Columbia River Project Water Use Plan
Arrow Lakes Reservoir Wildlife Management Plan
Physical Works Terms of Reference

- CLBWORKS-29A Arrow Lakes Reservoir: Wildlife Physical Works Feasibility Study

23 January, 2008
TERMS OF REFERENCE FOR THE COLUMBIA RIVER
PROJECT WATER USE PLAN

ARROW LAKES RESERVOIR WILDLIFE
MANAGEMENT PLAN

1.0 OVERVIEW

This document presents Terms of Reference for monitoring and feasibility studies required prior to implementation of the Arrow Lakes Reservoir wildlife habitat physical works (Table 1). These programs will ensure that the necessary feasibility/risk assessments, detailed planning and public consultation occur to address engineering design, questions around soil permeability, potential impacts on other interests, and regulatory and permitting issues.

The Consultative Committee (CC) agreed that any feasibility studies undertaken in support of proposed wildlife physical works would need to.

This document provides detailed Terms of Reference for the following programs:

1) CLBWORKS 29A Arrow Lakes Reservoir Wildlife Physical Works Feasibility Study: a 2-year program to evaluate the feasibility of undertaking the wildlife physical works project, identify priority sites for habitat enhancement and address potential impacts on private lands, vegetation, wildlife habitat, fish habitat and mosquito production, as well as any incompatibility risks with recreational use of the drawdown zone as part of the physical works design.

2) CLBWORKS 29B Arrow Lakes Reservoir Study of High-Value Wildlife Habitat for Potential Enhancement and Protection: a 3-year study to identify other potential candidate sites within Arrow Lakes Reservoir that could be enhanced through the wildlife physical works project to improve wildlife habitat within the drawdown zone.

Table 1  Arrow Lakes Reservoir Wildlife Management Plan Monitoring Program Terms of Reference Submission Information

<table>
<thead>
<tr>
<th>Name of Monitoring Program</th>
<th>Order Clause Fulfilled</th>
<th>Submitted with this Package</th>
<th>Previously Submitted To CWR</th>
<th>Submission Date</th>
<th>Leave to Commence</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLBWORKS 29A Arrow Lakes Reservoir Wildlife Physical Works Feasibility Study</td>
<td>Schedule C, Clause 6.a Schedule D, Clause 6.a</td>
<td>Yes</td>
<td>No</td>
<td>24 January 2008</td>
<td>No</td>
</tr>
<tr>
<td>CLBWORKS 29B Arrow Lakes Reservoir Study of High-Value Wildlife Habitat for Potential Enhancement and Protection</td>
<td>Schedule C, Clause 5.h Schedule D, Clause 5.c</td>
<td>Yes</td>
<td>No</td>
<td>24 January 2008</td>
<td>No</td>
</tr>
<tr>
<td>CLBWORKS 30 Arrow Lakes Reservoir Wildlife Physical Works</td>
<td>Conditional List Clause 7.a</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
2.0 MANAGEMENT PLAN RATIONALE

The impact of Arrow Lakes Reservoir operations on nesting and migratory birds was a key focus of technical group discussions throughout the Columbia River water use planning process. Part of the focus of the Step 5 studies was to review and summarize the relevant information around bird use of the Revelstoke wetlands, and to develop some measure of habitat suitability under various operating regimes. Based on local expert knowledge and discussions of the Fish and Wildlife Technical Subcommittee, operating alternatives were developed that were thought to provide benefits to, among other interests, the protection of bird habitat in the Revelstoke wetlands. Subsequent discussions of the subcommittee highlighted concern around the risk from inundation of nests under a rising reservoir in the late spring and early summer, and the availability of habitat for birds migrating south in the fall months. It was recognized, however, that these operating alternatives did not fully protect nesting birds, would not be practical given the Columbia River Treaty and substantial costs associated with the constraints they would impose on operations. The Committee acknowledged that the inundation of some bird habitat was inevitable under any operating alternative being considered for Arrow Lakes Reservoir, and that physical works should be investigated as a means of mitigating these impacts.

The Consultative Committee explored opportunities to undertake cost-effective, small-scale habitat enhancement works in the Revelstoke wetlands. Previous proposals for nesting islands were not considered a feasible approach given the high costs ($480,000 to $1.2 million per ha) and uncertainties associated with the potential risks to breeding birds (e.g., creation of source or sink habitat, increased predation pressures, increased nuisance wildlife species).

