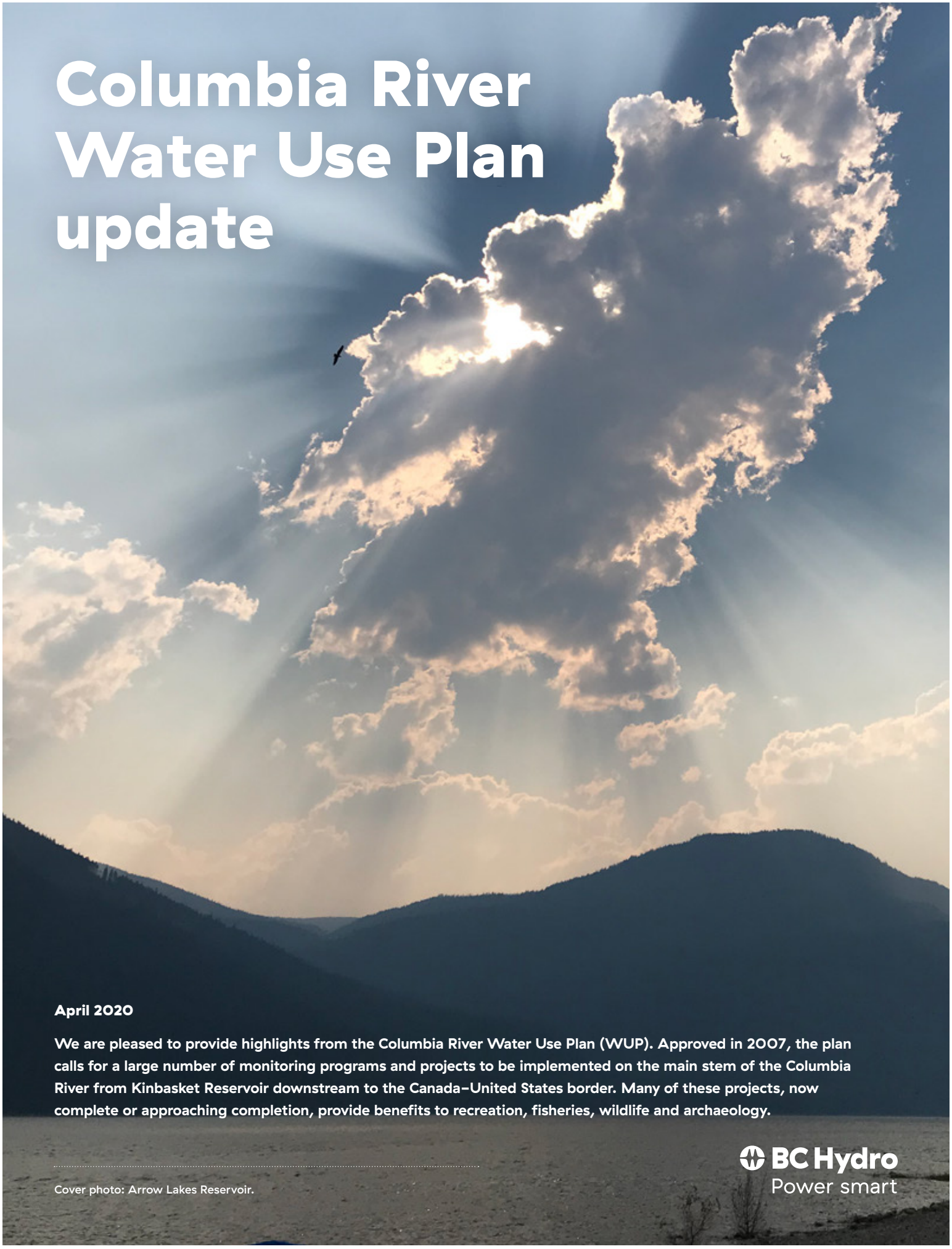
# Columbia River Water Use Plan update



**April 2020**

**We are pleased to provide highlights from the Columbia River Water Use Plan (WUP). Approved in 2007, the plan calls for a large number of monitoring programs and projects to be implemented on the main stem of the Columbia River from Kinbasket Reservoir downstream to the Canada–United States border. Many of these projects, now complete or approaching completion, provide benefits to recreation, fisheries, wildlife and archaeology.**

Cover photo: Arrow Lakes Reservoir.

