

## **Duncan Dam Project Water Use Plan**

### **Monitoring Programs and Physical Works Annual Report: 2022**

#### **Implementation Period: April 2021 to March 2022**

- DDMMON-1 Lower Duncan River Ramping Rate Monitoring
- DDMMON-2 Lower Duncan River Habitat Use Monitoring
- DDMMON-3 Lower Duncan River Hydraulic Model Development
- DDMMON-4 Lower Duncan River Kokanee Spawning Monitoring
- DDMMON-5 Upper Duncan River Bull Trout Migration Monitoring
- DDMMON-6 Lower Duncan Dam Bull Trout Passage Monitoring
- DDMMON-7 Lower Duncan River Water Quality Monitoring
- DDMMON-8 Duncan Watershed Riparian and Cottonwood Monitoring
- DDMMON-9 Lower Duncan River Mosquito Monitoring and Management Plan Development
- DDMMON-10 Duncan Reservoir Fish Habitat Use Monitoring
- DDMMON-11 Duncan Reservoir Burbot Monitoring
- DDMMON-12 Duncan Reservoir Archaeological Overview Assessment
- DDMMON-13 Duncan Reservoir Archaeological Site Erosion Monitoring
- DDMMON-14 Duncan Wildlife Use Monitoring
- DDMMON-15 Lower Duncan River Stranding Protocol Development and Finalization
- DDMMON-16 Lower Duncan River Fish Stranding Impact Monitoring
- DDMMON-17 Duncan Reservoir Kokanee Stock Assessment
- DDMWORKS-1 Lower Duncan River Argenta Slough Erosion Protection
- DDMWORKS-2 Duncan Reservoir Glacier Creek Boat Ramp Extension
- DDMWORKS-3 Plan to Address Nutrient Retention Caused by Duncan Dam Operations
- DDMWORKS-4 Action Plan to Minimize Stranding of Kokanee Spawning in Lower Duncan River Sidechannels

**For Conditional Water Licence for Duncan Dam and Reservoir 27027**

**April 29, 2022**

## **BC Hydro Duncan Dam Project Water Use Plan Monitoring Programs and Physical Works Annual Report: 2022**

### **1 Introduction**

This document represents a summary of the status and the results of the Duncan Dam Water Use Plan (WUP) monitoring programs and physical works to March 31, 2022, as per the Duncan Dam Order under the *Water Act*, dated December 21, 2007, and Clause 1 Amendment dated June 20, 2016. There are seventeen monitoring programs and four physical works.

### **2 Status**

The following table outlines the dates that Terms of Reference (TOR) for the Duncan Dam WUP monitoring programs and physical works were submitted to and approved by the Comptroller of Water Rights (CWR).