The Fish and Wildlife Technical Subcommittee identified possible options to improve habitat condition for nesting and migratory bird, and wildlife in general. These include:

- Stabilization of areas through development of berms.
- Creation of pocket wetland habitat and backchannel habitat through installation of water control structures.
- Protection of nesting habitat through creation of higher elevation points of land.
- Non-traditional terracing.

Some 42 potential sites were identified within the Revelstoke Wetlands (from the Revelstoke townsite to Shelter Bay) where habitat enhancement works could be undertaken to create or enhance wildlife habitat. Given the preliminary nature of these proposals, it was recognized that discussions with technical experts, engineering and environmental feasibility studies, and risk assessment would be required to further define treatment options (Table 2).

The Consultative Committee agreed to a phased approach in the implementation of the wildlife physical works over a 10-year period, with the first phase being small scale and experimental in nature. Sites considered to have a high probability of success were identified as potential candidates for experimental trials; however, it was recognized that alternate more preferable areas might be identified through the planning and feasibility studies. This would involve soft-engineered structures that exploit the existing landforms in the drawdown zone to improve the functioning of
existing wildlife habitat areas. It is expected that these initial works would only partially offset the negative impacts of reservoir operations on wildlife habitat and its use, but would provide learning around the most effective and cost-efficient approaches.

Table 2  Proposed schedule and estimated annual expenditures for the implementation of monitoring programs associated with the Arrow Lakes Reservoir Wildlife Management Plan

<table>
<thead>
<tr>
<th>Year of Implementation</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Total WLR (000$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Works</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLBWORKS-29A Arrow Lakes Reservoir Wildlife Physical Works Feasibility Study</td>
<td>-</td>
<td>$124,930</td>
<td>$83,086</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$208,016</td>
</tr>
<tr>
<td>CLBWORKS-29B Arrow Lakes Reservoir: Study of High-Value Wildlife Habitat for Potential Enhancement and Protection</td>
<td>-</td>
<td>-</td>
<td>$124,057</td>
<td>$139,699</td>
<td>$121,784</td>
<td>-</td>
<td>-</td>
<td>$385,540</td>
</tr>
<tr>
<td>CLBWORKS-30 Arrow Physical Works in Lieu**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Annual</strong></td>
<td>-</td>
<td>$124,930</td>
<td>$207,143</td>
<td>$139,699</td>
<td>$121,784</td>
<td>-</td>
<td>-</td>
<td>$593,556</td>
</tr>
</tbody>
</table>

**Currently on the Conditional List

Given significant uncertainties related to the feasibility of the physical works and whether these works will provide a level of benefit to wildlife that is commensurate with the cost, the CC recommended a number of monitoring studies to ensure that the goals of the program are being met. In addition to the two monitoring studies being undertaken as part of the Arrow Lakes Reservoir Wildlife Management Plan, several other programs will be undertaken in support of other non-operational changes in Arrow Lakes Reservoir, which will help to inform on the effectiveness of the wildlife physical works (Table 3). Terms of Reference for the studies outlined below are being submitted to the Comptroller of Water Rights as part of other TOR submission packages.

Table 3  Revegetation physical works and associated monitoring programs identified in the Columbia River Water Use Plan

<table>
<thead>
<tr>
<th>Management Plan/Study</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arrow Reservoir Operations Management Plan</strong></td>
<td></td>
</tr>
<tr>
<td>CLBMON-36 Kinbasket and Arrow Lakes Reservoirs Nest Mortality of Migratory Birds due to Reservoir Operations</td>
<td>10-year study to assess impacts of reservoir operations on nest mortality. Effectiveness monitoring of physical works on nesting success included within this study.</td>
</tr>
<tr>
<td>CLBMON-37 Kinbasket and Arrow Lakes Amphibian and Reptile Life History and Habitat Use Assessment</td>
<td>A multi-year study to assess impacts of reservoir operations on herptiles and their habitats. Effectiveness monitoring of physical works on herptiles included in this study.</td>
</tr>
<tr>
<td>CLBMON-40 Arrow Lakes Waterbird and Fall Shorebird Monitoring</td>
<td>10-year study to assess impacts of reservoir operations on shorebirds and waterbirds and their habitats. Effectiveness monitoring of shorebirds and waterbirds included in this study.</td>
</tr>
<tr>
<td><strong>Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan</strong></td>
<td></td>
</tr>
<tr>
<td>CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program</td>
<td>Multi-year program to revegetated site in the drawdown zone of Arrow Lakes Reservoir</td>
</tr>
<tr>
<td>CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis</td>
<td>A multi-year study to monitor the effectiveness of the revegetation program and to monitor the composition on plant communities in the drawdown zone of Arrow Lakes Reservoir</td>
</tr>
</tbody>
</table>
1.0 STUDY RATIONALE

