginning to monitor and design projects for some specific locations, there remain vast areas (especially on Kinbasket

[44] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q2/2012-04_gds12-80_columbia.Par.0001.File.2012-04-GDS12-80-Columbia-River-WUP-Update.pdf
[45] http://www.valemount.ca/Documents/ValemountProfile2010.pdf
[46] Bruce, D.R. (2004)
[47] Mica 5 and 6 Core Committee (2008)

Reservoir) where there has been no significant wildlife or aquatic remediation efforts. Further, these programs are based on arbitrary budget limits that do not reflect the scale and scope of environmental impact that the reservoirs created.[48]

- The pelagic ecology (water) of the reservoir is not well understood, and is currently being investigated as part of Water Use Planning.[49]

2. Revelstoke Dam and Reservoir

a) Description[50]

The Revelstoke Dam and Generating Station are located about 130 km downstream from Mica Dam and 8 km north of the City of Revelstoke. This complex was completed in 1985, and with the recent addition of a fifth generating unit has an installed generation capacity of 2,480 MW.

The hydroelectric complex is comprised of a 175-metre high concrete gravity dam in Little Dalles Canyon, a 122-metre high earth fill dam on the west bank of the river, and a powerhouse in the riverbed, immediately downstream of the concrete dam.

The concrete powerhouse is 213 metres long, 50 metres wide and 60 metres high. The powerhouse has four generating units, in service since 1984. Each unit has a capacity of 460.75 MW. A fifth unit (Unit 5) was added in 2011[51]. There is a provision for an additional unit (Unit 6) scheduled to be installed in 2018. Individually the units have the largest capacity of any in BC Hydro's system. The current Revelstoke Dam and Generating Station represents about 21 per cent of BC Hydro's installed generating capacity.

The Revelstoke Reservoir created by the Dam extends 130 kilometres upstream to the tail waters of the Mica Dam. It has a surface area of 11,534 hectares and a maximum depth of approximately 120 metres. Since regulated release water from Mica provides almost three-quarters of the inflow into the reservoir, the Revelstoke power plant operates as a run-of-the-river plant, with normal operations within the top 1.52 m (5 ft.) of the reservoir, or about 2% of the reservoir volume.

b) Biophysical Impacts

Revelstoke Dam and Reservoir flooded approximately 7,846.9 ha (19,390 acres) of land including 329 ha (812 acres) of highway and 2,675 ha (6,611 acres) of river. The inundated lands include 7,018 ha (17,341 acres) of forest land and 829 ha (2,049 acres) of old burn and brush. [52, 53]

[48] Mica 5 and 6 Core Committee (2008)
[49] BC Hydro (2010)
[50] http://www.bchydro.com/community/recreation_areas/revelstoke_dam_visitor_centre.html
[51] http://www.bchydro.com/etc/medialib/internet/documents/projects/revelstoke/Revelstoke_ProjBackgrounder_2011-Fall.Par.0001.File.Revelstoke-ProjBackgrounder-2011-Fall.pdf
[52] Janmaat , Dr. John M. and Islam, Shafiqul (2011) Review of Biophysical Impact of Columbia River Treaty Dams
[53] http://fwcpcolumbia.ca/version2/reports/pdfs/FWCP-CB_Impacts_Summary.pdf

Table 4: Area of Pre-Dam Aquatic and Terrestrial Ecosystems Inundated by the Revelstoke Dam Reservoir (ha)	
Lakes	0
Rivers	2,654
Streams	53
Shallow ponds	27
Gravel Bars	57
Wetlands	456
Floodplains and Riparian Areas	4,005
Upland Ecosystems	4,199
Total	**11,451**

The flooding of the reservoir largely eliminated the existing river and tributary fishery and removed key habitat areas, thus reducing the game population in the area. According to Revelstoke Economic Development Commission (1994):

- The Dam blocked migratory fish from their traditional spawning habitat in the upper Columbia River system and construction also caused a considerable loss in numbers of Dolly Varden, Rainbow Trout and Kokanee in the Upper Arrow.
- Approximately 20% of the Rainbow Trout netted below the Revelstoke Dam displayed Arrow Lakes "trophy fish" characteristics. Most (66%) of the available Upper Arrow Dolly Varden spawning habitat is above the Revelstoke Dam as well as 30% to 50% of the Kokanee spawning habitat.
- The number of spawning streams decreased from 24 to 14 with a net loss of 21 km (13.1 miles) of more suitable sections of spawning stream, particularly in the low gradient creek mouths.
- The flooding largely eliminated the existing river and tributary fishery and key upland habitat areas reducing the number of game.
- The reservoir is a hazard to moose, deer and caribou attempting to cross the valley.

c) Social and Economic Impacts

The Revelstoke and Area Impacts Report (1994)[54] notes that the greatest social and economic impacts (taxation, boom and bust cycles) for the City and area resulted from the flooding of the Arrow Lakes Reservoir, while the environmental impacts are more generally related to blocking the waterway, including both Mica and Revelstoke Dams, with the most significant impacts for the community coming from the Hugh Keeneleyside and Revelstoke Dams and Reservoirs. The report does note benefts including short term construction, and the recreational opportunities offered by Revelstoke Reservoir. The following impact detail is taken from that report.

[54] Revelstoke Economic Development Commission (1994)

i. Social Impacts

- The construction "boom" came with typical problems such as alcohol abuse, increases in petty and major crime, and family breakup, leaving many single mothers.
- Those on fixed and low income suffered a loss of purchasing power.
- Many young people left school to make money in construction and were left with poor education, skills and employability after the Dams were completed.
- Many (55%) of local people who wanted to work on the construction projects were unable to find jobs.
- The local community was alienated from the construction labour force.

ii. Economic Impacts

- Utzig and Schmidt (2011) estimated lost forest (dry forest, intermediate forest, wet forest and very wet forests) was 8,080 ha. The area of the reservoir that was logged included 3,350 ha (8,288 acres) of mature, merchantable timber and 217 ha (537 acres) of immature merchantable timber. Approximately 55% of the timber was saw logs and the remainder was pulp logs. Total volume was 1,670 880 m^3. [55]
- The permanent reduction in the AAC was approximately 20,390 m^3. The remaining areas are more difficult for silviculture management due to steeper terrain and poorer soils. The long term economic productivity loss goes beyond the allowable cut impacts. The reduction in the AAC would have provided 22.8 person-years on direct employment and 19.5 person-years of indirect employment, with a gross payroll of $1,550,000 annually.
- The road development to Mica Creek removed another 325 ha (800 acres).
- Revelstoke lumber mills suffered a significant decrease in timber supply.
- Access to tenures on the west side of the Reservoir requires ferry transport, which adds to operating costs.
- The reservoir has steep rocky shorelines with little tourism development potential.
- During the construction period, municipal infrastructure such as roads and landfill were significantly depreciated due to additional use.
- The construction period caused inflation of housing prices, business failures due to lack of anticipated business and population increases, property speculation, and increased costs for municipal services. The end of construction coincided with the mid 1980's downturn in the economy, and Revelstoke was left with closed businesses, abandoned mobile home parks and empty houses.

  Note: The current AAC in the Revelstoke TSA is 225,000 m^3. The actual harvest average from 1999 to 2009 was 93.6% of AAC. The average direct employment in harvesting between 2006 and 2008 was estimated at 71. Average harvest employment income for that same period was $53,037. The indirect and induced employment multiplier is 1.27.[56]

[55] Revelstoke Economic Development Commission (1994)
[56] http://www.for.gov.bc.ca/hts/tsa/tsa27/2009/Revelstoke_TSR4_Analysis_Report_23_Feb_10.pdf

d) Property Acquisition and Compensation

Private property acquired included 41 parcels (approximately 1,900 ha) owned by 2 forestry companies, one Mobile home Park (undefined area) and 29 other parcels (approximately 700 ha) owned by 22 owners, including a gas station at Downie[57].

e) Development Mitigation

- Some of the reservoir area was logged prior to inundation. The area logged totaled 3,571 ha (8,825 acres) containing 3,354 ha (8,288 acres) of merchantable mature timber and 217 ha (537 acres) of merchantable immature timber. Approximately 55% of the timber was saw logs and the remainder was pulp logs. This represents 1,670,880 m^3. [58]
- The Hill Creek spawning channel and hatchery were built as compensation for fisheries spawning habitat impacts.[59] **Note:** The hatchery facility was removed approximately 6 years ago.
- Through the course of construction BCH spent $46.65 million on mitigation and compensation.[60] Approximately $8 million went to Revelstoke and was spent on physical and community services including 200 mobile home spaces, $3.31 million in infrastructure improvements, $132,000 in a new fire truck and $1.574 million in a new recreational facility in Revelstoke.[61] The remainder was primarily spent on 'environmental matters' including reservoir clearing.
- Development of a log transfer facility ($2 million).
- BCH committed $1 million to a Park Development Fund that was expended by BC Parks for works at Martha Creek, Downie Creek and Columbia View. (1976)[62]
- When Unit 5 was added, BC Hydro contributed $30,000 to Okanagan College for training development, $150,000 for Westside Road Repairs and $250,000 to the Revelstoke Community Housing Society.

f) Construction Related Benefits

The total construction value of the Revelstoke Dam and Powerhouse was $1,921 million (1976-1984). The construction project created approximately 11,055 person-years of employment.[63]

g) Ongoing Impacts and Operational Concerns

- Maintaining minimum downstream flows for both fisheries and recreational benefits.[64]

[57] BC Hydro: File #202-1506.0(2). Part 1: Revelstoke Dam Project. Line List 178.
[58] Janmaat , Dr. John M. and S. Islam (2011) Review of Biophysical Impact of Columbia River Treaty Dams
[59] Revelstoke Economic Development Commission (1994)
[60] DPA Group Inc (1986)
[61] Missler, H.E. (1988)
[62] BC Hydro (2005)
[63] DPA Group Inc. (1986)

- Developing a better understanding of the impact of flow on the fisheries and habitat in the middle Columbia River.[65]
- Ongoing navigational hazards due to stumps and debris.[66]

3. Hugh Keenleyside Dam and Reservoir (Arrow Lakes)

a) Description

The Hugh Keenleyside Dam is located on the Columbia River just upstream from the City of Castlegar. At high water levels, the associated Arrow Lakes Reservoir reaches 250km upstream beyond the City of Revelstoke to just below the Revelstoke Dam. The Dam is 52 metres high and the resulting reservoir contains 8.76 km³ (7.1MAF) of Treaty storage and 0.31 km³ (.25 MAF) of non-Treaty storage. The water license maximum and minimum operating ranges are 1,444 feet and 1,378 feet (66 feet), however, in a typical year, Arrow Reservoir levels fluctuate by about 40 feet, although larger annual fluctuations have occurred in the past and will occur under some circumstances in the future.

Between 1998 and 2001, the Columbia Power Corporation in partnership with the Columbia Basin Trust built the 185 megawatt (2 units) Arrow Lakes Generating Station adjacent to the existing Hugh Keenleyside Dam, and entered into a Electricity Purchase Agreement with BC Hydro

The Arrow Lakes Reservoir resulted in significant social and economic impacts in addition to the biophysical impacts. Approximately half of the inundated area was the former Arrow Lakes, which did have fluctuating seasonal water levels, and significant flooding in major flood events such as 1948. The social and economic impacts resulted from the fact that a significant portion of the area to be flooded was privately owned. Over 2,000 people, 615 households and over a dozen small communities were displaced from the reservoir area, along with their houses, barns, farms and orchards, community facilities and infrastructure. The Arrow Lakes area was historically a traditional use area for regional First Nations, so archeological sites were also affected.[67, 68]

b) Biophysical Impacts

Over 50,000 hectares of land and water area were inundated by the Arrow Lakes Reservoir. Estimates of the area inundated do vary between reports, so the various subsequent estimates of types of uses inundated also vary. Following (Table 5) is a general summary of the types are areas and ecosystems inundated based on several recent reports.[69]

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[64] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2010q3/web_clbmon-15_tor.Par.0001.File.CLBMON_15_TOR_Addendum_2_12May2010.pdf
[65] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2010q3/web_clbmon-15_tor.Par.0001.File.CLBMON_15_TOR_Addendum_2_12May2010.pdf
[66] Mica 5 and 6 Core Committee (2008)
[67] Wilson, J.W. (1973)
[68] BC Hydro and Power Authority (1969)
[69] http://fwcpcolumbia.ca/version2/reports/pdfs/FWCP-CB_Impacts_Summary.pdf

Table 5: Area of Pre-Dam Aquatic and Terrestrial Ecosystems Inundated by the Arrow Lakes Reservoir (ha)	
Lakes	34,992
Rivers	2,022
Streams	51
Shallow ponds	103
Gravel Bars	3,263
Wetlands	3,432
Floodplains	3,563
Upland Ecosystems	3,844
Total	**51,270**

Recent estimates of types of uses on these lands include forest area lost in Arrow Lake (Utzig and Schmidt 2011). Specific uses are further described as shown in Table 6.[70]

Table 6: Use Types on the Inundated Terrestrial Area, Arrow Lakes Reservoir	
Forest Type (ha)	**Area (ha)**
Dry Forest	716
Intermediate Forest	1,888
Wet Forest	3,387
Very wet forest	1,951
Total Forest	7,942
Other Uses	
Agriculture	2,212
Gravel Bar	3,263
Rock/talus	64
Shallow water	103
Urban	194
Wetland	479
Cottonwood Forest	1,709
Total Other	8,024
Total Terrestrial Lost Area	**14,258**

Note: Cottonwood Forest appears to be double counted, both in forestry and as an "other use".

A recent GIS analysis undertaken by Selkirk College identified 2,153 ha of cultivated fields and 50 (ha) of cultivated orchards in the inundated area.

The Arrow Lakes Report (1994)[71] and the Revelstoke and Area Report (1994)[72] report the following impacts:

- Loss of fish habitat and spawning areas, and in some areas, significant erosion and turbidity.

[70] Janmaat , Dr. John M. and S. Islam (2011)
[71] MacPherson, Barbara (1994)
[72] Revelstoke Economic Development Commission (1994)

Approximately 20 to 30% of shoreline fish spawning habitat was lost. There is no or little productive littoral zone.

- Pre-flooding bird and wildlife populations are "much reduced."
- Lost wildlife habitat including overwintering for ungulates, wetlands for waterfowl and aquatic fur bearing animals, and forest areas for a variety of small game and other species.
- There is significant shoreline erosion (6 to 8 feet per year) between Arrow Park and Fauquier.
- There is an increase in winter fog.
- There are recurring dust storms at low water levels during high winds.
- Debris in the Reservoir is both unsightly and a navigation hazard. Lack of stump removal results in both navigational hazards and detracts from the beauty of the area.
- 21 shallow wells (domestic use) in the airport bench area south of Revelstoke have reported being contaminated or tainted.
- High water levels (above 1,440 feet) result in flooding at some homes near Big Eddy and the Airport and at Downie Sawmill, along with some septic tank failure. There is also bank erosion at the golf course.

c) Social and Economic Impacts

The communities and rural holdings in the Arrow Lakes valley were originally established on the basis of mining, forestry and agricultural activities. There were many small communities that developed along its shores accessed only by the "Minto" a stern wheel steamboat, owned by the Canadian Pacific Northwest that ran on the Arrow Lakes from 1898 to 1954.[73] Due to the need for investment in both docks and the vessel, and the fact that the ferry service was losing money, the Minto ferry service was withdrawn in 1954.

Although there were still viable farming activities at Renata, Burton, Nakusp and Revelstoke, by the 1960's, many of the residents had given up full time farming and were "working out" in the forestry sector primarily, and land was used for self-reliance or had been left to revert to a natural state. The region was not strong in economic terms, but had a stable population based on that faming/work lifestyle and older residents who were no longer working.[74] The impacts of the Arrow Lakes Reservoir are documented in "People in the Way" by J.W. Wilson (1973). The following summary is drawn largely on that book and on the Arrow Lakes and Revelstoke impacts reports and the more recent Mica 5 and 6 Core Committee letter to Mr. Bob Elton, B.C. Hydro (2008)[75]

i. Social Impacts

Social impacts started even before the Treaty was signed. Rumours of a Treaty led to uncertainty that had both social and economic impacts, especially on property values. The Treaty was then signed with

[73] http://en.wikipedia.org/wiki/Minto_(sternwheeler)
[74] Wilson, J.W. (1973)
[75] Mica 5 and 6 Core Committee (2008)

no meaningful consultation with Basin residents, which established a local distrust of both the Province and BC Hydro.

Because of the lack of previous consultation, residents attempted to express their concerns about the Treaty at hearings undertaken by A.F. Paget, the Comptroller of Water Rights, concerning water licensing, but were informed that arguments concerning the justification of the Arrow Lakes Project were not admissible. Further, the Comptroller could not answer their questions concerning their "personal or communal interests."[76] This deepened suspicion and distrust.

During the initial post Treaty community consultations, BC Hydro and the Province made several commitments to the residents of the area. These included: [77]

- A bridge between Fauquier and Needles,
- A new road connecting Fauquier and Castlegar,
- Lakeshore Parks (Syringa, Renata, Deer Park and Demars),
- A "ring of waterfront land" for resettlement,
- A "large volume" of increased tourism traffic.

When the Arrow Lakes Community Report was written in 1994, (and to date) neither the new road nor bridge had been built and only the resettlement communities of Burton, Fauquier and Edgewood had been established. The Community report stated that only one Park, McDonald Creek had been established. These promises were seen as regional opportunities at the time, and the failure to deliver them was a significant disappointment. **Note:** Syringa, Blanket Creek and Shelter Bay parks were also established by 1994.