**Table 2-1: Dates of Duncan Dam WUP TOR Submissions and Approvals by the Comptroller of Water Rights**

| Monitoring Program & Physical Works TOR   | Order Clause | Original ToR Submission |               | Most Recent ToR Resubmission |               |
|---|--------------|-------------------------|---------------|------------------------------|---------------|
|   |              | Date Submitted          | Date Approved | Date Submitted               | Date Approved |
| DDMMON-1 Lower Duncan River Ramping Rate Monitoring   | Clause 5(e)  | Apr 03, 2008            | Apr 30, 2008  |                              |               |
| DDMMON-2 Lower Duncan River Habitat Use Monitoring  | Clause 5(e)  | Aug 07, 2008            | Sep 9,2008    |                              |               |
| DDMMON-3 Lower Duncan River Hydraulic Model Development   | Clause 5(e)  | Apr 03, 2008            | Apr 30, 2008  | May 14, 2021                 | Jun 22, 2021  |
| DDMMON-4 Lower Duncan River Kokanee Spawning Monitoring   | Clause 6(a)  | Apr 03, 2008            | Apr 30, 2008  | Dec 19, 2008                 | Mar 17, 2009  |
| DDMMON-5 Upper Duncan River Bull Trout Migration Monitoring   | Clause 6(b)  | Jan 23, 2008            | Mar 05, 2008  | Feb 22, 2010                 | Mar 18, 2010  |
| DDMMON-6 Lower Duncan Dam Bull Trout Passage Monitoring   | Clause 6(b)  | Jan 23, 2008            | Mar 05, 2008  |                              |               |
| DDMMON-7 Lower Duncan River Water Quality Monitoring  | Clause 6(c)  | Dec 16, 2008            | Mar 11, 2009  |                              |               |
| DDMMON-8 Duncan Riparian Monitoring   | Clause 6(d)  | Aug 07, 2008            | Sep 09, 2008  | Nov 01, 2012                 | Nov 15, 2012  |
| DDMMON-9 Lower Duncan River Mosquito Monitoring and Management Plan Development                     | Clause 6(e)  | Aug 07, 2008            | Sep 09, 2008  | May 13, 2013                 | Jun 13, 2013  |
| DDMMON-10 Duncan Reservoir Fish Habitat Use Monitoring  | Clause 6(f)  | Dec 16, 2008            | Mar 11, 2009  |                              |               |
| DDMMON-11 Duncan Reservoir Burbot Monitoring  | Clause 6(g)  | Apr 03, 2008            | Apr 30, 2008  | May 01, 2013                 | May 29, 2013  |
| DDMMON-12 Duncan Reservoir Archaeological Overview Assessment                                       | Clause 5(f)  | Dec 04, 2009            | Feb 05, 2010  |                              |               |
| DDMMON-13 Duncan Reservoir Archaeological Site Erosion Monitoring                                   | Clause 5(g)  | Dec 04, 2009            | Apr 07, 2010  |                              |               |
| DDMMON-14 Duncan Wildlife Use Monitoring  | Clause 6(h)  | Aug 07, 2008            | Sep 09, 2008  | Jun 09, 2017                 | Jun 07, 2017  |
| DDMMON-15 Lower Duncan River Stranding Protocol Development and Finalization                        | Clause 5(e)  | Dec 16, 2008            | Mar 11, 2009  | Jul 30, 2009                 | Aug 31, 2009  |
| DDMMON-16 Lower Duncan River Fish stranding impact monitoring                                       | Clause 5(e)  | Jul 23, 2008            | Sep 08, 2008  | Jul 04, 2018                 | Jul 20, 2018  |
| DDMMON-17 Duncan Reservoir Kokanee Stock Assessment   | Clause 6(f)  | Dec 04, 2009            | Apr 08, 2010  |                              |               |
| DDMWORKS-1 Argenta Slough Erosion Protection  | Clause 5(a)  | Jan 23, 2008            | Mar 18, 2008  | Dec 31, 2018                 | Jan 25, 2019  |
| DDMWORKS-2 Glacier Creek Boat Ramp  | Clause 5(b)  | Jan 23, 2008            | Mar 18, 2008  |                              |               |
| DDMWORKS-3 Plan to Address Nutrient Retention Caused by Duncan Dam Operations                       | Clause 5(d)  | Jan 23, 2008            | Mar 18, 2008  | Dec 18, 2020                 | Jan 12, 2021  |
| DDMWORKS-4 Action Plan to Minimize Stranding of Kokanee Spawning in Lower Duncan River Sidechannels | Clause 5(c)  | Dec 04, 2009            | Apr 08, 2010  | Dec 03, 2013                 | Jan 15, 2014  |

### 3 Schedule

The following table outlines the current schedule for the monitoring programs and physical works being delivered for the Duncan Dam WUP.