1.1. Background

The Columbia River Water Use Plan (WUP) was developed as a result of a multi-stakeholder consultative process to determine how to manage the operations of BC Hydro’s Mica, Revelstoke, and Keenleyside facilities (reservoirs and dams) to balance environmental values, recreation, power generation, culture/heritage, navigation, and flood control. The process followed the guidelines established by the Government of British Columbia (BC Hydro 2000; Government of British Columbia 1998) and involved BC Hydro, interest groups, First Nations, government agencies and other stakeholders collectively referred to as the Consultative Committee (CC). Initiated in 2000, the WUP was complete in 2004 (BC Hydro 2005a, b) and was approved by the Water Comptroller in January of 2007.

The goal of the WUP is to accommodate environmental, recreation, power generation, culture/heritage, navigation, and flood control interests for the Columbia River; either through incremental changes to how water control facilities store and release water, or to undertake physical works in lieu of changes to reservoir operations to meet the specific interests. During the WUP, the CC supported the implementation of wildlife physical works in the mid Columbia River in lieu of changes to reservoir operations to help mitigate the impact of Arrow Lakes Reservoir operations on wildlife and wildlife habitat. Revelstoke Reach, which extends from Shelter Bay to Revelstoke Dam, is recognized as an area of significant regional biodiversity. Over 74 bird species have been documented, of which 41 are known to breed in the area (Boulanger et al. 2002). Thirty-five species are thought to be affected by the operations of the Arrow Lakes Reservoir (Manning - Cooper and Associates 2003). Revelstoke Reach also provides important habitat for amphibians and reptiles, including painted turtles, western toads, and garter snakes, and for a number of mammals.

The scope of the wildlife physical works as outlined by the CC is to employ an adaptive approach to create habitat for native wildlife (e.g. nesting habitat for birds, ponds for amphibians) in Revelstoke Reach. The CC provided direction and identified a number of constraints that were to guide the identification, implementation and monitoring of physical works, which, as quoted from the CC report, are as follows:

Feasibility Assessment and Consultation

- It was acknowledged that feasibility/risk assessments, detailed planning studies and public consultation would need to be undertaken to address engineering design, questions around soil permeability and potential impacts on other interests, and regulatory and permitting issues.

- The Consultative Committee (CC) agreed that any feasibility studies undertaken in support of proposed wildlife physical works would need to identify potential impacts on private lands, vegetation, wildlife habitat, fish
habitat and mosquito production, as well as any incompatibility risks with recreational use of the drawdown zone.

- Any wildlife physical works activities must be undertaken in a way that is respectful of existing First Nation archaeological sites. This would require co-ordination between activities undertaken for wildlife habitat and the Heritage Management Plan to ensure compatibility with archaeological site protection.

- The CC further recommended that a committee be established to assist in exploring options for physical works beyond those proposed in the Columbia WUP report.

- It was acknowledged that provincial and federal regulatory review of the wildlife physical works would be required prior to approval, and that re-design of these works may be required as a result of the review process.

**Implementation**

- The CC agreed to a budget of $2,350,000 over 10 years, which included funds ($100,000) for a feasibility study.

- The CC assumed that a third party would take on the responsibility for the construction, maintenance and liability of these works. If a third party could not be found, it was acknowledged that substantially less work would be undertaken.

- If found to be feasible and cost effective, pilot projects could be implemented to determine the success/benefits of these works in providing wildlife, nesting/migratory bird and fish habitat.

- Sites considered having a high probability of success were identified as potential candidates for the experimental trials; however, it was recognized that alternate more preferable areas might be identified through additional study.

- Significant uncertainties remain about the feasibility of physical works for wildlife in Revelstoke Reach, and whether implementation of these works will provide a level of benefit to wildlife that is commensurate with the cost.