The social impacts resulting from displacing over 600 households and over 2,000 people, with their associated farms and outbuildings, communities, infrastructure and a rural way of life is difficult if not impossible to capture in any description. Some of the key impacts that are noted include:

- Approximately half of the households left the region
- The inundation resulted in the loss of all or significant portions of the communities of[78]:

Sidmouth	Glendevon	Bellvue
Arrowhead	Bird's Landing	Burton
Beaton	Arrow Park	Needles
Galena Bay	East Arrow Park	Fauquier
Halcyon Hot Springs Resort	Makinson Landing	Edgewood
St. Leon Hot Springs Resort	Graham Landing	Sherwood
Demars	Carrol's Landing	Renata
Deer Park	Broadwater	

[76] Wilson, J.W. (1973), pg. 19
[77] Wilson, J.W. (1973), pg. 60
[78] MacPherson, Barbara (1994) pg.25

- Of those communities, Burton, Fauquier, and Edgewood were relocated, but at a substantially smaller scale. The Arrow Lakes community report estimated that from the original settlements of Burton and Fauquier, 1/3 relocated to Nakusp, 1/3 relocated out of the Valley, and 1/3 moved to the new Burton, Fauquier settlements.
- Approximately half of the population lived from Arrowhead north, in Columbia Shuswap RD, That portion of the reservoir was approximately 7,000 ha (17,290 acres) in area. It included the lost communities of Arrowhead, Sidmouth and Mt. Cartier.[79]
- The stress and emotional cost of going through the land sale negotiations, uncertainty, watching properties being burned or bulldozed after sales, and the stress of moving resulted in some cases in poor health, and stresses in relationships. There are several reports of people dying not long after moving.[80]
- Of the 8 cemeteries affected, 2 were relocated, 1 was abandoned due to lack of access, and 5 were protected with a concrete or rock blanket.[81]
- Landowners were given attention through land acquisition, relocation and development of new communities, but renters received little attention or support.
- Some of the acquired properties were later resold in the 1980's.[82]
- There was never any significant follow up with residents who relocated out of the area so the extent of those impacts is unclear. The Community Report for example notes that, "While there were many who gave up their homes without a murmur, and were happy with their offer, the majority suffered."[83]

ii. Economic Impacts

The Loss of Farms and Farmland[84]

- There were approximately 260 farmsteads in the valley. The scale of those affected by inundation was estimated at the time as shown in Table 7.

Table 7: The Distribution of Affected Farms According to the Acreage of Land Below 1,460 A.S.L Elevation

Farm size (acres)	Number of Farmsteads
1 - 30	215
31 - 60	34
61 - 100	10
101 - 165	1

- The agricultural use of land was also estimated at the time as shown in Table 8. Most of the improved cropland was used for hay and pasture, with approximately 1,000 acres (405 ha) of

[79] Revelstoke Economic Development Commission (1994)
[80] MacPherson, Barbara (1994) pg. 22, 23
[81] BC Hydro and Power Authority (1969)
[82] MacPherson, Barbara (1994) pg. 3
[83] MacPherson, Barbara (1994) pg. 7
[84] Economics Division, Department of Agriculture, Ottawa (1962)

cereal grains. A preconstruction assessment estimated the "cleared" area was 6,363 acres (2,575 ha).[85]

Table 8: The Acreage of Agricultural Land Below 1460 A.S.L. Elevation	
Orchard	200
Idle Orchard	43
Other Cropland	4,850
Idle Cropland	390
Aquatic Hay and Pasture	372
Isolated Lands	38
Total	5,893 acres (2,385 ha)

- The area of land that had potential for agriculture was also estimated that the time. That total area was 5,212 hectares (12,880 acres). Of that area, 4,280 ha. (10,573 acres) was "heavily wooded" **Note:** It is unclear if those latter lands were included in the totals for forestry land that was lost.
- The level of agricultural economic activity associated with these farmsteads is not clear. The District Agriculturalist reported in 1961 that 44 of these farmsteads sold produce off farm. The products that were produced and sold elsewhere included cream and eggs from the vicinity of Nakusp, beef cattle from Edgewood, and fruit from Renata.[86] There was also a dairy farm in Revelstoke.
- The Arrow Lakes Community Report (1994) notes that the loss of agriculture turned Nakusp into "a one industry town."
- There were approximately 1,820 ha (4,500 acres) of cleared land and a total of 9,510 ha of potentially arable land. BC Hydro acquired land to 1460 Above Sea Level (A.S.L.) even though the reservoir level was 1,440 A.S.L.
- Most of the remaining flat land in Revelstoke was inundated.

Loss of Forestry Lands

- The Arrow lakes Community Report quotes a 1983 report from the B.C. Association of Professional Foresters, which claimed that 27,251 hectares of flooded land was either in forestry or suitable for forestry. (**Note:** that estimate includes all the land area that was flooded, including the agricultural lands.)
- 11,053 hectares (27,312 acres) were cleared from the reservoir area.
- A preconstruction assessment estimated forestry area as 6,626 ha (16,372 acres) with 1,231 ha (3,403 acres) as mature forest.[87]
- The deletions from TFL 23 totalled approximately 962 ha (2,380 acres).[88] There is no estimate of loss of annual allowable cut.

[85] Forward, P.C., Bogyo, J.M. (circa 1961)
[86] Forward, P.C., Bogyo, J.M. (circa 1961)
[87] Forward, P.C., Bogyo, J.M. (circa 1961)
[88] Amendments 57, 6272, 82,84(1), 84(2), Lots 503, 504

- The Arrow Lakes Community report estimated potential losses of 210 direct forestry jobs and 420 indirect jobs, with employment income potential of $22.9 million annually.(1991) (**Note:** These loss estimates are based on the 1983 report from the B.C. Association of Professional Foresters noted above)
- In 1960, there were 672 people working a total of 6,226 "man months" (552 "man years") were employed in the forestry from Castlegar and Revelstoke.[89]
- Lock disruptions, the necessity to break up log booms at the narrows during low water levels, and the need to "adjust" log dump elevation levels all added costs to the forestry sector.
- Two sawmills at Arrowhead were bought out, and a portable mill was relocated to Revelstoke (Kozek Bros). The Bell pole yard was relocated and Arrowhead Preservers pole yard was closed. Three Revelstoke mills were closed, one relocated (Three Mile) but it closed soon after. Timber supply was a factor in the mills closing.

Note: Tree Farm licence (TFL) 23, held by Interfor, is located along Arrow Lake south of Glacier National Park, and extends from Valhalla Provincial Park in the east to Monashee Provincial Park in the west. TFL 23 consists of several separate areas which are accessed by provincial highways that run from Revelstoke to Castlegar and Vernon to Nakusp. Castlegar, Nakusp and Revelstoke are the main communities associated with the TFL. The total land base for TFL 23 is 554,977 hectares. Of this area, 4,710 hectares are private land owned by Interfor. The TFL has a productive forest land base of 37,300 hectares and a net operable land base of 21,288 hectares (i.e. 56.9 per cent of the productive forest or 38.1 per cent of the total TFL area). The AAC for the 2nd and 3rd management period 1961 to 1969 was 849,504 m3. The AAC increased to 1,053,385 in 1970.[90]

Other Impacts

- Loss of forested area in the valley and Lakes had a related loss of revenue from hunting and tourism.
- Using the reservoir for boating/canoeing is "monotonous" at low water levels.
- The marina had to expand its wharf to accommodate varying lake levels. The houseboat rental business was not doing well.
- The sport fishing business in the area claimed losses of $50,000 per year.
- There was a lack of wharves, campsites and accommodation to support tourism. Tourism appeal is the "natural beauty and outdoor recreation", which is not what the reservoir offers.
- The flooding destroyed approximately 50% of the rural taxable area in the Revelstoke School District. That tax burden was borne by the City of Revelstoke and area.
- Fluctuating water levels, navigation hazards in the river, the expense involved in constructing boat launches to accommodate water levels, and the unaesthetic shoreline at lower water levels limits tourism and recreation opportunities.
- Flooding of the old railway line from Revelstoke south to Arrowhead eliminated the tourism opportunity for rail trips or for recreation trail development.
- The Columbia River from Revelstoke down to the Upper Arrow Lake is now a very poor navigational waterway, with fluctuating water levels, unmarked stumps and sandbars.

[89] Forward, P.C., Bogyo, J.M. (circa 1961)
[90] http://www.for.gov.bc.ca/hts/tsr1/ration/tfl/t23/httoc.htm#RTppKC13

- Potential for waterfront property development has been lost. It is conservatively estimated that there could have been $40-50 million of construction related to recreational property development in the Revelstoke area if waterfront properties had been available.
- Many of the over 2,000 people displaced by the flooding of Arrow Lakes Reservoir left the area altogether. This leads to reduced population, reduced taxation base, reduced services and infrastructure, and reduced opportunities for small business.
- Land has been lost for habitation. Land and resources have been lost for the development of industry. The overall restriction in growth opportunities has concomitantly limited the development of energy infrastructure in the area (reliable electricity and natural gas).
- The grants-in-lieu of taxes, despite recent increases, fail to recognize the true costs of lost taxation to the communities and have not kept pace with inflation. Studies by the City of Revelstoke Finance department indicated that the grants-in-lieu received from BC Hydro for the Revelstoke Dam actually decreased in value in the period 1990-2006, during a time when the price of hydro-electricity was increasing and BC Hydro was making larger net revenues.[91]
- The significant fluctuations on Kinbasket and Arrow Lakes Reservoirs result in unsightly expanses of desiccated soils, stumps and shoreline debris zones at low reservoir elevations, and hazardous floating debris at high reservoir elevations. For some months of the year, low water levels present an unsightly and unattractive view from the communities bordering the reservoirs and river. These view scape impacts, which have a devastating footprint effect that extends far beyond the physical dimensions of the reservoirs themselves. [92]
- The Revelstoke Airport was relocated, but the runway was misaligned for north/south approaches making it unsuitable for instrument landing and scheduled air service.[93]

d) Property Acquisition and Compensation

There were significant concerns about both the process of communication about acquisition and the appraisal process leading to the offers to purchase that landowners received, and well as the amounts they received.

BC Hydro, in the initial stages of the process recognized that "Because the areas involved have been under the shadow of the Columbia Treaty in recent years, we realize that the normal buying and selling of real estate may have slowed down with an adverse effect on property values."[94]

The amount of private land acquired involved 1,350 ownerships, 3,144 parcels, over 2,000 people and 615 households, with about 260 of those on farmsteads or small ranches.[95] Of these, all but 78 owners settled voluntarily. Those cases went on to the process of formal arbitration, but over one quarter of

[91] Mica 5 and 6 Core Committee (2008)
[92] Mica 5 and 6 Core Committee (2008)
[93] Mica 5 and 6 Core Committee (2008)
[94] Wilson, J.W. (1973) People in the Way, pg. 184
[95] Wilson, J.W. (1973) People in the Way, pg. 184

those cases were settled before a formal hearing. A total of 13,557 ha (33,500 acres) were affected of which 10,846 ha (26,800 acres) were flooded.[96]

The compensation issues centred on the following:[97]

- The delay between the Treaty studies, which began in 1948, and the beginning of land acquisition in 1964 resulted in reduced market values.
- It sometimes took considerable time to complete negotiations with the BC Hydro appraisers, sometimes several years, which led to uncertainty.
- There was a perception that some appraisers offered higher amounts than others,
- There was the unstated "threat" that if a settlement was not reached, a hearing with attendant legal expenses would be required.
- There was a lack of detail in the offers. Owners were offered a "lump sum," and were not able to distinguish the relative value of the land, the value of the home and other improvements and the value of compensation for disturbance and moving.
- There was a difference between the reality of market value based compensation, and an expectation by some that compensation would be based on replacement value.
- There was no compensation for the loss of "traditional lifestyle."[98]
- There was no compensation for local opportunity costs related to the use of Crown lands that were inundated. [99]
- The Arrow Lakes community report also notes that some expropriated properties were subsequently resold. It is unclear if these were offered to or purchased by the original owners.

e) Development Mitigation[100]

- New town sites were established for Burton, Fauquier and Edgewood, including community facilities. Some residents moved their existing houses to these new locations. Additional residential lots were created in Robson, Nakusp, Revelstoke and Christina Lake.[101]
- 38 new houses were constructed and 37 houses and St. Johns Anglican Church were relocated.[102]
- A 10 bed extension was added to Castlegar hospital by BC Hydro.
- Approximately 5,480 metres (18,000 ft.) of dikes were installed at Revelstoke for the Big Eddy areas on the west shore, and the golf course (including a land consolidation and doubling in size), the ball park, and the Downie Mill on the east shore, and approximately 400 metres (1,300 feet) of eroding bank was stabilized.
- The Revelstoke airport runway was raised 15 feet.

[96] BC Hydro and Power Authority (1969)
[97] Wilson, J.W. (1973) People in the Way
[98] MacPherson, Barbara (1994) pg.7
[99] MacPherson, Barbara (1994) pg.7
[100] Wilson, J.W. (1973)
[101] Wilson, J.W. (1973) People in the Way, pg. 70
[102] BC Hydro and Power Authority (1969)

- Foreshore bank stabilization and construction of a marina and boat launch, a new beach, industrial park and landfill in Nakusp.
- New boat ramps at Shelter Bay, Fauquier and Edgewood.[103]
- BC Hydro contribution to BC Parks for park development at Syringa, MacDonald Creek and Blanket Creek.
- Provision of a museum site in Revelstoke.
- Provision of 200 water coolers at Consolidated Mining and Smelting Company in Trail for 1 year until a new water supply was developed.
- Construction of a new water intake for Celgar Limited (and the City of Castlegar).
- New ferry facilities were installed at Galena Bay, Needles and Fauquier.
- Public water supply wells were developed at Trail, Kinnard and Robson and two water treatment plants were built to serve Tadanac, Warfield and Cominco Ltd.
- BC Hydro has built a new boat ramp four kilometres south of Burton and installed floating walkways and floating log breakwaters at existing boat ramps at McDonald Creek Park and Fauquier.
- BC Hydro also started construction of the new Anderson Point boat ramp in 2011, beginning parking lot construction and upgrades to the access road from Deer Park Fire Service Road to the ramp. Planned projects include replacement of the Nakusp boat ramp, completion of the new ramp at Anderson Point, and upgrades to the existing Edgewood boat ramp.[104]

f) Construction Related Benefits

The construction value of the Keenleyside (Arrow Lakes) Dam was $195.1 million. It created approximately 4,000 person-years of employment, and over $30 million in wages.[105] The peak labour force reached 1,687 in May, 1967.[106]

g) Ongoing Impacts and Operational Concerns

- The community economic development issue is one of fairness; compensation has never been provided for lost opportunities. There has never been a fully comprehensive study of the cumulative social and economic impacts of hydroelectric system development and operations on the communities.[107]
- Arrow Lakes currently has relatively low levels of woody debris. Debris removal was not conducted in 2011 following an aerial survey that indicated very little debris accumulations located in areas where crews could undertake shoreline debris removal work.[108]

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[103] BCC Hydro and Power Authority (1969)
[104] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q2/2012-04_gds12-80_columbia.Par.0001.File.2012-04-GDS12-80-Columbia-River-WUP-Update.pdf
[105] BC Hydro and Power Authority (1969)
[106] BC Hydro (1967)
[107] Mica 5 and 6 Core Committee (2008)
[108] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q2/2012-04_gds12-80_columbia.Par.0001.File.2012-04-GDS12-80-Columbia-River-WUP-Update.pdf

- Managing low water levels for navigation and log transport.
- Managing water levels for waterfowl nesting and migration.[109]
- Managing water levels to maintain vegetation.
- Managing water levels to maintain Kokanee Salmon spawning habitat.
- Managing water levels for recreational use and water access (boat ramps).
- Protection of archeological sites through water management or site protection.
- Management of high water levels and draw down rates to minimize erosion.
- Lack of understanding of the effect of daily, season and annual drawdown on wildlife.
- Developing vegetative cover in the drawdown zone.

4. Libby Dam and Reservoir (Lake Koocanusa)

a) Description

Under the terms of the Columbia River Treaty, Canada permitted the U.S. to build the Libby Dam on the Kootenai River (U.S. spelling) in Montana. The dam was completed in 1975 and floods approximately 67 kilometers into Canada and was filled for the first time in 1974. Due to difference in spelling Kootenay (i) the reservoir was named Koocanusa for Kootenay (i), Canada and the U.S.A. [110] The dam was constructed by the U.S. Army Corps of Engineers between 1966 and 1972. Libby Dam spans the Kootenai River 27 km (17 km) upstream from the town of Libby, Montana.

Libby Dam is 129 m (422 feet) tall and 931 m (3,055 feet) long. Koocanusa Reservoir extends 140 km (90 miles) upriver from the dam and has a maximum depth of about 370 feet (110 m). The total usable storage for Libby Dam (Koocanusa Reservoir) is 5.0 MAF (7.2 km^3). The Treaty maximum and minimum operating ranges are 2,459 feet and 2,287 feet (172 feet) for Koocanusa Reservoir, however, in a typical year, water levels fluctuate by about 60 feet, although larger annual fluctuations have occurred in the past and will occur under some circumstances in the future.

The powerhouse contains five turbines and is capable of generating 604 megawatts. Power generation and sale is managed by the Bonneville Power Administration as part of their portfolio of loads and resources throughout the U.S. Pacific Northwest. The money earned from power sales goes to the United States Treasury to repay the cost of building and operating Libby Dam.[111]

No direct compensation was given to Canada for the land flooded by Koocanusa Reservoir, but Canada gains power generation benefits on the lower Kootenay River in B.C. from the regulated discharges at the Libby power generating facilities. Libby Dam also provides flood control benefits for Canada at Kootenay Lake and on the lower Kootenay and Columbia Rivers.

Under the Treaty, operation of Libby Dam was to be coordinated with Canada. Operations of Libby Dam from 1973 through 1992 were managed to optimize power generation and flood control in the two

[109] BC Hydro (2008)
[110] http://www.libbymt.com/areaattractions/libbydam.htm
[111] http://en.wikipedia.org/wiki/Libby_Dam

countries[112].

In 1993, the U.S. Army Corps of Engineers, responding to U.S. regulatory agency concerns, began to operate Libby in a manner designed to benefit downstream salmon passage and sturgeon spawning, with less water released from Libby during the fall and winter and more water released during the spring and summer. This operation resulted in power losses, including additional spill and reduced seasonal value, at downstream Canadian hydropower plants on the Kootenay River system. The Canadian Entity objected to this unilateral operating change. The dispute was set aside with the signing of the Libby Coordination Agreement.

In return for Libby Dam operations that meet U.S. regulatory requirements for fish, the Libby Coordination Agreement gives Canada the flexibility to self-compensate for its Kootenay River power value losses. Canada has the option to release water from the Arrow Lakes Reservoir and receive the resulting incremental power generated at U.S. federal plants during periods of high power value. Canada returns the power to the U.S. during times of lower power value, with the value difference being the net compensation to Canada. Under the Libby Coordination Agreement, Canada also obtains some non-power benefits, including more favourable Treaty requirements on Arrow discharges during January, which benefits mountain whitefish spawning, and an option to exercise an Arrow-Libby "storage swap" agreement when beneficial to Canada. This "storage swap" agreement has been used in several years to improve recreational conditions on Koocanusa Reservoir.