**Table 3-1: Monitoring Programs and Physical Works Schedule as of March 31, 2022**

| Monitoring Programs  | 2008    | 2009    | 2010    | 2011    | 2012    | 2013    | 2014    | 2015    | 2016    | 2017     | 2018                     | 2019     | 2020     | 2021     | 2022     |
|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|--------------------------|----------|----------|----------|----------|
|  | WLR YR1 | WLR YR2 | WLR YR3 | WLR YR4 | WLR YR5 | WLR YR6 | WLR YR7 | WLR YR8 | WLR YR9 | WLR YR10 | WLR YR11<br>Final Review | WLR YR12 | WLR YR13 | WLR YR14 | WLR YR15 |
| DDMMON-1 Lower Duncan River Ramping Rate Monitoring  | ✓       | ✓F      |         |         |         |         |         |         |         |          |                          |          |          |          |          |
| DDMMON-2 Lower Duncan River Habitat Use Monitoring   | ✓       | ✓       | ✓       | ✓       | ✓F      |         |         |         |         |          |                          |          |          |          |          |
| DDMMON-3 Lower Duncan River Hydraulic Model Development  |         | ✓       | ✓       |         | ✓       |         |         |         |         | ✓        | *                        | ✓        | ✓        | ✓F       |          |
| DDMMON-4 Lower Duncan River Kokanee Spawning Monitoring  | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓F       |                          |          |          |          |          |
| DDMMON-5 Upper Duncan River Bull Trout Migration Monitoring  | ✓       | ✓       |         |         | ✓       | ✓       |         | ✓       |         | ✓        | ✓F                       |          |          |          |          |
| DDMMON-6 Lower Duncan Dam Bull Trout Passage Monitoring  | ✓       | ✓       | ✓       | *       |         |         |         |         |         |          |                          |          |          |          |          |
| DDMMON-7 Lower Duncan River Water Quality Monitoring   |         |         | ✓       | ✓       | ✓F      |         |         |         |         |          |                          |          |          |          |          |
| DDMMON-8 Duncan Riparian Monitoring  |         | ✓       | ✓       |         | ✓       | ✓       | ✓       | ✓       | ✓       | ✓        | ✓F                       |          |          |          |          |
| DDMMON-9 Lower Duncan River Mosquito Monitoring and Management Plan Development                      |         | ✓       | ✓       | ✓       | ✓       |         | ✓       |         | ✓       | ✓F       |                          |          |          |          |          |
| DDMMON-10 Duncan Reservoir Fish Habitat Use Monitoring   |         | ✓       | ✓       | ✓       | ✓       |         | ✓       |         | ✓F      |          |                          |          |          |          |          |
| DDMMON-11 Duncan Reservoir Burbot Monitoring   |         | ✓       | ✓       | ✓       |         |         | ✓       | ✓       | ✓F      |          |                          |          |          |          |          |
| DDMMON-12 Duncan Reservoir Archeological Overview Assessment   |         |         | ✓F      |         |         |         |         |         |         |          |                          |          |          |          |          |
| DDMMON-13 Duncan Reservoir Archeological Site Erosion Monitoring                                     |         |         |         | ✓       | ✓       | ✓       | ✓       | ✓F      |         |          |                          |          |          |          |          |
| DDMMON-14 Duncan Wildlife Use Monitoring   |         | ✓       |         | ✓       |         |         | *       |         |         | *        | ✓F                       |          |          |          |          |
| DDMMON-15 Lower Duncan River Stranding Protocol Development and Finalization                         |         | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓        |                          | ✓        | ✓        | ✓F       |          |
| DDMMON-16 Lower Duncan River Fish stranding impact monitoring  | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓        | ✓                        | ✓        | ✓F       |          |          |
| DDMMON-17 Duncan Reservoir Kokanee Stock Assessment  |         |         |         |         |         |         |         |         | ✓       | ✓        | ✓F                       |          |          |          |          |
| <b>Physical Works</b>  |         |         |         |         |         |         |         |         |         |          |                          |          |          |          |          |
| DDMWORKS-1 Argenta Slough Erosion Protection   | ✓       | ✓       | *       |         |         | *       |         |         |         |          |                          | ✓F       |          |          |          |
| DDMWORKS-2 Glacier Creek Boat Ramp   | *       | ✓       |         |         |         |         |         |         |         |          |                          |          |          |          |          |
| DDMWORKS-3 Kootenay Lake Nutrient Loading Funding  | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓       | ✓        | ✓                        | ✓        | ✓        | ✓        | ■        |
| DDMWORKS-4 Action Plan to minimize stranding of kokanee stranding in Lower Duncan River Sidechannels |         |         |         |         |         | ✓       | *       | *       | ✓       | ✓        |                          | ✓        |          | ✓F       |          |

Legend: ■ = Program to be undertaken/initiated in identified year  
u/w = Program is underway  
✓ = Program completed for the year  
□ = Pending  
x = Program started, but encountered operational or hydrological delays  
✓F = All field work for this project is complete. No further field work is planned.

#### 4 Monitoring Programs and Physical Works Terms of Reference

The monitoring programs and physical works being implemented under the Duncan Dam WUP are described in Terms of Reference. These TOR and the reports for work completed to date can be found here:

[http://www.bchydro.com/about/sustainability/conservation/water\\_use\\_planning/south\\_ern\\_interior/duncan\\_dam.html](http://www.bchydro.com/about/sustainability/conservation/water_use_planning/south_ern_interior/duncan_dam.html)

## **5 Status of Monitoring Programs**

### **5.1 DDMMON-1 Lower Duncan River Ramping Rate Monitoring**

The objective of this study was to assess the impacts associated with the timing, magnitude, and rate of operational changes at Duncan Dam on Lower Duncan River fish species life histories of interest.

Several ramping experiments were conducted pre-WUP and in 2009 to support Clause 5(e) of the Order which requires the development of an adaptive protocol to minimize stranding of fish in the Lower Duncan River. In a subsequent stakeholder meeting, stakeholders agreed that ramping experiments were not the most effective way of answering the management questions. It was recommended that further study of fish stranding in LDR be obtained from modified stranding assessments (see DDMMON-16) as year-round stranding assessments cover more habitats, species and seasonal variables than can be simulated through field experimentation.

A review completed in 2017 confirmed that the management questions from DDMMON-1 are being sufficiently addressed through DDMMON-16.

### **5.2 DDMMON-2 Lower Duncan River Habitat Use Monitoring**

This monitoring project was initiated in 2008 and completed in 2012. The objective of this monitoring project was to assess fish habitat use and life histories of Rainbow trout, Mountain whitefish, and Burbot within the Lower Duncan River mainstem and sidechannels.

### **5.3 DDMMON-3 Lower Duncan River Hydraulic Development**

This monitoring program was initiated in 2009. The objective of this monitoring program is to provide a comprehensive model of hydraulic and fish habitat values for the Lower Duncan River floodplain for the normal range of flow conditions affected by Duncan Dam operations.

This program included a two-year development stage at the start of the review period, with model updates scheduled for Years five and ten of the review periods. The 2012 Annual Report provides an accurate summary of the project for the first two years of implementation.