**Effectiveness Monitoring**

- The Consultative Committee recognized the importance of effectiveness monitoring to assess the benefits to wildlife, as well as potential impacts on other interests. Much of the required monitoring has been included as elements of other studies undertaken in support of operational and non-operational changes in Arrow Lakes Reservoir.

- The Consultative Committee supported a number of monitoring studies to assess the effectiveness of the physical works in providing benefits to wildlife. They also supported feasibility studies to identify potential impacts on private lands, archaeological sites, vegetation, fish habitat and mosquito production, as well as any incompatibility risks with recreational use of the drawdown zone to support the development of the physical work options.
The WUP Fish and Wildlife Technical Subcommittee (FWTS) discussed the potential to create elevated sites in Revelstoke Reach to facilitate the expansion of willow and willow/cottonwood habitats to compensate for the loss of lower elevation nesting bird habitat due to reservoir flooding. Based on experience in other systems (e.g. Hayward Reservoir), a conceptual design was developed for a series of nesting islands within the reach, describing target elevations, construction and vegetation planting requirements, nest islands size, cost per hectare, probabilities of success, and potential risks (e.g., predation, recreation conflicts) (Carr 2003). While Carr (2003) predicted that the probability of creating successful nesting islands was high, considerable uncertainties remained around the risks of creating sink habitat for breeding birds, providing habitat for less desirable species (i.e. geese or other aggressive predatory species), and ongoing maintenance requirements. In addition, preliminary cost estimates for the construction of the islands were very high, ranging between $426,000 and $633,000 per hectare (based on a surface elevation of 441 m; 1447 ft). Concerns around high costs and uncertain benefits to target species led the FWTS to explore less intrusive, smaller scale enhancement works to mitigate operation-related impacts on nesting birds. Alternative wildlife physical works identified by FWTS included the construction of berms and water control structures, ranging in scale and complexity (Appendix A).

As there was some uncertainty related to the feasibility of the proposed projects, it was recommended that an adaptive approach should be adopted to provide flexibility and opportunity for ongoing discussions in the formulation and implementation of the wildlife physical works. It was acknowledged that feasibility/risk assessments, detailed planning studies, and First Nations, agency, stakeholder, and public input would required to address the target wildlife species/communities, engineering design, and potential impacts on other interests. This document provides the Terms of Reference outlining the approach to be taken to conduct a comprehensive feasibility study to identify and assess candidate sites for physical works and to develop an implementation plan.

2.0 STUDY PROPOSAL

2.1. Goal, Objectives and Scope

The scope of this study will be to identify and assess wildlife physical works opportunities in Revelstoke Reach and provide guidance towards the implementation of those works by defining treatment options, describing treatment methods, and providing a realistic treatment schedule. The objectives of this study include:

1) Review and summarize the existing environmental and engineering information pertinent to identifying and designing wildlife physical works in Revelstoke Reach. This will include an assessment of the attributes of functional wetlands that already exist in the drawdown zone (e.g. Revelstoke airport).

2) Review and assess preliminary environmental and engineering feasibility of wildlife physical works identified in Appendix DD of the WUP report (Appendix A herewith in) and from alternative sites identified in the process.

3) Establish a Wildlife Physical Works Committee (WPWC) to assist in providing information and recommendations with respect to the feasibility study. The
WPWC will also assist in overseeing the implementation and review the effectiveness of the wildlife physical works.

4) Seek agency, stakeholder, First Nations, and public input to identify potential impacts on other interests in the community and to identify support for proposed projects.

5) Provide a final report summarizing the findings of the feasibility study, identify treatment sites and methods, identify target wildlife species/community, and provide a treatment schedule and budget.

6) Develop an implementation plan that provides site specific treatments and/or prescriptions, supported by detailed environmental, engineering (civil, geotechnical, and hydrotechnical), and archaeological assessments\(^1\), where necessary.

7) Coordinate the wildlife physical works projects with the revegetation program (CLBWORKS-2)

2.2. Approach

A two-phased approach is recommended (Table 29A-1). The first phase will require a multi-disciplinary team to review and summarize the existing information, conduct the preliminary environmental and engineering feasibility assessments, and seek input from agencies, stakeholders, First Nations, and the public. In keeping with the recommendations of the Revelstoke Unit 5 consultation process, the assessments must take into account change in water levels and flow resulting from the operations of REV5 and REV6 turbines. A committee (WPWC) will be established to provide information and review the findings of the multi-disciplinary team. Upon review, a final report will be prepared and circulated to BC Hydro, the regulatory agencies, the Comptroller of Water Right, First Nations, local government, and stakeholders.