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## Boat ramp improvements

Between 2008 and 2016, we built new ramps and made improvements to existing ramps at two sites on Kinbasket Reservoir and eight sites on Arrow Lakes Reservoir. These new and refurbished ramps will provide area boaters with safe and improved access for many years to come.

Anderson Point boat launch.

| Arrow Lakes and Kinbasket Reservoir boat ramp elevations | | | | |
|---|---|---|---|---|
| Location | Elevation of ramp toe | | Lowest operational water level* | |
| | Metres | Feet | Metres | Feet |
| **Arrow Lakes Reservoir** | | | | |
| Syringa Creek | 421.87 | 1,384.08 | 422.87 | 1,387.37 |
| Anderson Point | 425.00 | 1,394.30 | 426.00 | 1,399.02 |
| Edgewood | 425.76 | 1,396.70 | 426.76 | 1,400.13 |
| Fauquier | 424.66 | 1,393.24 | 425.66 | 1,396.52 |
| Burton | 425.40 | 1,395.67 | 426.40 | 1,398.95 |
| McDonald Creek | 426.00 | 1,397.64 | 427.00 | 1,400.92 |
| Nakusp Boat | 420.50 | 1,379.59 | 421.50 | 1,382.87 |
| Shelter Bay | 422.86 | 1,387.34 | 423.86 | 1,390.62 |
| **Kinbasket Reservoir** | | | | |
| Bush Harbour | 724.60 | 2,377.30 | 725.60 | 2,380.58 |
| Valemount Marina | 727.59 | 2,387.11 | 728.59 | 2,390.39 |

*Operational according to the following boat dimensions: 9.3 metre length, 3.1 metre width, 1 metre maximum draft (amount below waterline), and maximum weight of 4 tonnes.

## Boat ramp use study

The Boat Ramp Use study ran from 2010 and will wrap up in April of this year. The purpose of this study is to understand how user satisfaction, as well as volume and frequency of ramp use has changed with the boat launch upgrades throughout Arrow Lakes and Kinbasket Reservoirs. The interim results suggest that user satisfaction has significantly increased with the upgrades while the change in volume of public use is mixed.

In order to understand the effects of the upgrades on usership, we monitored the traffic using the boat ramps and also conducted periodic face-to-face interviews both before and after the upgrades occurred. Some sites experienced an increase in volume of public use while other sites saw a decrease or no change in volume. A comprehensive report that analyzes and summarizes all the data collected over the ten year study period will be available by the end of 2020.

Debris removal on Kinbasket Reservoir.

## Woody debris removal

We continue to remove floating woody debris from Kinbasket and Arrow Lakes Reservoirs and meet with Debris Management Committee members in Castlegar, Nakusp, Golden and Valemount to plan and prioritize work. Since 2007, we have completed close to $8.2 million of debris removal work on Kinbasket and Arrow Lakes Reservoirs. We estimate that we have removed over 261,500 cubic metres of woody debris from Kinbasket Reservoir and over 80,500 cubic metres from Arrow Lakes Reservoir.

For Arrow Lakes Reservoir, we focused our efforts last year (2019) around the Narrows, Eagle Bay, Shelter Bay, and Windy Bay. We also piled and burned just under 4,500 cubic metres of woody debris in 2019. This year's work on Arrow Lakes Reservoir will focus on some of the same areas such as Shelter Bay and Windy Bay as well as new areas further south such as Pingston. Due to new burning restrictions related to the COVID-19 pandemic, the debris removal work on Arrow Lakes Reservoir is being deferred until this fall at the earliest.

On Kinbasket Reservoir, we removed 17,620 cubic metres of debris in 2019. Land-based removal near Windfall Creek on Canoe Reach is planned in addition to water-based removal described below. Crews will also remove debris from high priority areas identified for the entire reservoir by the Golden and Valemount Debris Management Committees. If reservoir water levels reach close to full pool this year, we will conduct a water based collection program that focuses on the northern part of the reservoir where debris accumulations and densities are highest.