The Year five (October 2013) model update captured changing conditions in the river; incorporated advancements in the hydraulic model; and reinforced the potential links between other monitoring programs in the Duncan Dam Project WUP.

In Year Ten (June 2017), the model was updated to adjust for technical differences between the 2010 and 2013 models, eliminating any bias when comparing the two years.

Channel morphology has changed significantly in sections of the river between modelling years. The bathymetry of the river was updated in September 2019. The updated model provides a much-improved representation of the river and side channels.

A TOR resubmission was approved in December 2020, to facilitate integration of habitat use data into the model and performance measures re-assessment. The final project report dated March 2022 is attached. This project is complete.

#### **5.4 DDMMON-4 Lower Duncan River Kokanee Spawning Monitoring**

This monitoring program was initiated in 2008 and completed in 2017. The objective of this monitoring program is to assess annual Kokanee escapement in the Lower Duncan River, Kokanee spawning as it relates to any operational constraints and defining Kokanee habitat preferences.

Three of the four management questions were addressed in the Year 10 (2017) final report dated May 2018. The fourth management question is answered through DDMWORKS-4.

This project is complete.

#### **5.5 DDMMON-5 Upper Duncan River Bull Trout Migration Monitoring**

This monitoring program was initiated in 2008 and was carried out periodically over ten years. The objective of the monitoring program is to determine the effectiveness of the adult Bull trout transfer program at Duncan Dam for contributing to Kootenay Reservoir and/or Duncan Reservoir Bull trout recruitment.

Study results demonstrate the need of the bull trout program at Duncan Dam as the transfer program is a significant contributor to Duncan and Kootenay bull trout recruitment.

This project is complete.

#### **5.6 DDMMON-6 Lower Duncan Dam Bull Trout Passage Monitoring**

This monitoring program was initiated in 2008 for three years.

The operation of the Bull trout transfer program at Duncan Dam May to September each year allows the migration of Bull trout from the Lower Duncan River to spawning locations in the Upper Duncan River system (upstream of Duncan Dam). Fish passage at Duncan Dam is facilitated through the installation of a weir immediately downstream of the flip bucket of the Low-Level Operating Gate. In 2012, it was concluded that the existing weir was an effective system for ensuring Bull trout passage through the dam.

The second objective of this study was to evaluate alternative passage methods. In 2011, redesign and automation of the weir was proposed primarily for operational flexibility and safety reasons. After 2011, the weir was damaged and has not been used since. As implementation of the improvements to update the weir is outside of the scope of the Duncan Dam Project WUP, BC Hydro commenced with design phases of the project under the regular capital planning process. The Duncan weir was approved in February 2021 to proceed to implementation under the capital plan. Construction is expected to commence in 2023.

### **5.7 DDMMON-7 Lower Duncan River Water Quality Monitoring**

This monitoring program was initiated in 2010 and was completed in 2012.

The objective of this monitoring program was to determine if a relationship exists between water quality parameters (TGP levels and water temperature) and Duncan Dam operations and decide how each of the water quality parameters affect fish species downstream of Duncan Dam using the total gas pressure as a performance measure (there is no performance measure for water temperature).

### **5.8 DDMMON-8 Duncan Watershed Riparian and Cottonwood Monitoring**

This project has been divided into two discrete monitoring components based on their locations in the Duncan River watershed.

#### **5.8.1 DDMMON-8-1 Lower Duncan River Riparian Cottonwood Monitoring**

This monitoring program was initiated in 2009. This study was carried out every year over a ten-year period with the exception of 2011. The field work was completed in January 2019.

The aim of the study is to provide site-specific data to guide the flow management regime and to improve the understanding of the relationships between flow regime, physical environmental conditions, and riparian vegetation.

This project is complete.

#### **5.8.2 DDMMON-8-2 Duncan Reservoir Riparian Monitoring**

This monitoring program was carried out in 2009, implemented in 2012 and 2015, and 2018. The field work for this project is now complete.

This long-term monitoring program is being implemented to assess the effects of Alternative S73 on reservoir riparian areas through observation of riparian distribution and abundance and testing of hypotheses underlying the approach taken in the WUP.

The 2018 (Year 4) report dated March 31, 2022 is attached. This project is complete.

### **5.9 DDMMON-9 Lower Duncan River Mosquito Monitoring and Management Plan Development**

This monitoring program was initiated in 2009 and completed in 2017. All management questions have been addressed.

Initial Lower Duncan flooding during the spring (largely driven by unregulated inflows) represents the largest opportunity for nuisance mosquito production, and re-flooding later in the summer (largely driven by regulated discharges from Duncan Dam) can increase production, depending on the difference between summer and spring peak river flows (regulated + unregulated).

Different vegetation support different levels of nuisance mosquito breeding; regulation of summer flows can influence the flooding of key vegetation types like grasslands. Other factors outside of BC Hydro control, such as precipitation and warmer temperatures, will increase the productivity of nuisance mosquito populations in any given period of the spring and summer.