Until 2002, Libby dam operations continued to observe the "Standard Flood Control" regime that had been in place since dam operations began. However, in response to a 2000 Biological Opinion, under the U.S. Endangered Species Act, Libby began operating to an interim alternative flood control procedure referred to as "Variable Flow" or "VARQ". Libby dam began discharging less water during the fall/winter period and more water during the spring/summer to benefit downstream fish. However, this new flood control operating regime also resulted in slightly higher frequencies of peak water levels on Kootenay Lake and on the Columbia River downstream of Castlegar.

In June 2008, the U.S. Entity permanently adopted the "Variable Flow" flood control regime for Libby which, while still providing significant energy benefits and flood protection for Canada, does so at a reduced level compared to the terms expected by Canada when it ratified the Columbia River Treaty. The Canadian Entity notified the U.S. that compensation would be required for the reduced levels. The Columbia River Treaty Operating Committee has made some good progress on this issue, but has not yet reached final agreement.[113]

As a result of the Koocanusa Reservoir being created by a U.S. dam and the fact there is no provincial water licence associated with Libby Dam, there is no Fish and Wildlife Compensation Program or Water Use Plan associated with the Koocanusa Reservoir.

[112] https://www.enewsletters.gov.bc.ca/Columbia_River_Treaty_Review_eNewsletter/October_2012/October_Question_Libby_Agreement/article

[113] https://www.enewsletters.gov.bc.ca/Columbia_River_Treaty_Review_eNewsletter/October_2012/October_Question_Libby_Agreement/article

b) Biophysical Impacts

Table 9 shows the estimated area affected in Canada by inundation. [114]

Table 9: Area of Pre-Dam Aquatic and Terrestrial Ecosystems Inundated in Canada by the Libby Dam Reservoir (ha)	
Lakes	0
Rivers	1,490
Streams	10
Shallow ponds	210
Gravel Bars	80
Wetlands	1,072
Floodplains and Riparian Areas	2,173
Upland Ecosystems	1,647
Total	**6,683 ha**

Biophysical impacts are discussed in a report prepared by the B.C. Fish and Wildlife Branch, Ministry of the Environment in 1983. Key observations included:[115]

- The reservoir has a Canadian footprint area of 6,649.4 ha. As for the other dams and reservoirs, the impacts have been classified as impacts on land and forest; and impacts on life and ecosystem.
- There is 4,264 ha of riparian habitat and 682 ha of upland habitat (4,946 ha total) of inundated area.
- It is part of the Rocky Mountain Trench, a critical overwintering area for ungulates.
- That habitat area had the capability of supporting 4,443 white tailed deer (1/3 of the regional population), 560 elk (4% of the regional population), an annual production of 210 to 300 geese, and annual harvest of 173 beaver, 108 muskrat and 60 mink.
- Relocation of Highway 3/95 and relocation and the continued upgrading of the highway to Newgate destroyed wildlife habitats and interfered with migration routes.
- Increased mortality of wildlife through road kills.
- Promotion of Libby Reservoir for recreation has decreased the quality of ungulate winter range.
- The commercial and recreational Burbot fishery in the Kootenay River and Kootenay Lake collapsed.[116]

A recent GIS analysis undertaken by Selkirk College identified 964 ha of cultivated fields in the inundated area.

[114] http://fwcpcolumbia.ca/version2/reports/pdfs/FWCP-CB_Impacts_Summary.pdf
[115] Tipper, K.G (1983)
[116] https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/ResAFSParagamian2002%20Collapse%20Of%20Burbot%20Fisheries%20in%20the%20Kootenai%20River%20and%20Kootenay%20Lake.pdf

c) Social and Economic Impacts

A community impact report was not prepared for the Koocanusa Reservoir as part of the 1994 compensation initiative, so impacts are not well documented. Following is a summary from a 1983 report prepared by K.G. Tipper.

- Relocation of farming activities from the floodplain onto adjacent bench land. (No estimate of loss of farmland is provided).[117]
- Loss of spring range for livestock grazing.
- The total discounted value of the loss of wildlife habitat at a rate of 10% over 20 years is $14,140,458 (1983),
- The projected loss of related hunting potential by 2000 was estimated to be 21,675 hunter days.

Note: The current allowable annual cut (AAC) for the Cranbrook TSA is 904,000 cubic metres. For the 2000 to 2002 period, average harvest employment was 400 on an average cut of 1,052,522 $m^{3.}$ The average AAC for that period was 864 000 m^3. Average harvest employee income for that period was $44,642. The forest harvest employment indirect and induced multiplier was 1.28.

d) Property Acquisition and Compensation

Under the 1963 Canada-British Columbia Agreement, B.C. took on the responsibility of to prepare and make available the land needed for the Koocanusa Reservoir. In carrying out this responsibility the Province enacted the *Libby Dam Reservoir Act* in 1968. Pursuant to section 2 of the Act the Department of Highways (now the Ministry of Transportation and Infrastructure) was appointed for this purpose and unlike the other Treaty storage projects was responsible for providing compensation for land when it was acquired.

Note: Unconfirmed estimates are that approximately 3,845 ha (9,500 acres) were acquired, including 182 parcels, and 74 owners. However, it is expected these estimates will be updated once this data is acquired.

e) Construction Related Benefits

The BC Department of Transportation contracted clearing of the reservoir. Documentation of the extent of clearing has not been located to date.

f) Development Mitigation

- In 1983 BC Hydro was directed by the provincial government to establish a debris management program on Koocanusa Reservoir. On average, the program expenditure is $100,000 per year.
- A boat launch facility has recently been constructed with financial support from BC Hydro, Columbia Basin Trust and Teck Resources and land made available by the Ktunaxa Nation and the Province of B.C. The two-hectare site is located on the northwest side of Kikomun Bridge,

[117] Tipper, K.G (1983)

and includes a ramp, floating breakwater, floating dock, outhouse, garbage receptacle and parking for up to 60 vehicles and trailers.[118]

- The U.S. Army Corps of Engineers developed a mitigation plan for the U.S. portion of the reservoir that addressed concerns about fish by building hatcheries, and by acquiring land to serve as grazing areas for animals whose normal ranges were submerged, and by implementing a technological fix as part of the Dam project that enabled control of the temperature of water released from the Dam.[119]

g) Ongoing Impacts and Operational Concerns

Previous consultations have identified several ongoing concerns:[120]

- The operations of the Libby Dam in the U.S. to protect endangered species in the downstream portions of the U.S. system (such as white sturgeon below Libby, and salmon below Chief Joseph Dam) can conflict with power generation, flood control, endangered species, agricultural, dike stability and recreational interests in the Canadian section of the Kootenay River.[121]

- The Koocanusa Reservoir plan area is currently not zoned or covered by any Regional District of East Kootenay (RDEK) long range strategic land use plans. Due to the popularity of the area for recreation use and the lack of planning, the Integrated Land Management Branch (ILMB) of the Ministry of Natural Resource Operations has placed a moratorium on *Land Act* applications including sales and tenures over the area. In addition, the Ktunaxa Nation Council (KNC) is at Stage 4 of the Treaty process, which includes a land offer for parcels in the vicinity of the Koocanusa Reservoir. As a result, this increase in pressure for Crown land development has led to the establishment of a tripartite Joint Steering Committee (JSC) made up of the RDEK, KNC and ILMB. The objectives of this collaborative approach to land use planning are to:
  - Develop an OCP and zoning bylaw to guide and regulate future growth and development in the area;
  - Encompass both the Crown and private lands, meeting the land management requirements of the Province and the RDEK;
  - Address the stewardship and development concerns of the Ktunaxa Nation Council and Tobacco Plains Indian Band. [122]
- There are ongoing issues with unsupervised camping and squatting on Crown lands adjacent to the reservoir.[123]
- There are ongoing interests in expanding tourism and recreation opportunities, and commercial development on the reservoir and managing the reservoir level to better serve those interests.

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[118] http://www.cbt.org/newsroom/?view&vars=1&content=News%20Release&WebDynID=1708
[119] http://en.wikipedia.org/wiki/User:Publicplanet/sandbox
[120] http://blog.gov.bc.ca/columbiarivertreaty/files/2012/07/regional-interests-koocanusa.pdf
[121] Hearns, Glen (2008)
[122] http://www.rdek.bc.ca/LakeKoocanusaOCP/ProjectCharterv4.pdf
[123] http://www.e-know.ca/news/rdek-board-highlights-2/?wpmp_switcher=mobile

- Ongoing concerns about habitat protection and habitat enhancement for fish and wildlife.
- There are concerns about protecting archeological sites.
- There are ongoing issues with debris management and related funding.

5. Duncan Dam and Reservoir

a) Description

The Duncan Dam and Reservoir are Columbia River Treaty water storage and flow management facilities. There is currently no hydroelectric development at the Duncan Dam site although projects in the range of 30 MW have been contemplated.

The Duncan Dam is an earth fill dam. Construction began in 1965 and the project became operational in 1967. It is 40 metres high and has a storage capacity of 1.73 km^3 (1.4 million acre feet) and is approximately 45 km long. The Dam controls 10% of the inflow to the Kootenay River system.[124] The water license maximum and minimum operating ranges are 1892 feet and 1794 feet (98 feet), in a typical year, Duncan Reservoir levels fluctuate throughout the entire licensed range for the reservoir (98 feet) to provide maximum downstream flood control and power benefits. Upgrades to the spillway were completed in 2012.

Discharge water from the Duncan Dam flows into the Kootenay Lake. The water level and water management of Kootenay Lake was originally established by the Corra Linn Dam built in 1931, which raised the Lake elevation by approximately two metres and is governed by an International Joint Commission Order.

b) Biophysical Impacts

Table 10 summarizes the areas of pre-Dam aquatic and terrestrial ecosystems inundated by the Duncan Dam Reservoir. [125]

Table 10: Area of Pre-Dam Aquatic and Terrestrial Ecosystems Inundated by the Duncan Reservoir (ha)	
Lakes	2,584
Rivers	425
Streams	18
Shallow ponds	172
Gravel Bars	22
Wetlands	1,824
Floodplains and Riparian Areas	1,397
Upland Ecosystems	860
Total	**7,301 ha**

A projected impact review undertaken in 1965 noted the following:[126]

[124] http://en.wikipedia.org/wiki/Duncan_Dam
[125] http://fwcpcolumbia.ca/version2/reports/pdfs/FWCP-CB_Impacts_Summary.pdf
[126] Peterson, G.R. and I.L. Withler (1965)

- Both resident fish and spawning fish from Kootenay Lake (Rainbow Trout, Dolly Varden, and Kokanee Salmon) will lose spawning areas and food supply.
- Habitat for resident and migratory game animals (400 white tailed deer, 200 mule deer, elk, caribou, 25 black bear, 5 grizzly bear), fur bearers (1,000 beaver, 2,000 muskrat), and waterfowl (50,000 ducks, 5,000 geese, 1,000 swans) will be lost and those populations will be displaced or removed.
- Flooding of forest habitat will remove an unknown number of squirrel, martin, weasel, fisher and grouse.
- Species affected by the loss of wetland habitat include bald eagle, osprey, coot, blue heron, grebes, snipe, plover and many other small birds and animals.

The report notes that there was little commercial exploitation of the area for hunting, fishing and recreation at the time due to its relative inaccessibility.

A recent GIS analysis undertaken by Selkirk College identified approximately 48.33 ha of cultivated land and 4.4 ha of orchard in the inundated area.

c) Social and Economic Impacts

Prior to the building of the Dam, Duncan Lake and River were main navigation routes used by the mining and logging industries to extract valuable natural resources from the valley. Two competing railroads that traveled north from the head of Kootenay Lake to the community of Howser, where there was a thriving saw mill, post office, store, assay office and small farms. Some buildings, including the post office, were relocated to higher ground prior to the flooding, but most were left to be cleared away or burnt before flooding. The reservoir was cleared of large trees.[127] No community impact report was prepared for the Duncan Dam and Reservoir area as part of the 1994 compensation initiative, so impacts are not well documented.

i. Social Impacts

Approximately 30 people were displaced as a result of property acquisition and flooding.[128]

ii. Economic Impacts

- Estimated lost forest area (dry forest, intermediate forest, wet forest, and very wet forests) was 3,001 ha.[129]
  Note: The current allowable annual cut (AAC) for the Kootenay Lake TSA is 640,000 cubic metres per year, effective August 12, 2010. For 1997-1999, the average harvest was 603,000 m^3 on a base ACC of 700,000 m^3. There were an estimate 266 harvest employees earning an average of

[127] http://www.museevirtuel-virtualmuseum.ca/sgc-cms/expositions-exhibitions/hydro/en/dams/index.php?action=duncan
[128] BC Hydro and Power Authority (circa 1969) Columbia Construction Progress: Duncan Project
[129] Utzig, G., and D. Schmidt (2011)

$46,844. The indirect and induced employment multiplier for the forest sector in the region was 1.53.[130]

d) Property Acquisition and Compensation

Most of the inundated land was Crown land. Approximately 39 private properties were acquired, and 30 people were displaced. Approximately 12 of those were located in the Howser area.[131]

e) Development Mitigation

i. A nesting habitat and resting area for waterfowl was created at Duck Lake to replace the marshland flooded by the Duncan Dam Reservoir and turned over to the Creston Valley Wildlife Management Authority.[132]
ii. BC Hydro built a community centre at Meadow Creek.
iii. Approximately 902 ha (2,230 acres) of area was cleared before inundation.
iv. A new recreation area was established above the Dam and boat launches were installed both above and below the Duncan Dam.
v. An addition was constructed on the Jewett school.
vi. A paved road was constructed from Kaslo to the Dam.
vii. A Kokanee spawning channel was constructed at Meadow Creek.

f) Construction Related Benefits

The construction value of the Duncan Dam (1964 to 1967) was $32.2 million. The peak labour force in 1965 was 481. Construction of the Dam created approximately 1,100 person-years of employment and related wages. Recent upgrades were valued at $23.4 million and created approximately 20 person-years of employment.[133]

g) Impacts and Operational Concerns

Following are the key points from the 2010 Duncan Dam Project Water Use Plan Report:[134]

- Shore spawning and tributary habitat within the drawdown zone are both marginalised by reservoir operations. In addition, there is a large body of evidence documenting the impacts that large annual drawdowns have on littoral and pelagic productivity in reservoir systems. These impacts affect Kokanee and Bull Trout populations.

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[130] http://www.for.gov.bc.ca/hts/tsa/tsa13/tsr2/analysis.pdf
[131] BC Hydro and Power Authority (circa 1969) Columbia Construction Progress: Duncan Project
[132] BC Hydro (1971)
[133] http://thenelsondaily.com/news/work-duncan-dam-boosts-local-economy-14208#.UHRVGRXA-So
[134] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/lower_mainland/2011q2/ddmmon-10_yr2_2011-03-15.Par.0001.File.DDMMON-10-Yr2-2011-03-15.pdf

- Kokanee are primarily distributed in the pelagic area, while Bull Trout and Rainbow Trout primarily utilize the littoral areas throughout the reservoir. However, the current methodology does not allow the relative abundance of any of the key fish life histories in the reservoir to be assessed.
- In 2010, over 1,000 spawning Kokanee were observed aggregating on alluvial fans. The eggs they deposited are expected to have suffered a high mortality rate when the reservoir was drawn down over the winter.

Other concerns include:

- Two archaeological sites were identified in the draw down zone of Duncan Reservoir during an archaeological overview conducted in 2002 and it is expected that other undocumented cultural sites of significance may exist within areas affected by reservoir operations. There is concern for the maintenance of the cultural, aesthetic and ecological context of cultural resource areas and spiritual sites. [135]
- Maintaining both minimum and maximum flow targets for fish and flood control.
- Upstream migration of Bull Trout using Dam outlets.

E. Regional Mitigation and Benefits

1. Treaty Related Employment

a) Construction

With the construction of the Treaty Dams and generation facilities, construction of additional facilities created as a result of storage benefits, and ongoing major maintenance and replacement, there has been ongoing construction activity almost continually since the establishment of the Treaty. Following is a summary of those investments and employment estimates (Table 11). Note that the construction values in this summary are not in current dollars, but in the dollar values current at the time the project was completed. Also note that the number of person-years of employment have been estimated from various annual and interim construction reports, and other sources, and should be considered as estimated numbers only.

Table 11: Treaty and Related Project Expenditures and Employment

Project Name	Date/Duration	Estimated Construction Value (millions)	Estimated Direct Employment (person-years)
Completed			
Mica Dam[136]	1964 - 1973	$378.5	8,750
Mica Powerhouse[137]	1973 - 1976	$403.6	4,200
Revelstoke Dam and Powerhouse	1976 - 1984	$1,920.6	11,055

[135] BC Hydro (2008) pg. 3
[136] BC Hydro Corporate Affairs (1988)
[137] [137] BC Hydro and Power Authority (circa 1974) Columbia Construction Progress: Mica Project
[137] BC Hydro and Power Authority, Construction Progress Reports-Mica (1973-75)

Keenleyside Dam[138]	1964 -1968	$195.1	4,000
Duncan Dam[139]	1964 - 1967	$32.2	1,100
Kootenay Canal Generation[140]	1971 - 1976	$147	2,000
Arrow Lakes Generation and Transmission[141]	1999-2001	$270	484
Brilliant Expansion [142]	April 2003 – September 2007	$207	983
Revelstoke #5[143]	November 2007- August 2010	$248.9	380
Duncan Spillway[144]	May 2011 to June 2012	$23.4	20
In Progress			
Mica #5, #6 and switchgear	May 2011 to 2015	$1,000	800
Waneta Expansion	2010 - 2015	$900	680
Keenleyside Spillway Upgrade	2011 to 2014	$91–102	
Future			
Kootenay Canal Forebay		TBD	
Revelstoke #6		TBD	

For these facilities, total construction employment is estimated to be approximately 33,000 or the equivalent of 685 jobs annually since 1964.

b) Permanent Employment

The Dams and infrastructure resulting from the Columbia River Treaty and related development have resulted in the creation of a permanent facilities management and maintenance employment base in the region. The following is a summary of the current number of employees and estimates of salary and benefits based on annual reports.

BC Hydro has several management and maintenance locations associated with the dams in the Basin. The estimated employment base and related budgets for the fiscal year 2012/13 are shown in Table 13. In addition, there are permanent employees with the Columbia Basin Trust, the Columbia Power Corporation and the Fish and Wildlife Compensation Program. In total, current employment is 191 full time positions, 11 part time positions with an annual budget of over $24 million.