In 2019, the Kinbasket Reservoir Debris Management Program collaborated for the fourth year with the Reservoir Archaeology Program (RAP). The RAP is an archaeological inventory program underway in Kinbasket Reservoir and a number of other Columbia reservoirs to identify and record archaeological sites within the active erosion zone. The goal of the cooperation is to ensure that ground disturbance as a result of debris management work is managed in a way that is consistent with our best management practices for heritage and archaeological resources, even though many of the locations have been used repeatedly in the past. The additional work focuses on assessing historical debris management locations for previously unrecorded archaeological material. The additional inventory data collected further supports the RAP to better understand settlement patterns and prehistoric land use in the region. The collaboration is expected to continue in both Arrow Reservoir and Kinbasket Reservoir again in 2020 with a focus on the Narrows area of Arrow Lakes Reservoir and the Ptarmigan Creek area of Kinbasket Reservoir.

## Reservoir productivity

The field component of programs that are investigating links between reservoir biological productivity and operation of Kinbasket and Revelstoke Reservoirs was completed in 2019 as scheduled. Final reporting, including a synthesis of all study years, is underway and planned for completion in 2021. These studies focus on learning how reservoir aquatic food webs work and whether we could make changes to reservoir operations to improve biological production. The food web starts with nutrients, such as phosphorus and nitrogen. Nutrients are made available to phytoplankton (algae) and then move up the food chain to zooplankton and kokanee. The data are combined with other large reservoir information to help investigate the influence of both operational and regional productivity drivers.

To gather year–round depth profiles of temperature, conductivity, and turbidity, BC Hydro moored three experimental tethered autonomous profilers in Revelstoke Reservoir. Data collection took place from 2012 to 2019. This is the first time these profilers have been tethered in one location and used in freshwater. This type of profiler is normally deployed to drift in the open ocean where it sits at depth and rises on a regular basis to collect a profile of temperature, conductivity, and other data. Upon reaching the ocean surface, the data and GPS location of the profiler are telemetered by ARGO satellite. The profiler then returns to depth to await the next cycle. There are thousands of these profilers throughout the oceans collecting data that would otherwise be very costly to gather by boat.

The profilers used to collect data in Revelstoke Reservoir were specifically designed to slide up and down a low friction tether that was held in place by subsurface flotation at the top and an anchor on the bottom. This tether makes these profilers suitable for mooring in lakes and reservoirs. Since the profiler does not rise all the way to the surface, it does not have satellite communications, and instead data are recorded within the profiler. The profiler is capable of collecting daily conductivity, temperature, and depth profiles for a year. Once recovered, the data are uploaded and the batteries changed for the next deployment. These instruments were courtesy of our collaboration with Dr. Roger Pieters at UBC's Department of Earth, Ocean, and Atmospheric Sciences.

Retrieving one of the experimental tethered autonomous profilers that was moored in the Revelstoke Reservoir.

The subsurface floats on one of the experimental tethered autonomous profilers that kept tension on the line.

## Revelstoke dam minimum flow

A variety of aquatic studies, most of which started in 2007 to monitor variables ranging from water temperature, water levels, nutrients, benthic productivity, and fish communities have been conducted. We began providing a minimum flow from Revelstoke Dam of 142 cubic metres per second (5,000 cubic feet per second) in December 2010 when we started operating the newly installed fifth generating unit. Since that time we have always maintained discharge flows above the required minimum flow. Flows are typically well above that level to prevent damage to the turbines that can be caused by cavitation. So far, the data collected does not show that there has been any change to fish distribution, growth, or diversity as a result of the minimum flow. We developed Habitat Suitability Indices (HSI) for juvenile fishes based on the minimum flow. A Technical Committee (TC) composed of First Nations, BC Hydro and regulatory agency representatives reviewed the HSIs and examined a recently developed bioenergetics model which looks at the effects of flows on Bull Trout and Mountain Whitefish energy expenditures. The model now needs to be field tested.

These studies are all grouped under the Revelstoke Flow Management Plan and most are either ending or nearing the end of their scheduled term. We will review them together once they all end, likely in the next two years.