This project is complete.

#### **5.10 DDMMON-10 Duncan Reservoir Fish Habitat Use Monitoring**

This monitoring program was initiated in 2009 and completed in 2016. A review of the monitoring program indicates that the management questions have been addressed.

The objective of the monitoring program is to monitor habitat use of reservoir fish species of interest (Rainbow trout, Kokanee, Bull trout and Burbot), reservoir water quality variables, and spawning timing data on a seasonal basis.

This project is complete.

#### **5.11 DDMMON-11 Duncan Reservoir Burbot Monitoring**

This monitoring program was initiated in 2009 and completed in 2016. In 2013, after three years of attempting to monitor adult Burbot spawning with little success and to capture juvenile Burbot with no success, this program changed its methods from direct biological monitoring to a physical modelling approach.

This program mapped potential Burbot habitat and monitored temperature in the upper Duncan Reservoir drawdown zone. The Burbot habitat mapping and modelling occurred in August 2015 and associated temperature monitoring was completed in 2016.

This project is complete.

#### **5.12 DDMMON-12 Duncan Reservoir Archaeological Overview Assessment**

The key objective addressed by this monitoring program was to collect information on cultural resource potential or sensitivity within portions of the drawdown zone of the Duncan reservoir and, based on this research, identify cultural site locations suitable for long-term erosion monitoring under DDMMON-13.

This study was initiated in 2010 and was completed in 2011.

#### **5.13 DDMMON-13 Duncan Reservoir Archaeological Site Erosion Monitoring**

The purpose of this study was to monitor the rate of erosion at two archaeological sites on Duncan Reservoir. This study was initiated in 2011 and was completed in 2015.

The information from this study will be used by BC Hydro's Reservoir Archaeology Program to assess the impacts of normal reservoir operations on these two



archaeological sites and to better understand erosion within the Duncan drawdown zone.

This project is complete.

#### **5.14 DDMMON-14 Duncan Wildlife Use Monitoring**

This monitoring program was initiated in 2009 and implemented in 2011. The objective of this monitoring program was to identify the impacts of the Duncan operating regime (Alternative S73) on the riparian wildlife community.

The 2014 field season was cancelled because, based on an external review of this study, the TOR required significant revision. Reservoir wildlife monitoring has been refocused on the identification of wildlife habitat values within the wetland at the northern reach of the reservoir.

The TOR was approved July 2017 and fieldwork was conducted in 2018.

This project is complete.

#### **5.15 DDMMON-15 Lower Duncan River Stranding Protocol Development and Finalization**

This monitoring program was initiated in 2009 and will be carried out every year for ten years.

The Year ten Adaptive Stranding Protocol (ASP) dated April 27, 2022 is attached.

This project is complete.

#### **5.16 DDMMON-16 Lower Duncan River Fish Stranding Impact Monitoring**

The objective of this monitoring program is to finalize a flow reduction protocol, including stranding response procedures (e.g., fish salvaging), flow reduction procedures at Duncan Dam, internal and external correspondence procedures, stranding assessment methodology, and reporting requirements.

Data collected under this study suggests the Water Use Plan flow reduction measures are effective at reducing fish stranding. When feasible, the Lower Duncan River Stranding Protocol, developed under DDMMON-15 should be consulted and recommendations followed prior to implementing flow reductions at Duncan Dam.

The Year 13 compendium (summarizing Year 1-13) dated December 23, 2021 is attached.

This project is complete.

#### **5.17 DDMMON-17 Duncan Reservoir Kokanee Stock Assessment**

The objective of this program was to improve understanding of the effects of reservoir operation on Kokanee populations to lead to a better understanding of the

implications of entrainment on Kokanee populations. This information will be used to assist in future decisions regarding the operation of Duncan Reservoir.

This monitoring program was carried out for three years from 2016 to 2018.

The final report (Year 3) will be submitted in the 2023 Annual Report.

## **6 Status of Physical Works**

### **6.1 DDMWORKS-1 Argenta Slough Erosion Protection**

The regulatory agencies (Fisheries and Oceans Canada and Ministry of Forests, Lands and Natural Resources) do not support proceeding with any proposed physical works to armour the eroding bend in Lower Duncan River. Regulators agreed to continue erosion monitoring and the creation of an ecological inventory of the areas of the slough that are threatened by a breach.

The Ecological Inventory was presented to regulators in May 2017. One of the outcomes of the presentation was for BC Hydro to recommend options in lieu of physical works. BC Hydro reviewed the options with the regulators in the fall of 2018 and agreed to provide a contribution to the acquisition of conservation property in lieu of physical works.

BCH has not been successful to date with obtaining a suitable property and anticipates that this issue will be advanced via the Duncan WUPOR process.