These employment estimates do not include consultants or other contractors engaged on a contract basis under the various programs of these organizations. In the case of BC Hydro, that contract expenditure for maintenance and operations is $4.28 million in 2012/13. In addition, all of the Water Use Planning work is contracted (approximately $10 million per year) as is most of the Fish and Wildlife

[138] BC Hydro and Power Authority (circa 1969) Columbia Construction Progress: Arrow Project
[139] BC Hydro and Power Authority (circa 1969) Columbia Construction Progress: Duncan Project
[140] BC Hydro and Power Authority (1972-1975) Kootenay Canal Development Progress Reports
[141] http://www.columbiapower.org/pdf/final_report_SEM_ALGS.pdf
[142] http://www.columbiapower.org/media/documents/final-s-e-monitoring-report.pdf
[143] http://www.bchydro.com/etc/medialib/internet/documents/projects/revelstoke/Revelstoke_ProjBackgrounder_2011-Fall.Par.0001.File.Revelstoke-ProjBackgrounder-2011-Fall.pdf
[144] Personal communication M. DeHaan, BC Hydro

Compensation Program work (approximately $4 million per year). The total value of contracted services related to general operations is approximately $16-18 million per year. This figure does not include CBT or CPC operational and professional contracted services.

These programs are described in more detail in the following sections.

2. BC Hydro Fish and Wildlife Compensation Programs

The FWCP- Columbia (FWCP-Columbia) was established in 1995 as an amalgamation of several pre-existing programs related to water license requirements for Arrow, Duncan, Mica, Seven Mile, and Revelstoke dams which began in 1988.[145] The program injected significant funding and formalized a long-term commitment to conserve and restore fish and wildlife habitats impacted by BC Hydro dams.

The FWCP-Columbia is a partnership between BC Hydro, the Province of B.C. and Fisheries and Oceans Canada, in collaboration with First Nations, local governments, community organizations and environmental groups. The FWCP-Columbia responds to requirements of BC Hydro's water licences in the region for the protection of fish and wildlife affected by BC Hydro owned and operated generation facilities. Because Libby Dam is not a BC Hydro project, there is no Fish and Wildlife Compensation Program for the Canadian portion of the Libby reservoir (Koocanusa).

In 1995, the consolidated FWCP-Columbia began investing $3.2 million each year to deliver conservation and enhancement projects targeting species and their habitats impacted by the construction of BC Hydro dams, and creation of reservoirs, in the Columbia Basin. The annual amount increased each year with the Consumer Price Index (CPI). That amount has grown to an annual investment of over $4.5 million in 2012. Since 1995 more than $67 million has been invested by FWCP-Columbia and its partners in approximately 750 projects that conserve and enhance fish, wildlife and their supporting habitats in areas affected by BC Hydro's facilities in the Columbia region. [146]

The strategic objectives of the FWCP-Columbia are:

1) Conservation
    i. Maintain or improve the in Maintain or improve the status of species or ecosystems of concern
    ii. Maintain or improve the integrity and productivity of ecosystems and habitats
2) Sustainable Use
    i. Maintain or improve opportunities for sustainable use, including harvesting and other uses
3) Community Engagement
    i. Build and maintain relationships with stakeholders and aboriginal communities

The work of the FWCP is guided by Policy and Steering Committees made up of Program Partners – BC Hydro, the B.C. Ministry of Environment (MoE), and the Department of Fisheries and Oceans Canada.

[145] http://fwcpcolumbia.ca/version2/reports/pdfs/FWCP-CB_Impacts_Summary.pdf
[146] http://fwcpcolumbia.ca/version2/projects/index.php

Public and First Nations representatives participate on the Steering Committee and help ensure the FWCP is aware of and responding to public and First Nations concerns and input. Fisheries and Wildlife Technical Committees provide additional biological expertise and guidance to the FWCP-Columbia.[147]

[147] http://fwcpcolumbia.ca/version2/info/media/fwcp-backgrounder.pdf

Table 12: Treaty Related Permanent Employment in the Columbia Basin						
BC Hydro 2012/2013 (Mica, Revelstoke, Duncan, Hugh Keenleyside and Kootenay Canal Generating Stations)						
	Mica & Mica Town site	**Revelstoke & Area**	**Duncan Dam**	**Keenleyside Dam**	**Kootenay Canal & Area**	**Total**
Regional Permanent and Part Time Employment						
Full Time Positions	43	33	3	10	20	109
Part Year Positions	3	3	1	2	2	11
Regional Contract Employment Base						
Contract Budget Estimates	$2.148	$0.802	$0.110	$0.507	$0.710	$4.28 million
Total Operation and Maintenance Staff Budgets	$8.041	$5.980	$0.586	$2.055	$3.14	$19.80 million
Fish and Wildlife Compensation Program						
Full Time Positions				1		1
Contract Positions						3
Contract Budget Estimates						$4 million
Columbia Power Corporation (2011/2012)				**Castlegar**		
Full Time Positions				40		40
Annual Budget						$4.48 million
Columbia Basin Trust	**Golden**	**Nakusp**	**Cranbrook**	**Castlegar**		
Full Time Positions	5	3	7	27		42
Annual Budget						$3.95 million
Total Employment	192 full time, 11 part time and contract					$23.95 million

Examples of current key priority conservation and restoration projects include:

- Nutrient restoration in Arrow Lakes Reservoir and Kootenay Lake;
- Maintenance and monitoring of the Hill Creek and Meadow Creek spawning channels;
- Contribution to the Upper Columbia White Sturgeon Culture Program;
- Ecosystem enhancement Programs for wildlife in the East and West Kootenay;
- Funding to acquire and ongoing management of conservation lands; and
- Large mammal monitoring (elk, moose), and support for caribou recovery.

The list of projects that have been completed can be found on the FWCP website at the following link http://fwcpcolumbia.ca/version2/reports/index.php. The scope of projects ranges from basic research and inventory studies related to fish, wildlife and avian species in the Basin, to gathering information on activities such as hunting and fishing and other uses and activities, through to projects such as cattle exclusion fencing, nutrient restoration and program support for initiatives such as Bear Smart programs. It is difficult to divide the projects by reservoir as some projects cross reservoirs and some are in general geographic areas rather than at specific facilities.

The current distribution of CB-FWCP annual funding is approximately 8.2% for administration, 1.4% on communications, 41.7% on wildlife program initiatives and 48.8% on fisheries initiatives.

When the FWCP was established in 1995, a total of 8 full time regular staff were hired and small offices were opened up in Nelson and Invermere. As of 2011, the two offices have been closed and one full time staff remains, along with 3 temporary full time contract positions. A new delivery model is in development and should be finalized in the near future.

3. Columbia Power Corporation Environmental Program

Columbia Power Corporation (CPC) also has an environmental compensation and mitigation program. Specific compensation and mitigation programs and measures include:

- Fish habitat enhancement through the Slocan River Rainbow Trout Habitat Enhancement Program;
- The Arrow Lakes Nutrient Restoration Program;
- Reuse of excavated rock in habitat enhancement projects;
- Reduce Total Gas Pressure (TGP) at facilities;
- Wildlife habitat creation and restoration;
- Water temperature stabilization measures; and
- Waneta Terrestrial Compensation Program.

CPC also carries out a number of monitoring programs. These programs vary in scope and scale. Some of these projects include:

i. Habitat usage by White Sturgeon at Brilliant Dam and Expansion Project;

ii. Terrestrial monitoring at Arrow Lakes Generating Station and Waneta Expansion Project;
iii. Habitat usage by Rainbow Trout in the Slocan River
iv. Total Gas Pressure monitoring at Brilliant Dam and Expansion Project; and
v. Riparian restoration work on the Slocan River.

Expenditures for the CPC compensation and mitigation activities within their Environmental Program are shown in Table 13.

Table 13: CPC Environmental Expenditures ($, 000)

	2002 /03	2003 /04	2004 /05	2005 /06	2006 /07	2007 /08	2008 /09	2009 /10	2010 /11	2011 /12
Arrow Lakes	$191	$194	$198	$200	$206	$209	$239	$258	$186	$236
Brilliant Expansion		$157	$202	$64	$53	$40	$138	$224	$129	$185
Total	**$191**	**$351**	**$400**	**$264**	**$259**	**$249**	**$337**	**$482**	**$315**	**$421**

4. Water Use Planning (WUP)

To address issues of declining fish stocks and aquatic habitat, and consequently water management, as well as the relationship between fish, flood protection, recreation, other water uses and power generation at hydroelectric facilities, the Province initiated the requirement to develop Water Use Plans for BC Hydro water control structures. To date only BC Hydro has been directed to develop Water Use Plans, however, license holders may also voluntarily undertake water use planning.

The requirement to undertake these plans for BC Hydro comes as a condition of its water licences. Although the Koocanusa Reservoir extends into Canada, the actual control of water releases takes place in the United States at the Libby Dam, and is the responsibility of the U.S. Army Corps of Engineers. No licensing is required in Canada and therefore a Water Use Plan does not exist for the Canadian portion of the Koocanusa Reservoir. Furthermore, no Water Use Plan has been undertaken on Kootenay Lake or the lower Kootenay River, as flow regulation is provided by the Corra Linn Dam which is owned by FortisBC. Newly licensed facilities, such as the Arrow Lakes and Brilliant Expansion Project, have conditions related to flows, recreation and environmental mitigation equivalent to WUP conditions.

Operations at BC Hydro hydroelectric facilities in the Basin were reviewed by consultative committees that involved water licensees, government agencies, First Nations, key stakeholders, and the general public. The Water Use Plans resulting from this consultative process describe a set of operating rules for each facility that address the interests at stake while respecting legislative and other boundaries.[149] There is one Water Use Plan for the facilities along the main stem of the Columbia River, and one for the Duncan Dam. The water use planning consultative process for BC Hydro's main stem Columbia River facilities was initiated in August 2000, completed in June 2004 and updated in 2007. Through public, First Nations and stakeholder consultation, a broad range of concerns has been identified including:

[149] http://www.env.gov.bc.ca/wsd/plan_protect_sustain/water_use_planning/index.html

- Flow management for various interests including navigation, recreation, fisheries, and flooding;
- Habitat, nutrient, migration, stranding and other issues related to fish;
- Waterfowl habitat;
- Ongoing dust and debris concerns;
- Ongoing reservoir access and access maintenance concerns;
- Wetland protection;
- Riparian and wildlife habitat; and
- Heritage site protection.[150]

A full review of the Columbia River Water Use Plan is recommended 13 years after implementation unless results of the monitoring program suggest an earlier review is appropriate or significant risks are identified that could result in a recommendation to change operations. The following is an inventory, with estimated related costs over 12 years (2008 to 2020), of the Water Use Plans and implementation actions that have been developed for the Columbia River system:

• Kinbasket Reservoir Fish & Wildlife Management Plan	$9.9M
• Kinbasket & Arrow Revegetation Reservoir Management Plan	$16.5M
• Kinbasket & Arrow Recreation Management Plan	$18.6 M
• Revelstoke Flow Management Plan	$8.8M
• White Sturgeon Management Plan	$35M
• Arrow Reservoir Operations Management Plan	$12.5M
• Arrow Reservoir Wildlife Management Plan	$3.8M
• Lower Columbia River Fish Management Plan	$9.8 M
• Heritage Management Plan	$600k
Total	**$115.5M**

Expenditures to date are $47.4 million or approximately $10 million per year. The Columbia River Water Use Plans and Updates can be found at http://www.bchydro.com/about/sustainability/conservation/water_use_planning/southern_interior/columbia_river.html

The Duncan Dam Water Use Planning Project was initiated in August 2001 and completed in April 2004. The Consultative Committee Report and draft Water Use Plan was submitted to the Comptroller of Water Rights in March and October 2005, respectively. The Duncan Water Use Plan expenditures are planned to be $13.4 M over 10 years from 2008 to 2018. Expenditures to date are $5.5 M.

The Duncan Dam Water Use Plans and Updates can be found at http://www.bchydro.com/about/sustainability/conservation/water_use_planning/southern_interior/duncan_dam.html

[150] http://www.bchydro.com/etc/medialib/internet/documents/environment/pdf/wup_columbia_water_use_plan_revised_for_acceptance_by_th.Par.0001.File.wup_columbia_water_use_plan_revised_for_acceptance_by_th.pdf

There is no permanent employment in the Basin associated with Water Use Plans. All work is contracted.

Heritage Protection

Under the Water Use Planning order, BC Hydro is also responsible for heritage protection. Although this requirement relates to First Nations interests, these sites are also of general interest to Basin communities. In 2007, under the WUP funding program, BC Hydro developed a Heritage Management Plan terms of reference for Arrow, Revelstoke and Kinbasket Reservoirs.

A total of 12 archaeological sites have been identified in the Kinbasket Reservoir during a vegetation survey. No archaeological sites were observed in the surveyed areas of the Revelstoke Reservoir drawdown zone. For the Arrow Lakes, over the course of this two-season study, a total of 26 new archaeological site locations (24 with high archeological significance) were identified and documented. Four of the newly discovered archaeological sites are situated in bank erosion loci identified as having potential to be affected by increased water level fluctuations associated with five-unit operations at Revelstoke Dam. The study report recommends that monitoring of these locations be undertaken to better assess the potential effects of Revelstoke facility flows on these archaeological resources. These sites will be considered as monitoring stations for the Arrow Wind and Wave Erosion Monitoring Study. Expenditures to date (2012) have been $573,814. Methods of protection for sites in the Duncan Reservoir are still being developed.[151]

Access to Reservoirs

Provision of access to reservoirs is part of Water Use Planning. In 2011, BC Hydro upgraded boat ramps at and McDonald Creek Park and built a new boat ramp near Burton. In 2012, BC Hydro and Columbia Power Corporation formed a partnership to complete the remaining Arrow Lakes Reservoir boat ramp improvement projects. Under the terms of the agreement, CPC will manage the construction of the three ramps. The projects are the replacement of the Nakusp ramp, a new ramp at Anderson Point, and upgrades to the existing Edgewood boat ramp. The designs for the remaining projects have been developed by BC Hydro in collaboration with local communities. CPC will be managing the development, construction and commissioning of the three ramps and will keep the community updated on a regular basis. The projects have been ordered by the Comptroller of Water Rights. Once the projects are complete, BC Hydro will maintain the boat ramps. The ramps are scheduled to be useable in 2013. [152]

BC Hydro is also completing a 10-year Boat Ramp Use Study for Kinbasket and Arrow Lakes Reservoirs. This study began in 2010. This study will monitor trends in public use to assess if boat ramp improvements planned and completed under the Columbia River Water Use Plan benefit recreation.

[151] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q2/ddm_annual_report.Par.0001.File.DDM-Annual-Report-2012-04-30.pdf
[152] http://www.columbiapower.org/pdf/projects/2012-04-28_BCH_release_MOU.pdf

Both volume of use and user satisfaction is being measured through traffic counters installed at established recreation sites and through face-to-face and online user surveys.

5. Heritage Management[153]

Archeological sites fall under the jurisdiction of the *Heritage Conservation Act* (1996) administered by the Ministry of Forests, Lands and Natural Resource Operations. Requirements under that legislation can differ from those required by the Water Comptroller as part of Water Use Planning. To meet any additional requirements under the *Heritage Conservation Act*, BC Hydro has developed a separate Reservoir Archeology Program. No estimate of expenditures from that program in the Columbia Basin is available as it is confidential.

6. Columbia Basin Trust (CBT)

In 1996, the Columbia Basin Trust (CBT) was created to support efforts by the people of the Basin to create social, economic and environmental well-being in the Canadian portion of the Columbia River Basin - the region most affected by the Columbia River Treaty.

During the creation of the Treaty, Basin residents weren't adequately consulted for their views, concerns or solutions. In the early 1990s, Residents, local officials and representatives from regional districts and tribal councils joined together to coordinate efforts, forming the Columbia River Treaty Committee. The committee approached the Province of B.C. in order to negotiate:

- that funds be allocated to the region, representing a fair share of the ongoing benefits being realized outside of the Basin as a result of the Treaty; and
- that a regional organization, governed by a board of Basin residents, be created to manage those funds.

The provincial response was to establish the Columbia Basin Trust, a provincial trust established under the *Columbia Basin Trust Act* (1995). The *Columbia Basin Trust Act* establishes the Province of B.C. as the shareholder of CBT. The agreement also established:

- $276 million over ten years to finance power project construction in partnership with Columbia Power Corporation;
- $45 million up front, which CBT used as an endowment; and
- $2 million per year from 1995 to 2010 for operations.

CBT's 12-member Board of Directors consists of one appointee from each of the five Regional

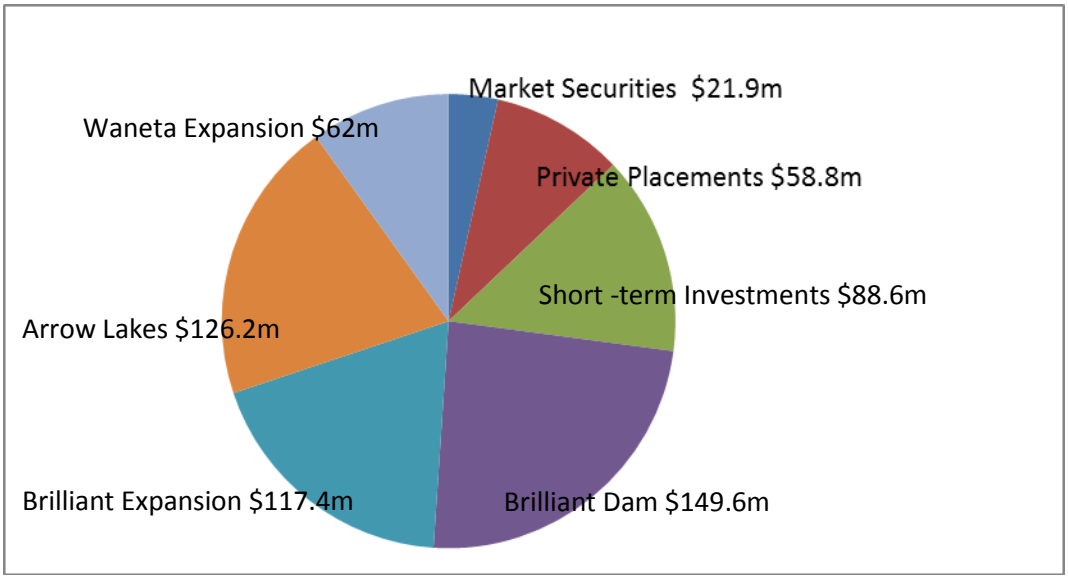
[153] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q1/CLB_MP9_AnnualReport.Par.0001.File.CLB-MP9-AnnualReport-2012-Feb-29.pdf

Districts and the Ktunaxa Nation Council, and six directors appointed directly by the Province. Regional governments nominate their directors to the Provincial government and the appointments are made by the Lieutenant-Governor through an Order-in-Council. All 12 directors must be residents of the Basin.[154]

At the same time CBT was created, the Province also established a provincial Crown Corporation, Columbia Power Corporation (CPC), to develop the untapped capacity in the lower Columbia and Kootenay systems, and to manage joint venture partnerships on power projects with CBT. An additional $250 million to finance construction was allocated to CPC by the Province (See section E.7 for detail on CPC). The result is that 50% of the net revenues from the generation capacity developed at the Arrow Lakes, Brilliant, and Brilliant Expansion generating stations, and 16.5% of the net revenues that will created from the Waneta Expansion Project, flow as revenues to the CBT.