## White sturgeon

The Canadian portion of the Upper Columbia River white sturgeon population was listed as endangered under the Species at Risk Act in 2006. This was due to recruitment failure, where an insufficient number of young survive to become mature adults. We are working in cooperation with First Nations, stakeholders, and federal and provincial government partners to help restore the Upper Columbia River white sturgeon populations through long-term monitoring programs developed under the Water Use Plan.

We are conducting several studies to better understand white sturgeon spawning and how conditions at identified spawning locations influence when spawning occurs and the rate of egg development. Results have shown that sturgeon spawn from June through August at multiple locations throughout the Columbia River including downstream of Revelstoke Dam, near Kinnaird downstream of the Hugh L. Keenleyside Dam and the Arrow Lakes Generating Station, downstream of Waneta Dam, and in the United States.

The white sturgeon conservation aquaculture program has been releasing hatchery-raised sturgeon into the Columbia River annually since 2002 and has been very successful. Monitoring shows that more of the young fish have survived

A juvenile White sturgeon.

than originally expected. As a result of high survival, numbers of juvenile sturgeon being released into the Canadian portion of the Columbia River has been reduced over the years with only 200 fish being released in the spring of 2020, compared to 4,000 a decade ago. The aquaculture program now focuses on collecting eggs and larvae from the wild for rearing in a hatchery to ensure as many wild adults are represented in the progeny released back into the river. After being collected in the river, wild eggs and larvae are initially reared in a streamside trailer near the Waneta spawning location to make sure they incubate in natural river conditions. The larvae are then transferred to the hatchery and reared until nine months of age and 200 grams in weight which has shown to improve survival after release into the Columbia River. This approach of collecting offspring produced in the wild is important to maintain as much genetic diversity as possible. In 2020, tissue samples from fish born at these various spawning areas are being analyzed using genetic techniques to estimate the number of wild adults contributing to spawning events. This information will help us continue to refine the conservation aquaculture program to ensure the genetic integrity of the wild population is maintained.

We are continuing stock assessments that estimate the number of wild white sturgeon remaining in the Columbia River between the Hugh L. Keenleyside and Grand Coulee Dams. The current estimate for the Canadian portion of the Columbia River is approximately 1,100 wild adults, with more than 5,500 hatchery-origin sturgeon at large. We are also finding that hatchery-origin sturgeon are becoming reproductive and preliminary results suggest that a small portion of hatchery-origin males are likely contributing to spawning events. How these reproductive hatchery fish will interact with wild spawners is unknown. In 2019, a number of hatchery-origin sturgeon in both Canada and the U.S. were implanted with telemetry tags allowing us to track their movements between key habitats, including which spawning

habitats they may be using. This information, along with population abundance estimates and juvenile survival numbers, is being used to help plan white sturgeon recovery efforts.

While the specific cause of recruitment failure is being investigated by multiple studies, changes to substrate conditions at spawning sites as a result of river regulation has been identified as an area where restoration could have a positive effect. However, the inter–annual variability and characteristics of substrate changes at known spawning sites is unclear. Beginning in 2017, BC Hydro commissioned a study to better understand current substrate conditions and to assess the feasibility of restoration options with high likelihood of benefiting white sturgeon. The study included the development of tools to describe current conditions and assess the potential efficacy of restoration options. Workshops were held in 2019 and early 2020 with experts to review current conditions and develop restoration options for areas designated as unsuitable based on biological and physical criteria. Preliminary results suggest that options likely to succeed exist at a few spawning locations and consist of placement of patches of suitable substrate that will be partially mobile on a nearly annual timescale. The next phase of the work will include more detailed designs of the habitat restoration options.

BC Hydro biologist James Crossman releases a White sturgeon into the Columbia River near Genelle.