### **6.2 DDMWORKS-2 Glacier Creek Boat Ramp Extension**

The ramp was completed in May 2009. The Regional District of Central Kootenay (RDCK) is maintaining the ramp. BC Hydro conducted an inspection of the ramp in 2016.

### **6.3 DDMWORKS-3 Plan to Address Nutrient Retention Caused by Duncan Dam Operations**

Payments are made annually to the amount of 17.5% of the previous year's fertilization cost as per the letter of agreement between BC Hydro and the Fish and Wildlife Compensation Program (FWCP). In 2021, the payment was \$165,636.

In 2020, a one-year assessment of the effectiveness of the DDMWORKS-3 contributions was initiated. This involves the review and evaluation of Duncan Dam nutrient retention and DDMWORKS-3 contribution to determine if the level of contribution reflects the level of impacts from Duncan Dam operations. The effectiveness report is in draft and will be submitted with the 2023 Annual Report.

#### **6.4 DDMWORKS-4 Action Plan to Minimize Stranding of Kokanee Spawning in Lower Duncan River Sidechannels**

The regulatory agencies (Fisheries and Oceans Canada and Ministry of Forests, Lands and Natural Resources) rejected physical works given issues with logistics, annual maintenance, and potential secondary effects on other resources in the area.

As an alternate method to mitigate Kokanee stranding, an opportunistic alteration to the flow regime was realized from September 2013 to February 2014. The results from the 2013 DDMMON-4 report were inconclusive about the benefits from the experimental flows because of changes in methodology and difficulties in conducting field studies during the brief peak spawning period.

BC Hydro undertook another opportunistic alteration to the flow regime which occurred from September to October 2016. Observations and data were collected under DDMMON-4 and shared with DDMWORKS-4. The results of this modified operation were shared with regulatory agencies and First Nations.

The flow variance was repeated in 2017 with the endorsement of the regulatory agencies. The study was extended to compare data from the 2017 Kokanee spawning flow variance.

Increasing the target of the Kokanee spawning protection flows from 75 to 100 m<sup>3</sup>/s could be beneficial by increasing the overall amount of wetted spawning/incubation habitat available if flows are maintained at or over the targeted flow through the duration of the emergence period. There is risk of mortality prior to fry emergence if it is not operationally feasible to maintain flows at or above the target flow, so it is important to consider flow timing and duration based on biological needs when making operational decisions.

### **7 Monitoring Programs and Physical Works Costs**

The following table summarizes the Duncan Dam WUP monitoring programs and physical works costs approved by the CWR and the Actual Costs to March 31, 2022.