CBT has several subsidiary companies that hold various investments. Investment categories include: the power projects noted above, private placements, which include regional investments in seniors housing, broad band telecommunication services, and market securities. CBT currently has a total of $624.4 million in investments distributed as shown in Figure 2.

Figure 2: Columbia Basin Trust Investment Distribution



From those investments, total CBT revenues in 2011/12 were $23 million, a decrease from $29.5 million in 2010/11. This decrease was a result of a number of factors, including the income from Power Projects dropping to $16 million from $22 million. However, the decrease was offset by the increase of $1.1 million for loan interest income from a $20-million loan to Columbia Power and an increase of $1 million in short-term Investments due to an increase in funds available for deposit from financing related to Arrow Lakes Generating Station.

[154] http://www.cbt.org/About_Us/

Since 2002, CBT's Delivery of Benefits program funding has increased significantly as a result of increased power sales revenues from the Arrow Lakes Generating Station, and the Brilliant Expansion Project (see Table 14)[155]

Table 14: CBT Delivery of Benefits Program Funding ($, 000) 2002 to 2012										
2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
$4,772	$4,036	$3,866	$4,156	$4,276	$5,256	$5,350	$8,976	$10,859	$11,167	$18,210

In 2011/12, CBT disbursements to communities were over $18 million. CBT initiatives include Community Development, Water, Environment, Economic, Social and Youth. Since its inception, CBT has provided $89,829,000 in program funding to communities and organizations through its various program initiatives. More than half (55%) of that program funding has been provided since 2009/10 when additional revenues from the Arrow Lakes and Brilliant Expansion projects began to significantly increase revenues. Following is a summary of revenues and program expenditures based on the 2011/2012 Annual Report (Table 15).[156]

Table 15: CBT Results of Operations 2010/11 to 2011/12		
	2011/12	***2010/11***
Revenues	***(in thousands)***	***(in thousands)***
Power Projects	$16,371	$22,360
Short-term Investments	$2,106	$1,080
Commercial Loans	$1,163	$1,197
Loan Income	$1,135	-
Market Securities	$860	$1,524
Recoveries	$786	$775
Real Estate Investments	$627	$596
Broadband Operations	$(110)	-
Contributions From the Province of B.C.	-	$2,000
Total Revenues	**$22,938**	**$29,532**
Expenses		
Community Development Initiatives	$9,046	$6,387
Water Initiatives	$2,244	$839
Environment Initiatives	$3,172	$1,066
Economic Initiatives	$1,931	$1,160
Social Initiatives	$1,276	$1,058
Youth Initiatives	$476	$352
Other	$65	$305
Administration	$6,175	$5,681
Total Expenses	**$24,385**	**$16,848**
Annual (Deficit)/Surplus	$(1,447)	$12,684

[155] http://www.cbt.org/Newsroom/?Publications
[156] http://www.cbt.org/OnlineReader/AnnualReport/index.html

Current levels of benefits are expected to continue at about the same level until 2015/16 when Waneta Expansion comes on line. Those additional revenues and increased revenues from a new sales agreement for the Arrow Lakes Generating Station will mean that by 2017/18, projected annual benefits to communities are expected to be double the current levels.[157]

Most of CBT's program initiatives apply to all areas of the Basin. The Community Initiatives Program (CIP) and Affected Areas Programs (AAP) are CBT's oldest programs. They support projects identified as priorities within individual communities. All regions with the Columbia Basin receive CIP funds which are allocated on a per capita funding formula and are distributed once a year to CBT's local government partners:

a) the Regional Districts (RD) of East Kootenay (RDEK), Central Kootenay (RDCK)and Kootenay Boundary (RDKB), and
b) the City of Revelstoke, Town of Golden/Columbia-Shuswap RD (CSRD) Area A, Village of Valemount and Ktunaxa Nation Council.

However, those identified by CBT as most affected by Dam construction under the Columbia River Treaty (Golden, Columbia-Shuswap RD Area A [within 10 km of reservoir], Revelstoke, CSRD Area B, RDEK Area B, RDEK Area C, Nakusp, RDCK Area K, RDCK Area J, RDCK Area D, Valemount, RDFFG Area H) all receive AAP funding. Community groups and organizations can apply for funding through these programs directly to the local government partner.

The CIP/AAP funding programs are designed to help address the needs of Basin communities, and are flexible and able to accommodate individual processes as they incorporate community-based funding decisions to better meet local priorities. As of April 2011, the CIP/AAP programs will be supporting communities with $3.6 million annually, over a five-year funding commitment. There will also be a new $30,000 minimum (based on combined CIP and AAP funding) per incorporated municipality, Regional District Electoral Area or First Nation Band. Allocations for the 2011 to 2015 period are shown in Table 16.[158] In 2012 the AAP program delivered $1,572,997 and the CIP program delivered $2,085,689 with a combined total of $3,658,686

Table 16: Columbia Basin Trust CIP/AAP Annual Allocations for 2011-2015	
Local Government Delivery Partner 2011 – 2015	**Allocation (*CIP Only)**
Ktunaxa Nation Council	$769,538*
Regional District of Kootenay Boundary	$1,543,360*
Village of Valemount	$1,138,915
Town of Golden (CSRD)	$1,415,485
City of Revelstoke (CSRD)	$1,757,691
Regional District of Central Kootenay	$6,461,795
Regional District of East Kootenay	$5,206,655
Total	**$18,293,439**

[157] Personal communication with J. Strilaeff, CBT
[158] http://www.cbt.org/uploads/pdf/CBT_CIP_AAPFactSheet_WEB.pdf

CBT currently has 42 employees in Nakusp (3), Castlegar (27), Golden (5) and Cranbrook (7). The current expenditure on salaries and benefits is $3,952,000.[159] There is no estimate of the employment generated as a result of the investment of program funding by regional organizations and communities.

7. Columbia Power Corporation

Columbia Power Corporation (CPC) is a Crown corporation wholly owned and controlled by the Province of British Columbia. The Columbia Basin Accord signed in 1995, established a primary mandate of Columbia Power to undertake power project investments as the agent of the Province in joint venture partnership with CBT. CPC's mandate is to:

- Efficiently develop and operate commercially viable, environmentally sound and safe power project investments for the benefit of the Province and the residents of the Columbia Basin;
- Act as the manager of power project joint ventures with the CBT; and
- Act as the owner's representative for construction of the Waneta Expansion Project.[160]

The Province of British Columbia committed to contribute $500 million over ten years to CPC and CBT to be used as equity funding for joint venture power projects. These contributions consisted of ten payments of $50 million and commenced on April 1, 1996 and concluded on April 1, 2005. These funds were combined with commercial debt financing provided by private sector lenders to facilitate a total investment of over $1 billion in the Columbia Basin.[161]

The purchase of the Brilliant Dam in 1996 was the first investment by the partners. The core projects undertaken by CPC and CBT are the Arrow Lakes Generating Station (completed), Brilliant Expansion Project (completed) and the current Waneta Expansion Project. [162]

The net income generated by CPC over the fiscal years 2009/10 through 2011/2012 was $14.885 million, $17.278 million and $14.686 million respectively. Income growth is expected to remain moderate until the completion of the Waneta Expansion project at which time it is expected to grow further.

CPC currently has approximately 40 employees working mainly in their head office in Castlegar. Over the fiscal years 2009/10 through 2011/2012 CPC had annual salary and benefits expenditures of $4.852 million, $4.079 million and $4.477 million respectively.[163]

In 2011/12, CPC sponsored 12 First Nations Sponsorship Program activities and 46 Community Sponsorship Program activities for a total of 58 supported activities and $93,000 in funding. In addition

[159] Communication with Johnny Strilaeff , Columbia Basin Trust
[160] http://www.columbiapower.org/files/2012-06-27_Annual_Report%20_Final.pdf
[161] http://www.columbiapower.org/company/ourcompany.asp
[162] http://www.columbiapower.org/company/ourcompany.asp
[163] http://www.columbiapower.org/files/2012-06-27_Annual_Report%20_Final.pdf

to monies provided via these two sponsorship programs, an additional $17,000 is awarded each year through a Scholarship and Bursary Program, which provides bursaries to deserving students at 19 secondary schools across the Columbia Basin, as well as scholarships for the College of the Rockies, Selkirk College and the Kootenay School of the Arts.

The following is a brief description of the CPC/CBT joint venture facilities.

a) Arrow Lakes Generating Station

The Arrow Lakes generating station has a generation capacity of up to 185 megawatts (2 units), or 772 GWh. Construction of the project began in March 1999 and was completed in the fall of 2001. The first unit began generating power in February 2002, and the second unit achieved commercial operation in May 2002. Both units were completed months ahead of schedule. The cost of construction was $270 million. The project created over 1,000 person-years of direct, indirect and induced employment. At the peak of construction, over 400 workers were employed on site. Over $45 million in wages and $25 million in other spending flowed into the regional economy from the project.[164]

b) Arrow Lakes Transmission Line

Forty-eight kilometres of new transmission line was constructed to carry power generated at the Arrow Lakes Generating Station to the Selkirk Substation. The project was initiated in 1999 and was fully completed in the spring of 2002. The Arrow Lakes to Selkirk Substation Transmission Line employed approximately 150 workers and management staff, with approximately 75% of the workforce being local.[165]

c) Brilliant Dam

CPC and CBT purchased the Brilliant Dam in 1996. The Dam, which was constructed in the 1940s, is located on the Kootenay River just north of Castlegar, B.C. At the time of purchase, the Dam was capable of producing 125 megawatts of electricity. Since the acquisition, a series of capital improvements to both the Dam and the powerhouse have been undertaken. These projects include concrete rehabilitation work, the switchyard replacement program, spillway gate refurbishment project, the seismic stabilization project and the upgrades and life extension project. Now complete, the multi-year upgrade/life extension project has increased generating capacity at the Dam by approximately 20 megawatts. The upgrade work also improved reliability and reduces the risk of sudden, unplanned outages. The project also reduced the amount of air in the water downstream of the Dam, which reduces the hazard to fish.[166] The eight spillway gates at Brilliant Dam are currently being overhauled, with one or two gates being done each year. This work will conclude by 2014.

[164] http://www.columbiapower.org/projects/arrowlakesstation.asp
[165] http://www.columbiapower.org/projects/arrowlakesline.asp
[166] http://www.columbiapower.org/projects/brilliantdam.asp

d) Brilliant Dam Expansion

Construction of the 120 MW Brilliant Expansion Project began in the spring of 2003 and commercial operation began in September 2007. The Brilliant Expansion uses seasonal flows previously released through the spillways at the Brilliant Dam. This $207 million project consisted of the construction of a short intake channel and powerhouse, and excavations for a power and access tunnel, and tailrace improvements, all on the left bank of the Kootenay River just below the Brilliant Dam. Access to the site is by a new one km road through the Kootenay Quarry, where excavated rock has been stored for future use by the Ministry of Transportation. At the peak of construction, on-site employment was approximately 400 workers, and over 85% were local residents. The project brought over $50 million in wages into the region, and over $44 million was injected into the local economy through the purchase of goods and services.[167 , 168]

e) Waneta Expansion Project

Although the Waneta Dam is not part of the Treaty (located on the Pend d'Oreille River), or of the water management benefits resulting from Treaty dam development, it is included here as the expansion project is part of CPC/CBT's assets and part of the revenue generated at this project will become a benefit to the region.

The Waneta Expansion, currently under construction will add a second powerhouse downstream of the Waneta Dam. The expansion project will share the existing Dam's hydraulic head and will generate power from flow that would otherwise be spilled. CPC and CBT have formed a partnership with Fortis Inc. for the project (Fortis Inc. - 51%, Columbia Power - 32.5%, and CBT - 16.5%). When operational, Fortis BC (a subsidiary of Fortis Inc.) will purchase the capacity. Two turbine units will produce up to a combined maximum capacity of 335 megawatts. Output from the units will be delivered to BC Hydro's Selkirk Substation through a new 10 km transmission line.

This $900 million project initiated in 2010 has a 4.5 year project duration. As of March 31, 2012, regional spending exceeded $84 million with 250 people working directly on the project. Local, qualified workers are given preference in hiring and equity provisions are in place for women, visible minorities, disabled persons and First Nations. In 2011/12 the project had a local hire rate of over 80 per cent and an equity hire rate of over 10 per cent.[169]

8. Payments In Lieu of Taxes

a) Grants in Lieu of Taxes

In the case of BC Hydro's generating facilities and dams, BC Hydro pays property Grants in Lieu of Taxes (GILT) rather than property taxes. The grant is calculated based on a formula that is based on installed capacity, or imputed nameplate generating capacity in the case of storage dams rather than on assessed

[167] http://www.columbiapower.org/projects/brilliantexpansion.asp
[168] http://www.columbiapower.org/media/documents/final-s-e-monitoring-report.pdf
[169] http://www.columbiapower.org/files/2012-06-27_Annual_Report%20_Final.pdf

values and municipal tax rates. Due to the size and location of the facilities, basing grants on what the tax would be if the facilities were privately owned would mean no payments would be made for several of the Dams because they are not within municipal boundaries, but BC Hydro would pay extraordinarily large amounts to a few municipalities. Grants increase annually based on an indexing formula set by the Province. Also, adjustments are made when there is a change in generating capacity, such as the additional unit added at Revelstoke.

In order to create a fairer distribution of payments to local governments impacted by generating facilities, BC Hydro is authorized to pay grants to not only the communities in which its generating facilities are located, but also to those surrounding municipalities and regional districts that are impacted by the operations of the facilities. [170] Columbia Power Corporation also pays grants-in-lieu of taxes although it pays full property taxes on the Brilliant Dam, continuing the payments made by previous owners Cominco Ltd. The most recent grant-in-lieu of taxes payments are shown in Table 17. Note that BC Hydro Dams on the Columbia (with the exception of Kootenay Canal) are exempt from paying school taxes.

Table 17: Grants in Lieu of Taxes Payments			
BC Hydro-Mica (Treaty)	**2010**	**2011**	**2012**
Columbia-Shuswap RD	$ 1,055,779	$ 1,108,660	$ 1,154,726
Fraser-Fort George RD	$405,682	$426,006	$443,711
Valemount municipality	$218,380	$229,321	$238,849
Total for BC Hydro-Mica	$ 1,679,841	$ 1,763,987	$ 1,837,286
BC Hydro- Duncan (Treaty)			
Central Kootenay RD	$ 35,502	$ 37,271	$ 38,831
BC Hydro-HL Keenleyside (Treaty)			
Central Kootenay RD	$ 31,210	$ 32,774	$ 34,125
Castlegar municipality	$ 42,756	$ 44,896	$ 46,761
Nakusp municipality	$ 4,138	$ 4,346	$ 4,527
Total for BC Hydro-HL Keenleyside	$ 78,104	$ 82,016	$ 85,413
BC Hydro-Revelstoke (Non-Treaty)			
Revelstoke municipality	$ 1,742,459	$ 2,175,395	$ 2,265,783
Columbia-Shuswap RD	$ 57,602	$ 71,916	$ 74,903
Total for BC Hydro-Revelstoke	$ 1,800,061	$ 2,247,311	$ 2,340,686
BC Hydro-Kootenay Canal (Non-Treaty)			
Central Kootenay RD	$ 454,598	$ 479,365	$ 499,282
Nelson municipality	$ 303,064	$ 319,572	$ 332,850
Total for BC Hydro-Kootenay Canal	$ 757,662	$ 798,937	$ 832,132

[170] Perrin, Thorau and Associates Ltd (2009), Cross Jurisdictional Review: Impact and Benefit Arrangements. Pg. 9

Columbia Power-Arrow Lakes Generation (Non-Treaty)[171]			
City of Castlegar	$143,802	$150,992	$157,372
Central Kootenay Regional District	$104,975	$110,224	$114,881
Nakusp	$13,923	$14,619	$15,237
Total for the Arrow Lakes Generating Station	$262,700	$275,835	$287,490
Columbia Power-Brilliant Dam Expansion (Non Treaty)[172]			
City of Castlegar	$170,400	$178,920	$186,400

BC Hydro does pay school taxes and grants-in-lieu (2012) at the Mica Dam switchyard ($307,249) and the Revelstoke switchyard ($673,637). It also pays school taxes for Kootenay Canal of $2,699,831. Brilliant Power Corporation also paid $264,653 property taxes to the City of Castlegar for Brilliant Terminal Station in 2012.

b) Regional Grant in Lieu of Taxes Allocation Policies

The grants in lieu of taxes that are paid to Regional Districts are reallocated based on regionally specific policies. In some cases, areas outside of the Basin benefit from these revenues. In Columbia Shuswap Regional District, the apportionment policy is shown in Table 18.

Table 18: Columbia Shuswap Regional District GILT Apportionment[173]	
a) An apportionment to the following functions:	
General Government	20%
Electoral Government	10%
Area B Recreation	4%
Golden and District Arena	4%
Area B Fire Protection	3%
Area A Community Parks	3%
Sicamous Rec Centre	3%
Area E Community Parks	2%
b) An apportionment payable directly for the following:	
Revelstoke Community Centre	1%
c) Balance of GILT apportioned to those members deemed to be the Impact Area as follows:	
Golden and Electoral Area 'A' EOF	20%
Revelstoke and Electoral Area 'B' EOF	20%
Sicamous and Electoral Area 'E' EOF	10%

The Impact Area component is for the purpose of establishing Economic Opportunity Funds (EOF). The EOF was created specifically as a means of compensating for the loss of economic opportunities on those lands affected by the Dams and reservoirs and the resultant economic impacts to the affected

[171] Personal communication with David De Git, Director, Finance, Columbia Power Corporation

[172] Personal communication with David De Git, Director, Finance, Columbia Power Corporation

[173] Columbia Shuswap Regional District Policy F-29

communities. As such, the EOF are to provide funding assistance for projects deemed by the participating members and ratified by the Corporate Board to be worthy of support in an effort to stimulate economic development within the impacted areas.