## Lower Columbia fish studies

We are continuing field surveys during flow changes from the Hugh L. Keenleyside Dam. Juvenile fish are at risk of being stranded during large flow reductions during the summer period when they are typically found in shallow, warm productive inshore areas. In accordance with the Lower Columbia River Fish Stranding Protocol, we assess the risk of stranding fish before we plan to reduce discharge flows from Hugh L. Keenleyside Dam using data collected during previous flow reduction events. For significant reductions in flows, we send out crews to look for stranded fish downstream of Hugh L. Keenleyside Dam. This represents a considerable amount of staff effort to understand the impacts of our operations and protect fish. From April 1, 2018 to March 31, 2019, BC Hydro sent out crews on 13 separate occasions.

We are also continuing annual surveys on fish abundance, distribution and life history in the Columbia River below Hugh L. Keenleyside Dam to better understand the effects of dam operations on fish populations. The Lower Columbia River Large River Fish Indexing Program completed its thirteenth year of monitoring in 2019. Key species monitored include Rainbow Trout, Mountain Whitefish and Walleye. Monitoring Rainbow Trout also helps assessing the long term effects of the Rainbow Trout Spawning Protection Flows.

## Rainbow trout technical forum

Rainbow Trout are a key sportfish in the mainstem Columbia River and typically spawn in the Lower Columbia River from March until June. Key mainstem spawning areas below the Hugh L. Keenleyside Dam are Norn's Creek Fan and in the mainstem area near Genelle. Rainbow Trout eggs may be vulnerable to reductions in water flows until fry hatch about six to eight weeks after the eggs are deposited. This vulnerability is dependent on a number of factors including weather conditions, substrate, and duration of exposure to air (dewatering).

An adult Rainbow Trout. Photo by Jeremy Baxter.

The Rainbow Trout Spawning Protection Flows (RTSPF) provide stable or increasing flows from April through June. Flows are also lowered at the end of March, prior to the peak spawning period, to encourage Rainbow Trout to spawn in lower elevations. This minimizes the chance that incubating eggs will be later dewatered.

While the results to date have shown that the Lower Columbia Rainbow Trout population has increased over the period of the RTSPF implementation, it is unclear if this is a direct result of the protection flows or another factor.

Starting last year, we alternate between years of RTSPF and no RTSPF. Hence 2019 was a year without RTSPF and 2020 will be with flows. We carefully monitor the survival of Rainbow Trout eggs at specific locations. This experimental approach will improve our understanding of the direct effects of these flows on the adult Rainbow Trout population in the Lower Columbia River. At the end of the second year of the study (this coming fall), the Columbia River Rainbow Trout Flows Technical Forum will review the results and decide if enough data have been collected or if further study is required.

The study may continue for up to a five-year period. If the RTSPF are determined to provide significant benefits to the adult Rainbow Trout population, they will be considered for further implementation. This approach is endorsed by the Columbia River Rainbow Trout Flows Technical Forum, which is composed of regulatory agencies, First Nations, and representatives from BC Hydro.

## Valemount peatland

This study's main objectives are to assess whether erosion is increasing or decreasing in the Valemount peatland and the primary causes of any observed erosion. A preliminary study conducted in 2008 concluded that erosion processes were directly related to Kinbasket Reservoir operations, although it would take 2,000 years to erode the entire site at the observed rates. We are evaluating if the current study (using the most recent available aerial surveys) can be used to better understand the erosion mechanisms and determine to what extent these are influenced by reservoir operations. Aerial photography flown in 2019 and a field assessment of the peatland has provided preliminary indications that reservoir operations are removing peatland material at lower elevations but at upper reservoir elevations the peatland remains functional. This could be due to a shorter inundation periods at upper elevations with a longer effective growing season for plants to maintain peatland function. The next aerial photography will be flown in 2024 to assess changes in peatland extent and live peat extent.

## Wildlife habitat enhancement projects

### ARROW LAKES RESERVOIR

In the fall of 2019, BC Hydro completed Phase 1 of the wildlife enhancement project in the drawdown zone of the Burton Flats. The project design creates a mixture of shallow and deep wetland habitat in the drawdown zone of the Lower Arrow Lakes Reservoir. The project consists of a series of habitat features which will be combined in phases to evaluate the effectiveness of the design and habitat establishment prior to completion of the entire proposed works. The main design features include primary shallow tiered wetlands; a secondary shallow disconnected wetland; habitat and planting mounds constructed of excavated material; a deep waterfowl pond; and drainage channels to connect the wetlands to the existing gravel pond and the reservoir. The total footprint of the wildlife enhancement project is 6.5 hectares. The full design will create 1.7 hectares of wetland area.