Table 7-1: Duncan Dam WUP Monitoring Programs and Physical Works Costs

| Monitoring Programs                     | Costs approved by CWR | Life to Date Actuals (LTD) | Estimated to Complete (Forecast) | Total Forecast (LTD and Forecast) | Variance Total to Approved | Explanation                                     | Corrective Action |
|---|-----------------------|----------------------------|----------------------------------|-----------------------------------|----------------------------|---|-------------------|
| Duncan Dam WUP Annual Report            | \$25,300              | \$17,819                   | \$1,044                          | \$18,863                          | \$6,437                    |   |                   |
| <b>DDMM01A Ramping Rate</b>             | \$247,883             | \$127,967                  | \$3,621                          | \$131,588                         | \$116,295                  | Project complete, completion report outstanding |                   |
| DDMM01A Ramping Rate - ONR DM           | \$34,639              | \$19,643                   | \$3,621                          | \$23,264                          | \$11,375                   |   |                   |
| DDMM01A Ramping Rate - ONR Imp          | \$213,244             | \$108,324                  |                                  | \$108,324                         | \$104,920                  |   |                   |
| <b>DDMM02A Low Duncan HabitatUse</b>    | \$566,815             | \$502,431                  | \$3,621                          | \$506,051                         | \$60,764                   | Project complete, completion report outstanding |                   |
| DDMM02A Low Duncan HabitatUse - ONR DM  | \$84,707              | \$40,958                   | \$3,621                          | \$44,579                          | \$40,128                   |   |                   |
| DDMM02A Low Duncan HabitatUse - ONR Imp | \$482,108             | \$461,472                  |                                  | \$461,472                         | \$20,636                   |   |                   |
| <b>DDMM03A Low Duncan Hydraulic</b>     | \$751,718             | \$731,105                  | \$16,121                         | \$747,226                         | \$4,492                    | Project complete, completion report outstanding |                   |
| DDMM03A Low Duncan Hydraulic - ONR DM   | \$118,096             | \$112,795                  | \$3,621                          | \$116,416                         | \$1,680                    |   |                   |
| DDMM03A Low Duncan Hydraulic - ONR Imp  | \$633,622             | \$618,310                  | \$12,500                         | \$630,810                         | \$2,812                    |   |                   |
| <b>DDMM04A Low Duncan Kokanee Sp</b>    | \$1,462,700           | \$1,029,437                | \$3,621                          | \$1,033,058                       | \$429,642                  | Project complete, completion report outstanding |                   |
| DDMM04A Low Duncan Kokanee Sp - ONR DM  | \$148,850             | \$78,412                   | \$3,621                          | \$82,033                          | \$66,817                   |   |                   |
| DDMM04A Low Duncan Kokanee Sp - ONR Imp | \$1,313,850           | \$951,025                  |                                  | \$951,025                         | \$362,825                  |   |                   |
| <b>DDMM05A Up Duncan Bull Study</b>     | \$436,738             | \$370,775                  |                                  | \$370,775                         | \$65,963                   | Project complete                                |                   |
| DDMM05A Up Duncan Bull Study - ONR DM   | \$88,738              | \$59,211                   |                                  | \$59,211                          | \$29,527                   |   |                   |
| DDMM05A Up Duncan Bull Study - ONR Imp  | \$348,000             | \$311,564                  |                                  | \$311,564                         | \$36,436                   |   |                   |
| <b>DDMM06A Low Duncan Bull Pass</b>     | \$280,970             | \$99,246                   |                                  | \$99,246                          | \$181,724                  | Project complete                                |                   |
| DDMM06A Low Duncan Bull Pass - ONR DM   | \$78,970              | \$33,316                   |                                  | \$33,316                          | \$45,654                   |   |                   |
| DDMM06A Low Duncan Bull Pass - ONR Imp  | \$202,000             | \$65,930                   |                                  | \$65,930                          | \$136,070                  |   |                   |
| <b>DDMM07A Low Duncan Water Qual</b>    | \$154,827             | \$106,813                  |                                  | \$106,813                         | \$48,014                   | Project complete                                |                   |
| DDMM07A Low Duncan Water Qual - ONR DM  | \$43,003              | \$22,776                   |                                  | \$22,776                          | \$20,227                   |   |                   |
| DDMM07A Low Duncan Water Qual - ONR Imp | \$111,824             | \$84,037                   |                                  | \$84,037                          | \$27,787                   |   |                   |
| <b>DDMM08A Low Duncan Riparian</b>      | \$1,457,738           | \$1,253,447                | \$4,010                          | \$1,257,457                       | \$200,281                  | Project complete, completion report outstanding |                   |
| DDMM08A Low Duncan Riparian - ONR DM    | \$192,758             | \$148,483                  | \$4,010                          | \$152,493                         | \$40,265                   |   |                   |
| DDMM08A Low Duncan Riparian - ONR Imp   | \$1,264,980           | \$1,104,964                |                                  | \$1,104,964                       | \$160,016                  |   |                   |
| <b>DDMM09A LDR Mosquito Mon</b>         | \$730,574             | \$572,966                  | \$3,621                          | \$576,587                         | \$153,987                  | Project complete, completion report outstanding |                   |
| DDMM09A LDR Mosquito Mon - ONR DM       | \$122,310             | \$116,395                  | \$3,621                          | \$120,016                         | \$2,294                    |   |                   |
| DDMM09A LDR Mosquito Mon - ONR Imp      | \$608,264             | \$456,571                  |                                  | \$456,571                         | \$151,693                  |   |                   |
| <b>DDMM10A Res Seasonal Habitat</b>     | \$791,362             | \$680,241                  | \$3,621                          | \$683,862                         | \$107,500                  | Project complete, completion report outstanding |                   |
| DDMM10A Res Seasonal Habitat - ONR DM   | \$117,205             | \$82,434                   | \$3,621                          | \$86,055                          | \$31,150                   |   |                   |
| DDMM10A Res Seasonal Habitat - ONR Imp  | \$674,157             | \$597,807                  |                                  | \$597,807                         | \$76,350                   |   |                   |
