Contact
Sustainable Hydropower Website
C/- Hydro Tasmania
4 Elizabeth St
Hobart TAS 7000
AUSTRALIA

sustainable.hydropower@hydro.com.au

Water quality

Arrow Lakes, Canada

The addition of a hydropower plant to the Keenleyside Dam in Canada significantly reduced the passage of water over the spillway, resulting in reduced incidences of dissolved gas supersaturation downstream of the dam and significant reductions in fish mortality.

Overview

The Columbia River is the fourth largest in North America. It drains an area of 670,520 km² of which 102,260 km² are in Canada. The Columbia River Valley is typical of British Columbian valleys formed by glacial advances and retreats.

The 1964 Columbia River Treaty (the "Treaty") between Canada and the United States of America was an agreement regarding joint development of the Columbia River System. The treaty precipitated the construction of a dam near the downstream end of Lower Arrow Lake in south-eastern British Columbia. Arrow Dam raised the level of two natural lakes to form Arrow Lakes Reservoir and was subsequently renamed Keenleyside Dam.

Keenleyside Dam is comprised a combination of concrete gravity and earthfill structures. Discharge is facilitated through four spillway bays controlled by vertical lift gates and four low level outlets located on each side of the spillway.

Dam name

Scheme operator
Arrow Lakes Power Company

Size of scheme (MW)
185

Country
Canada

Catchment area
102 260 km^2

River
Columbia

Effective reservoir capacity
8.8 x 10^9 m^3

Construction years
1996 to 2002

Reservoir size
51,600 ha

External Recognition

- IHA Blue Planet Prize Winner 1995
- Association of Consulting Engineers of Canada 2003. Canadian Consulting Engineering Awards – Award of Excellence – Category: Project Management
- CEBC 2003 Awards for Engineering Excellence – Lieutenant Governor's Award for Engineering Excellence
- CEBC 2003 Awards for Engineering Excellence – Award of Excellence

Details

Twenty-four fish species have been recorded in the lower Columbia River system between Keenleyside Dam and the Canada-USA border. Several are species of conservation interest and are listed by the Council on the Status of Endangered Wildlife in Canada (COSEWIC) as being "Vulnerable" or "Threatened".

Dissolved Gas Supersaturation (DGS) below Keenleyside Dam historically occurred due to the entrainment of gas in water passing over the spillway structures. Further dissolution of gas occurred in the energy dissipators below the spillway. DGS has been shown worldwide to impact on some fish species, causing 'gas bubble disease', an affliction similar to the bends in human divers. Gas bubble disease has been known to result in mass mortality of fish for some distance below the dam wall.

Aside from the obvious power generation benefits, the retro-fitting of a hydro power plant to the dam provided an opportunity to reduce the frequency and duration of spill events. As a result, preliminary measurements following commissioning of the power plant indicate that dissolved gas levels downstream of the wall are similar to those within the reservoir, and incidences of DGS have been significantly reduced.

The project was implemented through a collective labour agreement, through which all workers other than professional and management staff was employed. This agreement includes provisions for maximizing the hiring of workers from the Columbia Basin region and for the hiring of minorities.

The design-build contract for the powerplant included provisions for regional economic benefits and First Nations involvement in the project. Contractual commitments were made for regional economic benefits totaling $50.4 million Cdn. First Nations benefits also included training & skills development. The contract included provisions giving the owner recourse against the contractor if the regional economic and First Nations benefit goals were not achieved.

Other Aspects

Environmental assessment and monitoring
The construction of the power plant was preceded by intensive environmental investigations. Among the potential challenges for which mitigation measures were developed and effectively implemented were:
• Storage level fluctuations
• Hydropeaking in the downstream environment
• Increased downstream water temperatures

• Altered hydrological regimes
• Geomorphic impacts
• Entrainment of fish through the power plant
• Loss of fish habitat

Multiple use benefits
Fertilisation programs and fish habitat creation have improved the salmon fishery in the Arrow Lakes region.

Erosion and Sedimentation
It was recognised that the use of coffer dams during the construction of the power plant may deleteriously influence geomorphic processes, hence earth fill and solid rock plugs were employed as alternative. Strategic sediment release and other mitigation strategies were employed at the commissioning of the project. Potential for erosion resulting from hydropeaking operation of the power plant was mitigated through the implementation of rock groynes and fill in strategic locations.

Distribution and sharing of benefits
The project showed a commitment to employing the local labour force and engaging local services. A close working relationship with First Nation representatives also ensured the values of indigenous groups were respected throughout the project.

Local Capacity building
Capacity building programs enhanced capability and opportunities for local communities and First Nation people, increasing skills bases for future employment.

Resource use
Innovative power station design at Keenleyside Dam enabled the Arrow Lakes Power Company to build an economically viable power station where previous investigations had deemed development of the site uneconomical. The scheme creates additional energy without additional regulation of the Columbia River system.

Further information

Source: Hydropower Good Practices Workshop, Annex VIII - Examples for Good Practice Report, Villach, Austria, October 2005. International Energy Agency.

http://www.hydroquebec.com/visit/virtual_visit/index.html

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