Having a mix of ponds fed from groundwater and from the reservoir will provide a wider range of habitat for wildlife and plants. These wetlands are intended to remain "in the wet" even during the drawdown period, providing wildlife habitat year-round. Kingfishers, larkspurs and elk have already been observed using the newly constructed wetland.

The remainder of the work will be completed during Phase 2 of construction. The design details for Phase 2 may be refined following Phase 1 monitoring. The construction schedule will depend on a number of factors, including reservoir levels.

Phase 1 of the wildlife habitat enhancement project at the Burton Flats.


The Burton wetland design includes constructing ponds of different depths to support a wide range of wildlife.

Green-winged teals in pond B1 at Burton Flats.

## KINBASKET RESERVOIR

We are still waiting for full pool reservoir conditions, which did not occur in 2016 to 2018, to see whether the debris mounds we built in fall 2015 can withstand high water levels and wave action. We are monitoring in 2020 to get a baseline of vegetation and mound condition ahead of the anticipated full reservoir conditions. In the event the reservoir reaches full pool, a post-inundation monitoring session will assess any changes to the debris mounds and vegetation that may have occurred due to reservoir conditions.

To protect wetland habitat in the Valemount Peatland, large amounts of accumulated woody debris was removed from several kilometres of the drawdown zone in January 2018. Removal of this woody debris in other Kinbasket Reservoir and Valemount Peatland locations has been followed by a positive response in vegetation growth and diversity of plants. We will be monitoring if the debris exclusion booms are effective in excluding floating wood debris in the event the reservoir refloats deposited wood this summer.

# Arrow Lakes Reservoir soft constraints performance 2019

| Soft constraint | Target | 2019 performance |
|---|---|---|
| **Recreation** | Reservoir water levels between 1,435 feet and 1,440 feet from May 24 to September 30. Flexibility to achieve lower reservoir levels of 1,424 feet during the recreation season would be acceptable with proposed construction/upgrade of boat ramps for recreation interests served by these formal access points. | The reservoir water level was between 1,435 and 1,440 feet 41.5% of the time during the recreation season (May 24 to September 30) and above 1,424 feet 100% of the time. |
| **Wildlife** | Ensure inundation of nesting bird habitat by rising reservoir levels and availability of fall migratory bird habitat is no worse than recent average (1984–1999). Target a reservoir level of 1,438 feet or lower by August 7. | Arrow Lakes Reservoir was below 1,424 feet for about 21.8% of the time between April 30 and July 16. This resulted in below average conditions for nesting birds. The reservoir was below 1,438 feet for 100% of the time between August 7 and October 31 for fall migratory birds. |
| **Fish** | Reservoir levels above 1,424 feet to ensure tributary access during kokanee spawning period from late August to early November. | Reservoir was above 1,424 feet 100% of the time between August 25 and November 15. |
| **Vegetation** | Maintain current (2004) level of vegetation in the drawdown zone by maintaining lower reservoir water levels during the growing season. | Reservoir was below 1,424 feet for 8.7% of the time between May 1 and October 31. |
| **Erosion** | Minimize duration of full pool events and avoid sudden drawdown once full pool has been reached to avoid shoreline slumping. Reservoir water level of 1,440 feet is ideal. | The reservoir reached a peak level of about 1,440 feet on June 21, about 4 feet below full pool. Due to a return of drier summer conditions, the Columbia system was operated in proportional draft for the balance of summer. For this reason, the reservoir drafted to about 1,426 feet on August 31 and subsequently refilled to 1,429 feet on September 30 as inflow conditions improved. |
| **Culture and Heritage** | The original target was 'reservoir levels at or below 1,430 feet for as long as possible to limit impacts to archaeological sites'. During the five-year interim review of the Arrow soft constraints, this target was determined not to be effective due to the presence of 102 archaeological sites at elevations below 1,430 feet. | Lower Arrow Lakes to inventory heritage sites and identify impacts as a result of normal reservoir operations. Information gathered by the RAP is expected to assist future decision makers and development of an Archaeological Management Plan. |