In the second phase, site-specific treatment plans and prescriptions, detailed treatment schedules and budgets will be developed and supplemented with detailed engineering, environmental, and archaeological assessments, where required. At this stage, effectiveness monitoring of the wildlife physical works (CLBMON-11B) will be initiated. Archaeological assessments will be conducted under a separate mechanism (e.g. contract); however, the wildlife physical works feasibility study will incorporate the findings of these assessments into the project design and recommendations\(^2\).

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\(^1\) Archaeology studies will be conducted separately from the feasibility study and the design aspects of the physical works projects. Consequently, these studies are not included as a task; nor are they budgeted for in this Terms of Reference.

\(^2\) The details of the archaeological assessments will not be provided to the public or with stakeholder groups; rather BC Hydro will identify that such studies have been completed and, that while the information can not be shared publicly, the information has been incorporated into the decision-making process, as appropriate.
Table 29A-1. Components of Phases 1 and 2 of the wildlife physical works feasibility assessment.

<table>
<thead>
<tr>
<th>Phase 1: Preliminary Feasibility Assessment</th>
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<tbody>
<tr>
<td>i) Information Summary</td>
</tr>
<tr>
<td>ii) Preliminary Environmental Objectives and Feasibility</td>
</tr>
<tr>
<td>iii) Preliminary Engineering Feasibility</td>
</tr>
<tr>
<td>iv) Agency, stakeholder, First Nations, and public input</td>
</tr>
<tr>
<td>v) Identification of Risks and Conflicts</td>
</tr>
<tr>
<td>vi) Preliminary Treatment Recommendations, Options, Schedule, and Budget</td>
</tr>
<tr>
<td>vii) Review Process - Draft report to be reviewed by Committee, BC Hydro, and Public.</td>
</tr>
<tr>
<td>viii) Final Treatment Recommendations, Options, Schedule, and Budget</td>
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</tbody>
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<table>
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<tr>
<th>Phase 2: Implementation Plan</th>
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</thead>
<tbody>
<tr>
<td>i) Restoration Plans and Prescriptions</td>
</tr>
<tr>
<td>ii) Environmental and Archeological Assessments</td>
</tr>
<tr>
<td>iii) Final Implementation Plan</td>
</tr>
<tr>
<td>iv) Effectiveness Monitoring</td>
</tr>
</tbody>
</table>

2.3. Methods

**Task 1: Project Coordination**

Project coordination involves the general administration and technical oversight of the feasibility study, which will include, but may not be limited to:

i. Budget management
ii. Program team management
iii. Logistics coordination
iv. Technical oversight in field and analysis components
v. Facilitation of data transfer among other investigations associated with the feasibility, implementation, and monitoring of wildlife physical works (Table 2, page 4)
vi. Coordinate the wildlife physical works projects with the revegetation program (CLBWORKS-2)


viii. Applying for permits and applications
ix. Liaison with the Wildlife Physical Works Committee and regulatory agencies, as required.

Ducks Unlimited has agreed to participate on a cost recovery basis to assist BC Hydro with project coordination, information gathering, and in reviewing the feasibility assessment. This arrangement will be extremely beneficial to BC Hydro as Ducks Unlimited has considerable expertise in developing and implementing wildlife enhancement and restoration projects and has a considerable amount of biological and engineering information on Revelstoke Reach.
PHASE 1

Task 2: Information Gathering

Over the past three decades, there has been a considerable desire to enhance and restore habitat for wildlife in Revelstoke Reach. As such, much biological and civil engineering, geotechnical, and hydrotechnical information already exists and compiling this will be valuable to determine the preliminary feasibility of wildlife physical works. Organizations such as Ducks Unlimited, Ministry of Environment, Canadian Wildlife Service, and the Fish and Wildlife Compensation Program have valuable biological and technical information for Revelstoke Reach. Hydrological information and data will also be available from BC Hydro. Additional pertinent information may also be available from local sources such as the Town of Revelstoke and the Regional District. Historical and recent information will be important in the preliminary assessment of wildlife physical works and will be summarized in the report. Sections of the report will include, but not be limited to:

i. Pertinent historical and recent information
ii. Wildlife information, data, and reports
iii. Engineering information, data, and reports
iv. Hydrological information, data, and reports – including Rev 5 data