| <b>DDMM11A Duncan Burbot</b>            | \$829,768             | \$656,245                  | \$3,621                          | \$659,866                         | \$169,902                  | Project complete, completion report outstanding |                   |
| DDMM11A Duncan Burbot - ONR DM          | \$173,632             | \$68,105                   | \$3,621                          | \$71,726                          | \$101,906                  |   |                   |
| DDMM11A Duncan Burbot - ONR Imp         | \$656,136             | \$588,140                  |                                  | \$588,140                         | \$67,996                   |   |                   |
| <b>DDMM12A Duncan Arch Assess</b>       | \$68,632              | \$71,633                   |                                  | \$71,633                          | (\$3,001)                  | Project complete, completion report outstanding |                   |
| DDMM12A Duncan Arch Assess - ONR DM     | \$21,870              | \$27,104                   |                                  | \$27,104                          | (\$5,234)                  |   |                   |
| DDMM12A Duncan Arch Assess - ONR Imp    | \$46,762              | \$44,529                   |                                  | \$44,529                          | \$2,233                    |   |                   |
| <b>DDMM13A Duncan Arch Monitor</b>      | \$306,185             | \$246,165                  | \$3,718                          | \$249,883                         | \$56,302                   | Project complete, completion report outstanding |                   |
| DDMM13A Duncan Arch Monitor - ONR DM    | \$79,579              | \$67,259                   | \$3,718                          | \$70,977                          | \$8,602                    |   |                   |
| DDMM13A Duncan Arch Monitor - ONR Imp   | \$226,606             | \$178,906                  |                                  | \$178,906                         | \$47,700                   |   |                   |
| <b>DDMM14A DuncanResRiparianWLD</b>     | \$578,836             | \$426,689                  | \$3,621                          | \$430,310                         | \$148,526                  | Project complete, completion report outstanding |                   |
| DDMM14A DuncanResRiparianWLD - ONR DM   | \$119,625             | \$123,015                  | \$3,621                          | \$126,636                         | (\$7,011)                  |   |                   |
| DDMM14A DuncanResRiparianWLD - ONR Imp  | \$459,211             | \$303,673                  |                                  | \$303,673                         | \$155,538                  |   |                   |
| <b>DDMM15A LDR StrandingProtocol</b>    | \$257,049             | \$218,251                  | \$4,101                          | \$222,352                         | \$34,697                   | Project complete, completion report outstanding |                   |
| DDMM15A LDR StrandingProtocol - ONR DM  | \$71,421              | \$63,893                   | \$3,621                          | \$67,514                          | \$3,907                    |   |                   |
| DDMM15A LDR StrandingProtocol - ONR Imp | \$185,628             | \$154,358                  | \$480                            | \$154,838                         | \$30,790                   |   |                   |
| <b>DDMM16A LDR Stranding Assess</b>     | \$1,166,464           | \$1,166,462                |                                  | \$1,166,462                       | \$2                        | Project complete, completion report outstanding |                   |
| DDMM16A LDR Stranding Assess - ONR DM   | \$100,166             | \$82,684                   |                                  | \$82,684                          | \$17,482                   |   |                   |
| DDMM16A LDR Stranding Assess - ONR Imp  | \$1,066,298           | \$1,083,778                |                                  | \$1,083,778                       | (\$17,480)                 |   |                   |
| <b>DDMM17A Duncan Res KoK Mon</b>       | \$248,583             | \$140,681                  | \$3,621                          | \$144,302                         | \$104,281                  | Project complete, completion report outstanding |                   |
| DDMM17A Duncan Res KoK Mon - ONR DM     | \$49,281              | \$18,365                   | \$3,621                          | \$21,986                          | \$27,295                   |   |                   |
| DDMM17A Duncan Res KoK Mon - ONR Imp    | \$199,302             | \$122,316                  |                                  | \$122,316                         | \$76,986                   |   |                   |
| <b>DDMW01A Argenta Slough Eros</b>      | \$735,777             | \$242,012                  | \$5,652                          | \$247,664                         | \$488,113                  |   |                   |
| DDMW01A Argenta Slough Eros - ONR DM    | \$69,080              | \$79,204                   | \$5,652                          | \$84,856                          | (\$15,776)                 |   |                   |
| DDMW01A Argenta Slough Eros - ONR Imp   | \$666,697             | \$162,808                  |                                  | \$162,808                         | \$503,889                  |   |                   |
| <b>DDMW02A Glacier Creek Boat</b>       | \$197,339             | \$125,474                  |                                  | \$125,474                         | \$71,865                   | Project complete, completion report outstanding |                   |
| DDMW02A Glacier Creek Boat - ONR DM     | \$71,139              | \$38,898                   |                                  | \$38,898                          | \$32,241                   |   |                   |
| DDMW02A Glacier Creek Boat - ONR Imp    | \$126,200             | \$86,576                   |                                  | \$86,576                          | \$39,624                   |   |                   |
| <b>DDMW03A Plan Nutrient Reten</b>      | \$2,366,810           | \$2,172,209                | \$174,199                        | \$2,346,408                       | \$20,402                   |   |                   |
| DDMW03A Plan Nutrient Reten - ONR DM    | \$37,030              | \$40,292                   | \$14,199                         | \$54,490                          | (\$17,460)                 |   |                   |
| DDMW03A Plan Nutrient Reten - ONR Imp   | \$2,329,780           | \$2,131,917                | \$160,000                        | \$2,291,917                       | \$37,863                   |   |                   |
| <b>DDMW04A Action Plan Kokanee</b>      | \$241,650             | \$85,006                   |                                  | \$85,006                          | \$156,644                  | Project complete, completion report outstanding |                   |
| DDMW04A Action Plan Kokanee - ONR DM    | \$90,342              | \$37,723                   |                                  | \$37,723                          | \$52,619                   |   |                   |
| DDMW04A Action Plan Kokanee - ONR Imp   | \$151,308             | \$47,283                   |                                  | \$47,283                          | \$104,025                  |   |                   |

OR - Ordered Remissible  
ONR - Ordered Non-Remissible

\* Red values in parentheses denote overage.