## HOW TO GET MORE INFORMATION

Copies of the Columbia River Water Use Plan, study terms of reference, reports, performance measures, Columbia River WUP Consultative Committee report, and other water use planning information are available at: **bchydro.com/about/sustainability/conservation/water_use_planning/southern_interior/columbia_river.html.**

**Questions? Please get in touch.**


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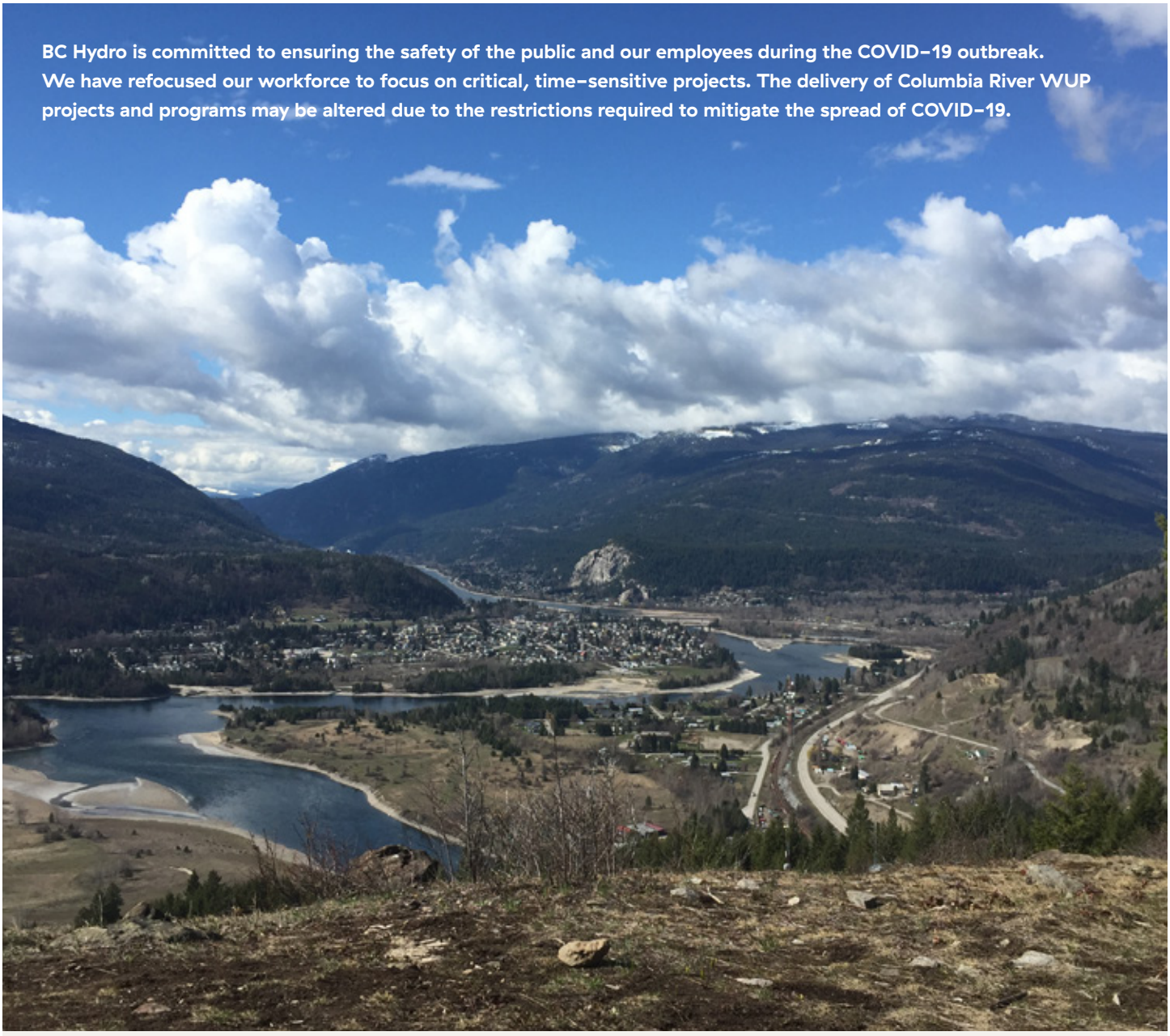
**BC Hydro is committed to ensuring the safety of the public and our employees during the COVID–19 outbreak. We have refocused our workforce to focus on critical, time–sensitive projects. The delivery of Columbia River WUP projects and programs may be altered due to the restrictions required to mitigate the spread of COVID–19.**