Central Kootenay Regional District, under policy 300-09-01, allocates all GILT funds to a Community Development Grant Program. In 2008, the funds were allocated as follows:

- $70,000 annually to electoral areas D, E, H, J and K.
- $20,000 annually to each remaining electoral area and municipality with a population of over 1,000.
- $8,000 annually to each remaining electoral area and municipality with a population of under 1,000

Allocation of the funds for specific uses within each municipality and electoral area are approved by the RDCK Board.[174]

The Cities of Castlegar and Nelson are not included in this program as they retain their individual GILT's for municipal purposes.

The Regional District of Fraser Fort George allocates these funds to 3 region wide services: Corporate Services, Economic Development and Community Services. [175]

9. Regional Flood Mitigation

The 1948 and 1961 floods caused extensive damage in Trail, but there was no loss of life in either of those events. In those years, the Kootenay River also flooded and inundated the valley floor in Creston. There are no available estimates for the costs of damages in those flooding events. The system of dams and related water management has substantially reduced the risk of flooding within the region, both on Kootenay Lake and on the Columbia River.

In the summer of 2012, Columbia River flows were within 5% of the historic maximum flows seen in the major pre-dam flood years of 1948 and 1961. The last time the Arrow Lakes Reservoir level went to 440.7 metres (1,446 feet) was in 1990. Without the operation of upstream Treaty Dams, the peak flow in the Columbia River at Castlegar and Trail would have been approximately 1% below the historic maximum flows seen in the major pre-dam flood year of 1961 and 4% above the 1948 peak flows.[176] A BC Hydro simulation shows that Kootenay Lake would have peaked at 1760.4 ft. without the upstream

[174] Regional District of Central Kootenay Policy 300-09-01
[175] Personal communication with Diane Hiscock, CA, General Manager of Financial Services, Regional District of Fraser-Fort George
[176] http://www.revelstokecurrent.com/2012/07/04/arrow-lakes-reservoir-water-levels-expected-to-remain-high/

regulation provided by the Libby and Duncan Dams, two metres (6.6 ft.) above the actual peak of 1753.8 ft. [177]

Although flood risks are substantially reduced, extremely high water does still affect areas around Kootenay Lake, Castlegar and Trail, and the banks along the lower Columbia.

10. Tourism and Recreation

One of the anticipated outcomes of the Treaty Dams and reservoirs was additional tourism and recreation opportunities. The operational issues with the reservoirs related to recreational use and the fact that this promise did not materialize in a significant way is noted in the previous sections dealing with social and economic impacts. However, there have been some tourism and recreation benefits.

Several provincial facilities have been built, such as the BC Parks and Forestry Recreation Sites. These facilities are owned by the Province and any related fees flow to the Province. However, any other visitor expenditures flow to businesses and services in the region. There has also been development of some private facilities. The following is a brief summary of some of the available tourism and recreation opportunities near reservoirs.

There is no current detailed overview of all the tourism and recreation services, including private businesses offered for these reservoirs, the number of visitors they all serve, or the related economic and employment benefits. Table 190 provides a summary of visitation to the B.C. Provincial Parks noted above for 2010/2011. In 2011, traffic counters recorded approximately 560 boat launches at Kinbasket Reservoir ramps and 11,400 boat launches at Arrow Lakes Reservoir boat ramps.[178]

Table 19: Total B.C. Parks Attendance – 2010/11 Fiscal Year

	Day Use	Camping	Total
Martha Creek	28,636	6,525	35,161
Shelter Bay	12,691	3,296	15,987
Syringa Park	57,939	17,286	75,225
Blanket Creek	21,077	16,771	37,848
McDonald Creek	21,532	15,478	37,010
Kikomun Creek	126,473	36,950	163,423
Total	268,348	96,306	364,654

[177] Personal communication with Kelvin Ketchum, BC Hydro

[178] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q2/2012-04_gds12-80_columbia.Par.0001.File.2012-04-GDS12-80-Columbia-River-WUP-Update.pdf

4.1.1. Kinbasket Reservoir

Cummins Lakes Provincial Park

Cummins Lake Provincial Park is located approximately 60 km north of Golden on the east side of Kinbasket Lake at the head of the Cummins River. It is a remote park established in 1995 that encompasses 21,728.5 hectares. Its focus is conservation. There is forest road access from Wood River to Jeffrey Creek, but no trails into the park.

Foster Arm Protected Area (BC Parks)

Foster Arm Protected Area is located on the north side of Foster Creek, and on the west side of Kinbasket Reservoir. This is a very remote area. The closest community is Valemount. Access to this park is by active logging roads. The park was established in 2001 and is 1,020 hectares in area. The park has no developed facilities.

Goosegrass Creek Ecological Reserve[179]

Goosegrass Creek Ecological Reserve is located on the west side of Kinbasket Reservoir 20 km east of Mica Creek. It has a total area of 2,699 hectares and was established in 1974. The forests are in a climax state and wildfire influence has been negligible. The reserve provides good habitat for Grizzly and Black Bears, American Marten and a variety of small mammals and birds at home in old-growth forest.

Cummins River Protected Area

Cummins River Protected Area was created in 2000. It is located on the east shore of Kinbasket Lake, opposite Goosegrass Creek Ecological Reserve. It covers 260 ha of old growth forest on the lower Cummins River. It is contiguous with the Cummins Lake Park but contained mineral claims and an industrial road that prohibited park designation.

In addition to the Provincial Park and Ecological Reserves and Protected Areas, there are Forest Service Recreation Sites and private facilities on Kinbasket Reservoir.

4.1.2. Revelstoke Reservoir

Martha Creek Provincial Park

Martha Creek Provincial Park is located western shore of the Revelstoke Reservoir, 20 km north of Revelstoke on Highway 23. The park was established in 1993. The park has a boat launch, a day use area, and 25 vehicle accessible camp sites.

Revelstoke Dam Visitor Centre

The Revelstoke Dam Visitor Centre offers a wide range of exhibits and activities for all ages. There are 14 interactive displays, a First Nations gallery and theatre and a self-guided tour to the lookout located atop the massive, 175-metre high concrete Dam.

[179] http://www.env.gov.bc.ca/bcparks/eco_reserve/goosegras_er.html

There are also a number of forestry recreation sites around the Reservoir.

Arrow Lakes

Syringa Creek Provincial Park

Syringa Provincial Park is located 19 km northwest of Castlegar on Hwy 3A. It encompasses 4,417 hectares. It was established in 1968 to provide recreational opportunities, and was increased to its present size in 1995 to protect a provincially significant ecosystem. The adjacent Woods Family Property (29.4 ha.) was donated to The Land Conservancy on December 31, 2001 to protect a rare vegetation community, enhance ecological integrity of Syringa Creek Provincial Park, and to conserve habitat for bighorn sheep. The Park has hiking trails, a boat launch, three day use areas, a sani-dump station, a group campsite, 61 vehicle accessible campsites and is wheelchair accessible.

Blanket Creek Provincial Park

Blanket Creek Provincial Park is located 25 km south of Revelstoke on Hwy 23. It is 318 hectares in area. The park protects the scenic qualities of Sutherland Falls, a regionally significant natural feature. The park was established in 1982, and has a day use area, a sani-dump station and 60 vehicle accessible campsites

McDonald Creek Provincial Park

McDonald Creek Park is located on the east and west shores of the Upper Arrow Lake, 10 km south of Nakusp on Highway 6. It was established in 1982 and encompasses 468 ha. The park facilities are only in the eastern section of the park. The park has a boat launch, a day use area and 46 vehicle accessible campsites.

Shelter Bay Provincial Park (Arrow Lakes Park)

Shelter Bay Park is located adjacent to the Shelter Bay ferry terminal on the west shore of Arrow Lake. The park was established in 1981 and is 93 hectares in area. It offers a boat launch, a day use area, and 17 vehicle accessible campsites.

Hugh Keenleyside Dam navigational lock

The Hugh Keenleyside Dam navigational lock is available for all properly equipped watercraft, but commercial traffic has priority usage. Closing of the customs facility in Trail in 2000 has resulted in virtually no U.S. boater traffic through the lock.

Other sites include Edgewood Park, Burton Historical Park, Taite Creek Recreation Site, Octopus Creek Recreation Site, Sunshine Bay Recreation Site, Bowman Point Recreation Site, Begbie Falls Recreation Site, Akolkolex Falls Recreation Site, Eagle Bay Recreation Site, Nakusp Recreation Area, and Centennial Park (Revelstoke).

Boat launching facilities exist at Syringa Park Marina, Scotties Marina, Syringa Creek Provincial Park, McDonald Creek, Shelter Bay, Edgewood Park, Park, Burton Historical Park, Eagle Bay, Nakusp and

Centennial Park. However, some facilities are not useable or accessible when the Arrow Lakes Reservoir reaches low elevations.[180]

5. Koocanusa Reservoir

Kikomon Creek Provincial Park

Kikomon Creek Park in accessible from Highway 3, and is located 8 kilometers west of Elko, or 16 kilometers south of Jaffary. Created on May 18, 1972, the park encompasses 682 hectares. Many endangered plants are found throughout the park. The Park offers a boat launch, 2 rental cabins, hiking trails, a sani-dump, a day use area and 171 vehicle accessible campsites.

Wardner Provincial Park

Wardner Provincial Park is located on the west side of the Koocanusa Reservoir, south of the Crowsnest Highway crossing. The Park was established in 1977 and is 4 hectares in area. It is a day use area.

In addition to Kikomun Creek Provincial Park, there are also two Ministry of Forests Recreation sites on Lake Koocanusa, Door Road, which has 59 campsites and Englishman Creek, which has 42 campsites. [181]

There are several private campground facilities on Lake Koocanusa including, Madera Ranch, Newgate Sandy Shores Campground and Koocanusa Lake Campsite and Marina. These facilities provide two marinas and boat launches. Boat fuel is also available.

6. Duncan Reservoir

Glacier Creek Forest Service campsite is located on Duncan Reservoir and is accessible by the Duncan Forest Service Road. This site has approximately 35 campsites and a boat launch. The site is maintained by the Regional District of Central Kootenay.[182] The Howser Glayco Forest Service site has tent camping capability as well as a boat launch. The site is located off Highway #13 at Howser.[183]

7. Kootenay Canal

At the Kootenay Canal Generating Station between Nelson and Castlegar, BC Hydro has developed a gentle, level walking trail running parallel to the canal.

F. PROVINCIAL BENEFITS

Following are the general benefits that flow to the Province from Treaty and related developments in the Columbia Basin. As most of these are financial benefits which go into the Province's Consolidated Revenue Fund, and help support provincial government services and programs.

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[180] http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q2/2012-04_gds12-80_columbia.Par.0001.File.2012-04-GDS12-80-Columbia-River-WUP-Update.pdf

[181] http://www.for.gov.bc.ca/drm/!bak/Recreation/RecreationHuts/Forest%20Recreation.htm

[182] http://www.rdck.bc.ca/community/parks/kootena_lake_-_north/glacier_creek_regional_park.html

[183] https://www.for.gov.bc.ca/dkl/rec/recsites/Howsermap.htm

1. Electrical Generation

The major benefits to the Province flow from hydroelectric generation. Table 20 summarizes the current and future power generation capacity of the BC Hydro Treaty facilities as well as the facilities that have been constructed as a result of improved water regulation on both the Columbia and Kootenay River systems.

Table 20: Capacity of Treaty related Hydro Electric Generation Facilities			
Dam	**Design Capacity (MW)**	**Installed Capacity (MW)**	**Average Generation (GWh)**
Mica (BCH)	2,805	1,805	7,302.5
Revelstoke (BCH)	2,980	2,480	8,340
Kootenay Canal (BCH)	624	580	2,980
Arrow Lakes (CPC/CBT)	185	185	772
Brilliant Upgrade and Expansion (CPC/CBT)	140	140	602

The BC Hydro facilities as well as the other smaller BC Hydro facilities in the region, and Columbia Power Corporation facilities currently comprise approximately 44% of the hydroelectric generation capacity of BC Hydro. The flexibility provided by large hydroelectric facilities with storage also supports electricity trading with Alberta and the U.S., generating additional revenue for BC Hydro which helps to keep rates low.

As a result of extensive hydroelectric generation in British Columbia, the Province enjoys the third lowest rates among Canadian provinces. Only Quebec and Manitoba have lower rates. In 2011, average prices for residential customers, in cents per kilowatt-hour, were 6.82 in Montreal, 6.94 in Winnipeg and 7.68 in Vancouver – the lowest in major North American cities, while prices in Calgary – 17.47 and Edmonton – 16.40 were among the highest.[184]

2. Value of Treaty Downstream Benefits from U.S.

As a condition of the Columbia River Treaty, the U.S. was required to pay Canada 50% of the estimated value of the future flood control benefits in the U.S. Canada (B.C.) received an up-front lump sum pre-payment of US$64 million. That payment covered the benefits of an assured flood control plan for the first sixty years of the Treaty (i.e. to September 2024).

In addition, Canada receives one-half of the potential annual additional power produced at the downstream U.S. projects resulting from the water flow regulation provided by Canadian storage under the Treaty (Canadian Entitlement). These rights were transferred to the Province in 1963, and Canada pre-sold the first 30 years of those benefits in 1964. The first 30 years of those Canadian Entitlement benefits were sold to the U.S. for a lump sum of US$254 million payable in 1964. After the 30 year sale

[184] http://www.nrcan.gc.ca/energy/sources/electricity/1387

period expired, the benefits began to return to the Province of B.C. beginning in 1998, and reverted to full provincial ownership in April 2003.

Since the full return of the Canadian Entitlement, annual delivery has been at least 1,176 megawatts (MW) capacity and 4,073 GWh of energy to the British Columbia border over the last 10 years. The Canadian Entitlement is currently worth about $100-$300 million annually (varies with market prices). That power is owned by the Province and marketed on its behalf by Powerex, a BC Hydro subsidiary. Over the last 10 years, annual revenue from the sale of the Canadian Entitlement has averaged approximately $202 million annually (see Table 21). Those revenues go into the Province's Consolidated Revenue Fund.

Table 21: Columbia River Treaty Canadian Entitlement Revenue to B.C. ($ Million)									
2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
$100	$230	$258	$319	$223	$246	$231	$168	$136	$110

3. Water License/Rental Payments

Under the *Water Act* and Water Regulation, the Province requires users of publically owned water to pay annual fees known as water rentals. Water rentals are based on the size of the generating facility, the volume of storage and annual power output. [185] Water rentals are paid into the Provincial Consolidated Revenue Fund.[186]

The water rental payments for BC Hydro facilities and for Columbia Power Corporation/Columbia Basin Trust joint venture facilities are shown in Tables 22 and 23 respectively. For the 2011/2012 fiscal year, the Province received a total of $166,500,000 in water rental fees from these facilities.

Table 22: BC Hydro Water Rental on Generation and Capacity			
Plant Name:	**Calendar Year**	**Generation Output (GWh)**	**Total Charges (before Remissions)**
Mica Creek	2003	6,554.3	$38,198,414
	2004	6,532.8	$38,094,390
	2005	5,826.6	$36,358,348
	2006	7,883.7	$46,785,714
	2007	6,013.9	$37,882,051
	2008	8,590.6	$60,172,157
	2009	6,101.3	$45,793,536
	2010	6,248.3	$50,849,127
	2011	6,137.3	$50,776,339
	2012	7,539.1	$62,026,744

[185] http://www.env.gov.bc.ca/wsd/water_rights/licence_application/index.html
[186] http://www.env.gov.bc.ca/wsd/water_rights/water_rental_rates/cabinet/new_rent_structure.pdf

Revelstoke	2003	7,794.6	$44,794,556
	2004	7,776.3	$44,705,914
	2005	7,042.6	$43,150,450
	2006	8,706.1	$51,582,606
	2007	6,896.1	$43,062,192
	2008	9,467.6	$66,245,739
	2009	7,406.9	$54,727,307
	2010	6,777.2	$55,252,444
	2011	7,040.8	$59,681,076
	2012	8,339.8	$70,409,388
Kootenay Canal	2003	3,116.8	$17,072,444
	2004	2,418.7	$13,697,050
	2005	3,110.5	$17,866,478
	2006	3,280.8	$18,729,927
	2007	3,220.4	$18,707,638
	2008	3,301.1	$22,602,549
	2009	2,616.5	$18,789,361
	2010	2,233.3	$17,788,553
	2011	2,510.3	$19,966,286
	2012	3,448.2	$27,162,667

Table 23: Columbia Power Corporation Total Water Rental Payments ($'000)

	2002/ 03	2003/ 04	2004/ 05	2005/ 06	2006/ 07	2007/ 08	2008/ 09	2009/ 10	2010/ 11	2011/ 12
Arrow Lakes	$812	$3,009	$3,512	$3,120	$3,564	$3,604	$4,051	$4,124	$4,420	$4,526
Brilliant Expansion						$258	$386	$1,732	$2,289	$2,374

4. Provincial Crown Land Occupation Fees

In addition to the use of publically owned water, the facilities and reservoirs typically occupy provincial Crown lands. BC Hydro pays an annual licence fee to occupy those Crown lands. Those fees go into the Provincial Consolidated Revenue Fund. Fees paid since 2003 are shown in Table 24.

Table 24: BC Hydro Crown Land Reservoir Fees ($000)

Reservoir	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Kinbasket	$263.6	$263.6	$263.6	$264.9	$266.7	$266.7	$266.7	$266.7	$266.7	$266.7
Arrow	$27.0	$27.0	$27.0	$27.1	$27.3	$27.3	$27.3	$27.3	$27.3	$27.3
Duncan	$18.47	$18.47	$18.47	$18.56	$18.68	$18.68	$18.68	$18.68	$18.68	$18.68
Revelstoke	$53.6	$53.6	$53.6	$53.86	$54.23	$54.23	$54.23	$54.23	$54.23	$54.23
Kootenay Canal	$0.171	$0.171	$0.171	$0.170	$0.170	$0.170	$0.170	$0.170	$0.170	$0.170
TOTAL	$362.83	$362,83	$362,83	$364.65	$367.09	$367.09	$367.09	$367.08	$36708	$367.08

5. BC Hydro and CPC Payments to B.C.

- ***BC Hydro***

BC Hydro total and net revenues for 2001 to 2012 is shown in Table 25.[187] The approximate proportional share for the Columbia Basin generating facilities using an estimate based on the share of generation capacity (40%) prior to 2011/12 is also shown in Table 25. As the Revelstoke Unit #5 was on-line for the 2011/2012 fiscal year, the proportional share of generation capacity increased to 44% for that period. The share of Basin generating capacity will continue to increase with the additions of Mica Units #5 and #6. These estimates should be used with caution as they include all of the BC Hydro generation facilities in the Basin, treaty and non-treaty. Also, actual power generation is based on available water flows, not on capacity. Any differences in operating costs and transmission losses and costs between Basin and other BC Hydro facilities are also not included.