The confluence of the Columbia and Kootenay Rivers in Castlegar.

## Completed projects

Shelter Bay Park boat ramp upgrades (Arrow Lakes Reservoir)
Nakusp boat ramp replacement (Arrow Lakes Reservoir)
MacDonald Creek Park boat ramp upgrades (Arrow Lakes Reservoir)
Burton boat ramp construction (Arrow Lakes Reservoir)
Fauquier boat ramp upgrades (Arrow Lakes Reservoir)
Edgewood boat ramp upgrades (Arrow Lakes Reservoir)
Syringa Park boat ramp upgrades (Arrow Lakes Reservoir)
Anderson Point boat ramp construction (Arrow Lakes Reservoir)
Bush Harbour boat ramp construction (Kinbasket Reservoir)
Valemount Marina boat ramp upgrades (Kinbasket Reservoir)
Cartier Bay wetland protection project (Revelstoke)
Airport Slough wetland protection project (Revelstoke)
Revegetation planting (Arrow Lakes Reservoir)
Sturgeon hatchery upgrade (mid–Columbia River)

## Completed studies

Recreation demand study (Arrow Lakes Reservoir)
Woody debris removal environmental review (Kinbasket, Arrow Lakes Reservoir and Lower Columbia River)
Woody debris inventory, management strategy and removal (Kinbasket and Arrow Lakes Reservoir)
Feasibility of boat ramp improvements (Kinbasket, Arrow Lakes, mid–Columbia River and Lower Columbia River)
Indian Eddy dredging engineering and environmental review (Lower Columbia River)
Erosion protection and monitoring (mid–Columbia River)
Erosion long term monitoring (mid–Columbia River)
Inventory of vegetation resources (Kinbasket and Arrow Lakes Reservoir)
Juvenile fish stranding study (mid–Columbia River)
Bull trout monitoring program (Kinbasket Reservoir)
Rainbow trout monitoring program (Kinbasket Reservoir)
Burbot life history (Kinbasket and Arrow Lakes Reservoir)
Macrophyte study (Revelstoke Reservoir)
Nagle Creek wetland study (Revelstoke Reservoir)
Wetland vegetation study (Kinbasket Reservoir)
Sturgeon spawning habitat assessment (mid–Columbia River)
Sturgeon incubation and rearing study (mid–Columbia River)
Effects of Revelstoke 5 flow changes on incubation of sturgeon (mid–Columbia River)
Sturgeon inventory and habitat use (Kinbasket Reservoir)
Sturgeon recolonization risk assessment (Kinbasket Reservoir)
Spawning fish tributary access study (Arrow Lakes Reservoir)
Sculpin and dace study (Lower Columbia River)
Rainbow trout spawning study (Lower Columbia River)
Whitefish spawning study (Lower Columbia River)
Whitefish egg monitoring study (Lower Columbia River)
Great blue heron study (Lower Columbia River)
Nest mortality of migrating birds (Kinbasket and Arrow Lakes Reservoir)
Neotropical migrant bird use study (Arrow Lakes Reservoir)
Shorebird and waterbird monitoring study (Arrow Lakes Reservoir)
Amphibian and reptile monitoring study (Kinbasket and Arrow Lakes Reservoir)
Heritage monitoring wind and wave erosion study (Arrow Lakes Reservoir)
Archaeological overview assessment (Kinbasket, Revelstoke, and Arrow Lakes Reservoir)
Juvenile fish habitat use (mid–Columbia River)
Inventory of mosquito populations (Revelstoke area)

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