Under a Special Directive from the Province, BC Hydro is required to make an annual Payment to the Province, on or before June 30 of each year, equal to 85 per cent of BC Hydro's net income for the most recently completed fiscal year assuming that the debt to equity ratio, as defined by the Province, after deducting the Payment, is not greater than 80:20. If the Payment would result in a debt to equity ratio exceeding 80:20, then the Payment will be based on the greatest amount that can be paid without causing the debt to equity ratio to exceed 80:20. Those payments, or dividends, and the approximate Basin share are also shown in Table 25.

Table 25: B.C. Commercial Crown Corporation Revenue ($ Million): BC Hydro

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Total Revenue	$3,107	$3,424	$3,725	$4,311	$4,197	$ 4,210	$4,269	$4,028	$4,028	$4,684
Net Revenue	$418	$111	$402	$266	$407	$369	$365	$447	$591	$558
Columbia Basin Contribution (of total)	$167	$44	$161	$106	$163	$148	$146	$179	$236	$246
B.C. Dividend	$338	$73	$339	$223	$331	$288	$288	$47	$463	$230
Columbia Basin Contribution (of dividend)	$135	$29	$136	$89	$132	$115	$115	$19	$185	$101

Over the last ten years, that approximate Basin component has averaged $105.7 million per year. These payments go into the Province's Consolidated Revenue Fund.

- **Columbia Power Corporation**

Columbia Power Corporation (CPC), also a Provincial Crown Corporation, generates power based on the benefits of water management on the Kootenay and Columbia systems. Gross and net revenue for CPC from 2003 to 2012 is shown in Table 26.

[187] http://www.fin.gov.bc.ca/tbs/F&Ereview12.pdf (page 70)

Table 26: B.C. Crown Corporation Revenue ($ Millions): Columbia Power Corporation										
	2002/ 03	2003/ 04	2004/ 05	2005/ 06	2006/ 07	2007/ 08	2008/ 09	2009/ 10	2010/ 11	2011/ 12
Gross Revenue	$45.35	$29.97	$29.20	$31.68	$35.04	$41.80	$49.52	$51.56	$55.02	$59.10
Net Revenue	$13.44	$8.26	$5.74	$3.10	$14.80	$15.90	$18.30	$14.90	$17.30	$14.70

CPC pays an annual dividend to the Province of $2.0 million. That dividend goes into the Province's Consolidated Revenue Fund. The remainder of its net income is reinvested in project development.

6. Non-Treaty Storage Agreement (NTSA)

BC Hydro designed and built the Columbia River Treaty (Treaty) storage projects (Mica, Arrow and Duncan) with more than 5 Million Acre Feet (MAF) of usable storage in addition to the 15.5 MAF required under the Treaty. Most of this extra volume is physically located at Mica but is contractually not attached to any specific project or location. This additional water storage space is referred to as Non-Treaty Storage, and is utilized under a long term commercial agreement between BC Hydro and the Bonneville Power Administration (BPA). The NTSA essentially allows BC Hydro and BPA to fine-tune the Treaty-specified releases of water across the B.C. – U.S. border in response to prevailing loads, market prices and non-power interests such as fisheries and habitat protection.

BC Hydro and BPA signed the first long term Non-Treaty Storage Agreement (NTSA) in 1984 to provide mutual energy benefits and to address a dispute over the initial filling of Revelstoke Reservoir. The current agreement was signed in March 2012 and continues until 2024[188]. The agreement allows for compensation from the U.S. for benefits resulting from the Non-Treaty storage.

BC Hydro estimates the average hydroelectric generation value of the regulation improvement provided by non-Treaty storage to be approximately $12 million annually. [189] This benefit is part of BC Hydro's power sales revenue, and helps to minimize customer rates.

BC Hydro and BPA have also routinely negotiated short-term operating agreements to coordinate Treaty and Non-Treaty Storage for mutual benefit. Canadian benefits from these short term agreements have included increased power generation, protection of whitefish and trout eggs within Canada and improved summer recreation levels for Canadian reservoirs.[190]

[188] http://projects.compassrm.com/ntsa/

[189] Personal communication with BC Hydro.

[190] http://www.bchydro.com/etc/medialib/internet/documents/stakeholder_engagement/ntsa_fact_sheet_march.Par.0001.File.NTSA%20Factsheet%20Mar%202012.pdf

7. Kootenay River Power Generation Benefits

The generation potential of the lower Kootenay River between Nelson and Castlegar has long been recognized and utilized. Prior to the Treaty, the following facilities were in place:

- Bonnington Falls (1905), 16 MW, owned by Nelson Hydro
- Corra Linn (1932), 49MW, owned by Fortis BC[191]
- Upper Bonnington (1907) 66 MW, owned by Fortis BC
- Lower Bonnington (1924) 66MW, owned by Fortis BC
- South Slocan (1928) 544 MW owned by Fortis BC
- Brilliant (1944) 145 MW, owned by CPC and CBT

The improved regulation of the Kootenay River provided by the upstream Columbia River Treaty storage projects (Duncan Dam and Libby Dam) rendered the Kootenay Canal project economic, and led to the negotiation of the 1972 Canal Plant Agreement. An updated version of this coordination agreement continues to facilitate the optimization of the multi-owner generation facilities located within the basin, retain the Treaty regulation benefits for the Province, and provide the project owners (Cominco, FortisBC, CPC/CBT) with dependable energy and capacity entitlements to serve their respective load obligations in a reliable manner.

The Kootenay Canal Generating Station on the south side of Kootenay River began construction in the fall of 1971. It was completed in 1976. Power first became available in the fall of 1975, when two 132.3 MW generating units were placed in service. Two units of similar capacity were put in service in 1976, bringing the total nameplate capacity to 529.2 MW. Since the original construction, BC Hydro's Resource Smart program has added another 51 MW of capacity to the powerhouse in 1999, for a total of 580 MW.[192]Approximately 2,000 person-years of employment were created in constructing this facility.

The Brilliant Expansion project generating station has a capacity of 125 MW and was completed in 2007.

With the addition of the Kootenay Canal and Brilliant Expansion capacity, and other system improvements, the additional power generated as a result of the improved regulation provided by the Treaty is estimated at 3,250 GWh annually.[193]

Because Kootenay Canal and Brilliant Expansion facilities were constructed in conjunction with pre-existing Dams, there was no additional reservoir development and little biophysical impact.

8. Other Provincial Benefits

The Province also gains income tax revenues for wages for permanent employees of BC Hydro, Columbia Power and the Columbia Basin Trust, and for contracted employees, or project labour income from

[191] http://www.fortisbc.com/About/ProjectsPlanning/ElecUtility/ElecFacilitiesOperations/Pages/default.aspx
[192] http://www.bchydro.com/community/recreation_areas/kootenay_canal.html
[193] Correspondence with BC Hydro

those organizations, the Fish and Wildlife Compensation Program and the Water Use Planning programs. In addition, there are provincial tax benefits on the wages paid to contracted employees working on major capital projects, such as the current Mica Dam Units #5 and #6 and the Columbia Power Corporation project at Waneta Dam. The Province also receives tax benefits on the materials used in construction and maintenance. Fees paid at Provincial Parks also become part of provincial revenue, as do fees paid for fishing licences for recreational fishing on the reservoirs. No estimate of the total value of these benefits is documented.

G. SUMMARY

In summary, the Columbia River Treaty Dams had significant biophysical impacts as a result of the inundation of rivers, lakes, streams wetlands and riparian ecosystems. Those losses also had economic impacts related to loss of agricultural activities and arable land, loss of forestry resources, loss of tourism and recreation opportunities and the loss of infrastructure. The process of establishing the Treaty, the acquisition of private lands and the displacement of approximately 2,300 people and the losses noted above all had a significant social impact in the region, some of which continues through to the present.

Currently, there are several compensation/mitigation initiatives underway, including Water Use Plans, Fish and Wildlife Compensation Program, BC Hydro Archeological Sites Program to address some of the biophysical impacts.

The Province also established the Columbia Basin Trust to support efforts by the people of the Basin to create social, economic and environmental well-being.

The benefits to the region that have resulted from development of the Treaty Dams and related development include construction employment, permanent employment, Provincial Parks and recreation sites, some new road and marine infrastructure, reduced flood risk and grants to municipalities in lieu of taxes for the Dams and generating facilities.

Benefits to the Province include increase hydroelectric generation, both from Treaty facilities and from the new capacity developed by BC Hydro and other power projects created by improved water management on both the Columbia and Kootenay Rivers. The Province also receives downstream benefit payments from the U.S., a portion of the net income from BC Hydro, including the power generation in the Columbia Basin in Canada, as well as fees for the use of water and lands associated with the Dams and generation facilities. The Province also gets fees from parks and fishing and hunting licences. Through taxes, the Province also benefits from both construction and permanent employment.

This report does not attempt to determine the net benefit of the Treaty to B.C., the Columbia Basin in Canada, or the communities most affected by Treaty or related development, or to define the current

scope or scale of unaddressed or partially addressed impacts, other than how they have been addressed in other reports.

Appendix 1: Columbia River Treaty Geospatial Assessment

Introduction

The Selkirk Geospatial Research Centre (SGRC) was contracted by the BC Columbia River Treaty (Treaty) Review Team to provide a summary of economic features lost due to the four reservoirs (Arrow, Kinbasket, Duncan, and Koocanusa) created by the construction of the four Treaty dams. The specific economic features we summarized are listed in Table 1, below, along with the methods used to compile the summary data.

Table 1: Feature and Calculation Methods

Feature Class	Calculation Methods	Units
Infrastructure – roads/bridges/railways	Digitize features from historic maps	metres
Community lands	FWCP dam impact data : type "UR" - urban	hectares
Private lands outside community lands	Digitize lot lines from historic maps	hectares
Agriculture lands	FWCP dam impact data: types "CO" – orchards and "CF" - fields	hectares
Forest lands	FWCP dam impact forest ecosystem types. Subdivide forest lands by slope breaks at 5% increments using a DEM.	hectares

Historic maps were used to capture infrastructure and lot lines prior to dam construction: there are both paper and digital (scanned and georeferenced) versions of this product. Previously SGRC had digitized contours and streams from these maps which were used to develop a master digital elevation model (DEM): this was used to generate slope breaks for the forest lands in this project. SGRC used dam habitat impact GIS data prepared by Ketcheson *et. al* . (2005) for the Fish & Wildlife Compensation Program (FWCP) to identify urban, agricultural, and forest lands, as well as pre-dam water features.

SGRC found that many of the polygons classed as "Urban" were road cuts and similar disturbed areas. SGRC removed these areas from our calculations so that we were left with communities. We digitized the lot lines for the Arrow reservoir only due to some concern that lots may or may not have actually been private at the time of the dam construction. SRGC discovered that in many cases the lots included

significant gravel bank components which likely were flooded at times: these are reported separately in the summary table. SRGC reported forest lands using ecosystem classes determined by MacKillop and Utzig (2005) in their primary productivity report as there is significant variation in forest productivity across the region. We further decided to separate cottonwood floodplains from other forest types since these highly productive forests are not usually used for timber harvesting.

It is important to note that retrospective projects of this kind can not provide the same degree of resolution or certainty as a project looking at current conditions. We were limited to using secondary sources and had no opportunity to ground-truth the data. Furthermore, the SGRC team's expertise lies in spatial analysis and not in economic analysis. As such, the summary information provided in this report should be interpreted as reconnaissance –level data about geographic features, not their economic value. Furthermore, the data that is presented does not show 'net' loss as some infrastructure was replaced post-inundation.

Summary Tables

Infrastructure lost per Reservoir

Arrow Reservoir

Type	Number	Total Length (metres)
Bridge (iron)	2	192
Bridge (wood)	34	1,654
Culvert	73	1,833
Dam (concrete)	1	26
Dam (concrete, earth)	1	87
Ferry	7	15,039
Main highway (gravel)	91	55,053
Other/motor road	172	78,472
Railway	68	34,729
Tunnel	1	33
Wharf	7	657

Duncan Reservoir

Type	Number	Total Length (m)
Bridge (wood)	3	385
Culvert	3	99
Other road (poor condition)	1	3,090
Other/motor road	18	9,877

Kinbasket Reservoir

Type	Number	Total Length (m)

Bridge (iron)	1	98
Bridge (wood)	9	855
Culvert	41	1,004
Dam (concrete, earth)	1	373
Main highway (gravel)	84	88,086
Other road (poor condition)	1	2,741
Railway	6	5,887
Winter road	5	2,691

Koocanusa Reservoir

Type	Number	Total Length (m)
Bridge (iron)	2	263
Bridge (wood)	8	821
Culvert	11	405
Main highway (gravel)	22	13,926
Main highway (paved)	1	794
Other/motor road	23	8,946
Railway	2	1,161
Railway (abandoned)	11	22,948
Wagon road	27	21,505

Community Areas lost by Reservoir

Reservoir	Area (ha)
Arrow	233.72
Duncan	18.39
Kinbasket	103.16
Koocanusa	17.87
Total	373.14

Lots Lost in the Arrow Reservoir

	Area (ha)
Forest Reserve	1,074.74
Gravel	383.00
Other	691.74
Indian Reserve	12.86
Gravel	12.57
Other	0.29
Lots	11,355.60

Gravel	3212.31
Other	8143.28
Waterworks District	40.60
Gravel	35.04
Other	5.56
Total	**12,483.80**

Agricultural Land lost per Reservoir

a. Areas of Cultivated Fields and Orchards

Reservoir	Cultivated Fields (ha)	Cultivated Orchards (ha)
Arrow	2,152.76	58.97
Duncan	48.33	4.40
Kinbasket	29.69	
Koocanusa	963.98	
Total	3,194.76	63.37

5.2. Agriculture (Combined Fields and Orchards) by 5% Slope Breaks

Slope breaks are in 5% increments. Slope Break of 1 means between 0 and 5 slope percent, 2 means 5 to 10 percent, etc.

Reservoir	Slope Break	Area (ha)
Arrow	1	1,676
Arrow	2	304
Arrow	3	179
Arrow	4	26
Arrow	5	26
Arrow	6	2
Arrow Total		2,212

Reservoir	Slope Break	Area (ha)
Duncan	1	41
Duncan	2	4
Duncan	3	4
Duncan	6	4
Duncan Total		53

Reservoir	Slope Break	Area (ha)
Kinbasket	1	30

Kinbasket Total	30	

Reservoir	**Slope Break**	**Area (ha)**
Koocanusa	1	864
Koocanusa	2	100
Koocanusa Total		964
Total	3,258	

Forested Areas in Hectares Lost By Reservoir without Slope Break

StudyArea	**Forest**	**EcoSystem**	**Area (ha)**
Arrow	Forest	Dry Forest	716
Arrow	Forest	Forested Wetland	1,951
Arrow	Forest	Intermediate Forest	1,888
Arrow	Forest	Wet Forest	2,602
Arrow	Cottonwood	Floodplain	732
Arrow Total			7,157
Duncan	Forest	Dry Forest	383
Duncan	Forest	Forested Wetland	487
Duncan	Forest	Intermediate Forest	294
Duncan	Forest	Wet Forest	1,068
Duncan	Cottonwood	Floodplan	724
Duncan Total			2,232
Kinbasket	Forest	Dry Forest	658
Kinbasket	Forest	Forested Wetland	1,076
Kinbasket	Forest	Intermediate Forest	8,634
Kinbasket	Forest	Wet Forest	18,157
Kinbasket Total			28,525
Koocanusa	Forest	Dry Forest	39
Koocanusa	Forest	Forested Wetland	709
Koocanusa	Forest	Intermediate Forest	1,529
Koocanusa	Forest	Wet Forest	1,159
Koocanusa Total			3,436
Total			**42,805**

Forested Areas in Hectares Lost By Reservoir with Slope Break

Slope breaks are in 5% increments. Slope Break of 1 means between 0 and 5 slope percent, 2 means 5 to 10 percent, etc. Areas in ha.

	Slope Break																					
Study Area/Forest	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	23	26	Total
Arrow	3759	1256	599	491	395	240	221	172	222	171	115	72	91	47	13	14	3	3	1	4	0		7888
Dry Forest	5	46	15	48	48	62	61	48	111	74	54	37	46	36	12	9	3		1	2	0		716
Intermediate Forest	402	224	211	194	213	117	109	106	85	90	47	30	38	10	0	5	0	3	0	2	0		1888
Wet Forest	1470	505	235	144	91	42	47	16	26	6	10	5	6	1		0							2602
Forested Wetland	1634	235	47	30	4					1									0	0			1951
Floodplain	248	246	91	76	41	18	5	2	0		3		1	0	0								732
Duncan	2192	287	95	59	83	96	93	34	4	7	3	2	1	0									2956
Dry Forest	35	43	20	32	36	87	81	33	4	6	3	1	1	0									383
Intermediate Forest	171	41	24	17	28	8	4	0		0	0	1	0										294
Wet Forest	852	136	47	10	16	0	8	0	0														1068
Forested Wetland	467	15	4																				487
Floodplain	668	52			3	2																	724
Kinbasket	11515	4222	3480	2722	1900	1475	1105	745	583	516	127	57	36	9	27		3	2	0			0	28525
Dry Forest	26	3	45	38	88	168	167	67	18	20	7		2	0	6		3	0	0			0	658
Intermediate Forest	1109	1325	1393	1204	873	872	540	412	408	393	50	11	24	3	15			1				0	8634
Wet Forest	9435	2805	2007	1478	939	432	398	267	157	103	70	45	11	6	6			0					18157
Forested Wetland	945	90	35	2		4																	1076
Koocanusa	2504	345	311	95	123	43	11	4	0														3436
Dry Forest	19	3	9	8																			39
Intermediate Forest	972	179	158	78	102	25	10	4	0														1529
Wet Forest	915	92	107	7	21	17	0																1159
Forested Wetland	598	72	37	2		0																	709
Total	19970	6111	4485	3367	2501	1854	1430	955	809	694	245	131	127	56	40	14	6	4	1	4	0	0	42805

References

M.V. Ketcheson *et al*. 2005. Columbia Basin BC Hydro Footprint Mapping. JMJ Holdings Inc., Nelson BC.

MacKillop, D.J. and G.F. Utzig. 2005. Primary Production in the Flooded Terrestrial Ecosystems of the Columbia Basin. Unpublished report prepared for the Columbia Basin Fish and Wildlife Compensation Program, Nelson, BC.

BIBLIOGRAPHY

a) Publications

Anderson, James D. (2011) British Columbia's Magnificent Parks: The First 100 Years. Harbour Publishing

BC Hydro (1969-1971) Annual Reports

BC Hydro (2008) Columbia River Project Water Use Plan Monitoring Program Terms of Reference, Arrow Lakes Reservoir Operations Management Plan.

BC Hydro Corporate Affairs (1988) Benefit/Cost Analysis of the Sale of the Columbia River Downstream Benefits (Draft)

BC Hydro (2008), Duncan Dam Water Use Plan Monitoring Program Terms of Reference: Cultural Resources Monitoring Plan

BC Hydro (2010) Kinbasket and Revelstoke Reservoirs Ecological Productivity Monitoring. Progress Report Year 1 (2008).

BC Hydro (2010) Non-Treaty Storage Agreement Renegotiations Performance Measure: Total Power Gain

BC Hydro and Power Authority (circa 1969) Columbia Construction Progress: Arrow Project

BC Hydro and Power Authority (circa 1969) Columbia Construction Progress: Duncan Project

BC Hydro and Power Authority (circa 1974) Columbia Construction Progress: Mica Project

BC Hydro (2005) Reservoir Recreation facility Obligations under CWL #47215 – Clause (o), Revelstoke Reservoir

BC Hydro (circa 1986). File #202-1506.0(2). Part 1: Revelstoke Dam Project. Line List 178.

Brent Harley and Associates (2004) Socio Economic Opportunity Study for the Valemount Area prepared for the Village of Valemount British Columbia

Bruce, D.R. (2004) Reservoir Access Obligations at Columbia Generation Facilities – Mica

Columbia Shuswap Regional District (2011) Policy F-29: BC Hydro Grants-in Lieu for Power Generating Facilities

Departments of External Affairs and Northern Affairs and National Resources (1964) *"The Columbia River Treaty and Protocol: A Presentation."*

de Zwart, I., G. Andrusak, J. Thorley, R. Irvine, S. Masse (2011) Duncan Dam Project Water Use Plan: Duncan Reservoir Fish Habitat Use Monitoring

DPA Group Inc. (1986) Revelstoke Canyon Dam: Socio-economic Impact Monitoring

Economic Growth Solutions (2009) Kinbasket Reservoir Commercial and Recreation Opportunities Study for Golden and Area Initiatives

Economics Division, Department of Agriculture, Ottawa (1962), A Preliminary Report on the Agricultural Potential of the Area Affected by the Proposed High Arrow Lakes Dam Project

Forward, P.C., Bogyo, J.M. (circa 1961). The present Economic Status of the Arrow Lakes Valley

Hearns, Glen (2008), The Columbia River Treaty: A Synopsis of Structure, Content, and Operations Prepared for: The Canadian Columbia River Forum

Janmaat, Dr. John M. and S. Islam, (2011) Review of Biophysical Impact of Columbia River Treaty Dams. Prepared for the Columbia Basin Trust

Hambruch, Paul (1994) Town of Golden and Area Mica Report

MacPherson, Barbara (1994) Columbia River Treaty Committee Arrow Lakes Report

Mica 5 and 6 Core Committee (2008) Letter to Mr. Bob Elton, President and Chief Executive Officer British Columbia Hydro and Power Authority

Missler, H.E. (1988) The Revelstoke Dam: A Case Study of the Selection, Licensing and Implementation of a Large Scale Hydroelectric Project in British Columbia, UBC Faculty of Graduate Studies

Perrin, Thorau and Associates Ltd. (2009), Cross Jurisdictional Review: Impact and Benefit Arrangements. Prepared for: BC Hydro

Peterson, G.R. and I.L. Withler (1965) Effects on Fish and Game Species of Development of Duncan Dam for Hydro-electric Purposes, Management Publication No. 8, B.C. Fish and Wildlife Branch.

Revelstoke Economic Development Commission (1994) Columbia River Treaty Committee: Impacts Revelstoke Area

Scott-May, Cathy and John Lerner (2007) Final Socio-Economic Monitoring Report Brilliant Expansion Project April 1, 2003 to Sept 30, 2007. Prepared for: Columbia Power Corporation

Tipper, K.G (1983), Compensation Proposal for the Impacts of the Libby Reservoir upon the Wildlife Resources of Southeastern BC

Townsend, Mayor Jeanette (1994) Columbia River Treaty Committee: Valemount Report

Utzig, G. and D. Schmidt (2011), Dam Footprint Impact Summary: BC Hydro Dams in the Columbia Basin. Prepared for: Fish and Wildlife Compensation Program: Columbia Basin

Wilson, J.W. (1973) People in the Way, University of Toronto Press

b) Web Based Sources

Arrow Lakes TSA Socio Economic Profile
http://www.for.gov.bc.ca/hts/tsa/tsa01/tsr3/Arrow_TSA_20032004_SEA_v1.1.pdf Accessed October 22, 2012

Arrow Lakes Transmission Line Description http://www.columbiapower.org/projects/arrowlakesline.asp Accessed October 1, 2012

BC Hydro Annual Report 2011
http://www.bchydro.com/etc/medialib/internet/documents/annual_report/2011_BCH_AnnualReport.Par.0001.File.2011-BCH-Annual-Report.pdf Accessed October 10, 2012

BC Hydro Columbia Basin Fish and Wildlife Compensation Program
http://www.bchydro.com/about/sustainability/environmental_responsibility/compensation_programs/about_fwcp/columbia_region.html Accessed October 16, 2012

BC Hydro Recreational Areas http://www.bchydro.com/community/recreation_areas.html Accessed September 26, 2012

BC Hydro Water Use Plan Update April 2012
http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q2/2012-04_gds12-80_columbia.Par.0001.File.2012-04-GDS12-80-Columbia-River-WUP-Update.pdf Accessed October 12, 2012

BC Parks Descriptions http://www.env.gov.bc.ca/bcparks/explore/ Accessed October 11, 2012

BC Water Licence Description
http://www.env.gov.bc.ca/wsd/water_rights/licence_application/index.html Accessed October 3, 2012

BC Water Rental Rate Schedule
http://www.env.gov.bc.ca/wsd/water_rights/water_rental_rates/cabinet/new_rent_structure.pdf Accessed October 4, 2012

Boat Launch Upgrades Arrow Lakes http://www.columbiapower.org/pdf/projects/2012-04-28_BCH_release_MOU.pdf Accessed October 1, 2012

Brilliant Dam Description http://www.columbiapower.org/projects/brilliantdam.asp Accessed October 1, 2012

British Columbia Financial and Economic Review 72nd Edition (July 2012)
http://www.fin.gov.bc.ca/tbs/F&Ereview12.pdf Accessed September 23, 2012

Columbia Basin Trust Annual Report 2011/2012
http://www.cbt.org/OnlineReader/AnnualReport/index.html Accessed September 29, 2012

Columbia Basin Trust Annual Reports 2002-2012 http://www.cbt.org/Newsroom/?Publications Accessed November 6, 2012

Columbia Basin Trust Act http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_96053_01 Accessed October 13, 2012

Columbia Basin Trust Description http://www.cbt.org/About_Us/ Accessed September 27, 2012

Columbia Basin Trust Community Initiatives and Affected Areas Programs http://www.cbt.org/uploads/pdf/CBT_CIP_AAPFactSheet_WEB.pdf Accessed October 11, 2012

Columbia Power Corporation Annual Report 2011/12 http://www.columbiapower.org/files/2012-06-27_Annual_Report%20_Final.pdf Accessed October 2, 2012

Columbia Power Corporation Description http://www.columbiapower.org/company/ourcompany.asp Accessed October 1, 2012

Columbia River Treaty http://www.empr.gov.bc.ca/EAED/EPB/Pages/Treaty.aspx Accessed September 23, 2012

Columbia River Treaty: A Short Summary http://www.rdck.bc.ca/publications/pdf/BC%20Hydro-%20Treaty%20pres.pdf Accessed October 1, 2012

Columbia River Treaty History http://blog.gov.bc.ca/columbiarivertreaty/history/ Accessed September 29, 2012

Columbia River Treaty Highlights http://blog.gov.bc.ca/columbiarivertreaty/treaty-highlights/ Accessed September 29, 2012

Columbia River Treaty Overview http://www.rdck.bc.ca/publications/pdf/BC%20Hydro-%20Treaty%20pres.pdf Accessed October 10, 2012

Columbia River Treaty Overview (U.S.) http://www.crt2014-2024review.gov/Files/Columbia%20River%20Treaty%20Slide%20A%20package.pdf Accessed October 10, 2012

Columbia River Treaty Past and Future http://www.crt2014-2024review.gov/Files/10Aug_Hyde_TreatyPastFuture_FinalRev.pdf Accessed October 10, 2012

Columbia River Treaty Protocol and Related Documents http://blog.gov.bc.ca/columbiarivertreaty/history/ Accessed September 23, 2012

Columbia River Treaty Review http://www.empr.gov.bc.ca/EAED/EPB/Documents/ColumbiaRiverTreatyReviewNov13(web).pdf Accessed September 23, 2012

Columbia River Water Use Plan
http://www.bchydro.com/etc/medialib/internet/documents/environment/pdf/wup_columbia_water_use_plan_revised_for_acceptance_by_th.Par.0001.File.wup_columbia_water_use_plan_revised_for_acceptance_by_th.pdf Accessed October 22, 2012

Columbia River Water Use Plan – Heritage Management Plan Monitoring Programs Annual Report: 2012
http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q1/CLB_MP9_AnnualReport.Par.0001.File.CLB-MP9-AnnualReport-2012-Feb-29.pdf Accessed October 11, 2012

Columbia River Water Use Plan - Revelstoke Flow Management Plan Monitoring Program Terms of Reference Resubmission, May 2010
http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2010q3/web_clbmon-15_tor.Par.0001.File.CLBMON_15_TOR_Addendum_2_12May2010.pdf
Accessed October 20, 2012

Columbia River Water Use Plan Update, April 2012
http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q2/2012-04_gds12-80_columbia.Par.0001.File.2012-04-GDS12-80-Columbia-River-WUP-Update.pdf Accessed October 12, 2012

Dam Footprint Impact Summary BC Hydro Dams in the Columbia Basin, March, 2011. Prepared by: Utzig, F. and D. Schmidt http://fwcpcolumbia.ca/version2/reports/pdfs/FWCP-CB_Impacts_Summary.pdf
Accessed September 27, 2012

Duncan Dam Description http://en.wikipedia.org/wiki/Duncan_Dam Accessed October 8, 2012

Duncan Dam Water Use Planning Report 2010
http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/lower_mainland/2011q2/ddmmon-10_yr2_2011-03-15.Par.0001.File.DDMMON-10-Yr2-2011-03-15.pdf Accessed October 9, 2012

Duncan Dam Water Use plan Annual Report 2011/2102
http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/wup/southern_interior/2012q2/ddm_annual_report.Par.0001.File.DDM-Annual-Report-2012-04-30.pdf Accessed November 2, 2012

Duncan Dam Spillway Upgrades http://thenelsondaily.com/news/work-duncan-dam-boosts-local-economy-14208#.UHRVGRXA-So Accessed October 9, 2012

Electricity Rate Comparison http://www.nrcan.gc.ca/energy/sources/electricity/1387 Accessed October 30, 3012

Final Socio-Economic Monitoring Report Arrow Lakes Generating Station and Transmission Line
http://www.columbiapower.org/pdf/final_report_SEM_ALGS.pdf Accessed October 5, 2012

Final Socio-Economic Monitoring Report Brilliant Expansion Project http://www.columbiapower.org/media/documents/final-s-e-monitoring-report.pdf Accessed October 1, 2012

Fish and Wildlife Compensation Program (Columbia Basin) http://www.fwcpcolumbia.ca/ Accessed September 22, 2012

Glacier Creek Park Description http://www.rdck.bc.ca/community/parks/kootena_lake_-_north/glacier_creek_regional_park.html Accessed October 17, 2012

Golden TSA Report http://www.for.gov.bc.ca/hts/tsa/tsa07/2008_tsr/Golden_TSR4_Analysis_Report_Feb20_09.pdf Accessed October 22, 2012

Goosegrass Creek Ecological Reserve Description http://www.env.gov.bc.ca/bcparks/eco_reserve/goosegras_er.html Accessed October 11, 2012

Hambler Provincial Park Description http://en.wikipedia.org/wiki/Hamber_Provincial_Park Accessed October 1, 2012

Horse Creek Recreation Site Description http://www.sitesandtrailsbc.ca/search/search-result.aspx?site=REC5775&districtCode=RDHW&type=Site Accessed October 17, 2012

Howser Description http://www.museevirtuel-virtualmuseum.ca/sgc-cms/expositions-exhibitions/hydro/en/dams/index.php?action=duncan Accessed October 8, 2012

Howser Glayco Campsite Description https://www.for.gov.bc.ca/dkl/rec/recsites/Howsermap.htm Accessed October 17, 2012

Kinbasket Lake Resort Description http://www.kinbasketlakeresort.com/ Accessed October 17, 2012

Koocanusa Boat Launch Press Release http://www.cbt.org/newsroom/?view&vars=1&content=News%20Release&WebDynID=1708 Accessed November 7, 2012

Koocanusa Reservoir Region interests area residents have identified in past public engagements http://blog.gov.bc.ca/columbiarivertreaty/files/2012/07/regional-interests-koocanusa.pdf Accessed October 11, 2012

Kootenay Canal Description http://www.bchydro.com/community/recreation_areas/kootenay_canal.html Accessed October 4, 2012

Kootenay Lake TSA Review http://www.for.gov.bc.ca/hts/tsa/tsa13/tsr2/analysis.pdf Accessed October 22, 2012

Lake Koocanusa Land Use Plan Joint Steering Committee Project Charter and Work Plan http://www.rdek.bc.ca/LakeKoocanusaOCP/ProjectCharterv4.pdf Accessed October 10, 2012

Libby Dam Coordination Agreement
https://www.enewsletters.gov.bc.ca/Columbia_River_Treaty_Review_eNewsletter/October_2012/October_Question_Libby_Agreement/article Accessed November 7, 2012

Libby Dam: Collapse of the Burbot Fishery
https://research.idfg.idaho.gov/Fisheries%20Research%20Reports/ResAFSParagamian2002%20Collapse%20Of%20Burbot%20Fisheries%20in%20the%20Kootenai%20River%20and%20Kootenay%20Lake.pdf
Accessed October 26, 2012

Libby Dam Description http://en.wikipedia.org/wiki/User:Publicplanet/sandbox Accessed October 26, 2012

Libby Dam Description http://www.libbymt.com/areaattractions/libbydam.htm Accessed October 9, 2012

Libby Dam Description http://en.wikipedia.org/wiki/Libby_Dam Accessed October 8, 2012

Mica Dam Description http://en.wikipedia.org/wiki/Mica_Dam Accessed September 29, 2012

Libby Dam Reservoir Act (1996)
http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_96262_01 Accessed November 6, 2012

Mica Generating Station Upgrade Description
http://www.bchydro.com/energy_in_bc/projects/mica_generating_station_upgrade.html Accessed September 29, 2012

Minto Ferry Description http://en.wikipedia.org/wiki/Minto_(sternwheeler) Accessed October 3, 2012

Non Treaty Storage Agreement Factsheet
http://www.bchydro.com/etc/medialib/internet/documents/stakeholder_engagement/ntsa_fact_sheet_march.Par.0001.File.NTSA%20Factsheet%20Mar%202012.pdf Accessed October 1, 2012

Non-Treaty Storage Agreement Project http://projects.compassrm.com/ntsa/ Accessed October 29, 2012

RDEK Board Highlights http://www.e-know.ca/news/rdek-board-highlights-2/?wpmp_switcher=mobile Accessed October 10, 2012

Recreational Opportunities Arrow Lakes
http://www.bchydro.com/community/recreation_areas/arrow_lakes_reservoir.html#Recreation_opportunities Accessed October 1, 2012

Revelstoke Dam Description
http://www.bchydro.com/community/recreation_areas/revelstoke_dam_visitor_centre.html Accessed September 29, 2012

Revelstoke Unit 5 Backgrounder
http://www.bchydro.com/etc/medialib/internet/documents/projects/revelstoke/Revelstoke_ProjBackgrounder_2011-Fall.Par.0001.File.Revelstoke-ProjBackgrounder-2011-Fall.pdf Accessed October 11, 2012

Revelstoke TSA Description
http://www.for.gov.bc.ca/hts/tsa/tsa27/2009/Revelstoke_TSR4_Analysis_Report_23_Feb_10.pdf
Accessed October 22, 2012

Revelstoke Unit 5 Description
http://www.bchydro.com/etc/medialib/internet/documents/projects/revelstoke/Revelstoke_ProjBackgrounder_2011-Fall.Par.0001.File.Revelstoke-ProjBackgrounder-2011-Fall.pdf Accessed September 29, 2012

Robson Valley TSA Report http://www.for.gov.bc.ca/hts/tsa/tsa17/tsr2/analysis.pdf Accessed October 22, 2012

The Future of the Columbia River Treaty http://munkschool.utoronto.ca/wp-content/uploads/2012/07/Bankes_and_Cosens_POWI_2012.pdf Accessed October 12, 2012

Tree Farm Licence 23 Description
http://www.for.gov.bc.ca/hts/tsr1/ration/tfl/t23/httoc.htm#RTppKC13 Accessed December 1, 2012

Valemount Profile http://www.valemount.ca/Documents/ValemountProfile2010.pdf Accessed October 6, 2012

Waneta Expansion Project http://www.columbiapower.org/projects/wanetaexpansion.asp Accessed October 1, 2012

Waneta Expansion Project Factsheet
http://www.columbiapower.org/files/WAX_FactSheet_Update_2012-08-27.pdf Accessed October 1, 2012

Waneta Terrestrial Compensation Program http://www.columbiapower.org/files/WTCP_Poster.pdf
Accessed October 1, 2012

Water Use Planning in BC
http://www.env.gov.bc.ca/wsd/plan_protect_sustain/water_use_planning/index.html Accessed October 5, 2012

Yellowjacket Creek Recreation Site Description http://www.sitesandtrailsbc.ca/search/search-result.aspx?site=REC1253&districtCode=RDHW&type=Site Accessed October 17, 2012