Task 3: Preliminary Environmental Objectives and Feasibility

Upon reviewing the available wildlife and environmental information and with stakeholder input (Task 5), preliminary target wildlife species and habitat conditions will be identified and described. This process will identify potential environment conflicts (e.g. wildlife, fish, population sinks, mosquito, weeds, water quality) at an overview level and will entail a review of the 42 sites identified in the CC report (Appendix A). Field reconnaissance will be required to assess the attributes of functional wetlands that already exist in the drawdown zone (e.g. Revelstoke airport), assist in the preliminary assessment of the 42 sites identified in the Columbia River WUP, identify alternative sites, and to confirm information obtained in Task 2. A list of potential wildlife enhancement and habitat restoration sites will be developed for preliminary engineering assessment and further consideration. General guidelines for developing restoration projects are outlined by the Society for Ecological Restoration (Clewell et al. 2005) and the Government of British Columbia (Douglas 2003). Environmental permitting requirements will also be identified under this Task. Input and participation from agencies such as the Canadian Wildlife Service, Ministry of Environment, and Ducks Unlimited will be important during this stage to ensure the target wildlife species and habitat conditions are appropriate and consistent with the wildlife management objectives for these agencies.

Task 4: Preliminary Engineering Feasibility

Preliminary engineering assessments of candidate sites identified in Task 3 will be performed using existing civil engineering, geotechnical, and hydrotechnical information, field reconnaissance, and expert opinion. This process will identify engineering challenges and provide solutions and/or engineering options for each candidate site. It is anticipated that the preliminary engineering assessments will coincide with the environmental assessment (Task 3). The preliminary engineering
assessment shall consider the implications of the additional turbines at Revelstoke (Rev5 and Rev 6). Engineering permitting requirements will also be identified for candidate sites.

**Task 5: Agency, Stakeholder, First Nations, and Public Input**

Obtaining stakeholder, public, agency, and First Nations input will be an important component of the feasibility study and will be carried out through four mechanisms:

i) **Wildlife Physical Works Committee**

   A Wildlife Physical Works Committee (WPWC) will be established to provide information and review the feasibility assessment. The WPWC will be comprised of BC Hydro and Ducks Unlimited staff, and key stakeholders such as representatives from local government, members of the WUP wildlife technical subcommittee and the Revelstoke drawdown zone committee. Local First Nations and government agencies will be invited to participate.

ii) **Stakeholder and agency meetings**

   Stakeholder and agency meetings will be conducted with local and regional stakeholders and with key government agencies including federal, provincial, and municipal governments. Meetings will also be held among BC Hydro environmental, generation, and engineering staff to incorporate concerns related to current and future reservoir operations.

iii) **Open house and public meetings**

   A public meeting will be held to inform the public of the wildlife physical works feasibility study. An open house will be held upon the completion of the draft feasibility study to solicit public input.

iv) **First Nations**

   A meeting will be held directly with interested First Nations, and First Nations will be given the opportunity to provide input on the draft feasibility study and the implementation plan, as well as any consequent archaeological assessments.

In identifying the resources required for obtaining agency, stakeholder, First Nations, and public input, we assume:

- One full day & four half-day meetings with the wildlife physical works committee
- One full day meeting with First Nations
- One half-day public meeting
- One half-day open house
- Two days for BC Hydro and agency consultation

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3 Additional discussions with First Nations may be necessary, particularly with respect to archeological and heritage resources.
The meetings will be facilitated by a third-party (e.g. consultant) and will include a communications specialist, a biologist, and an engineer. While it is anticipated that a third-party will facilitate these meetings, they will be monitored by BC Hydro’s stakeholder engagement advisor, the project manager, and partnering agencies. Resources are included in the budget for meeting preparation and synthesis.

Task 6: Preliminary Treatment Recommendations, Options, Schedule, and Budget

A report providing the results of the preliminary feasibility assessment will be developed based on a review of the existing information, the preliminary environmental and engineering assessments, and from agency, stakeholder, First Nations, and public input (Task 2-5). This assessment will:

   i) Provide background information summarizing all the information compiled as part of this study

   ii) Identify priority sites for wildlife physical works and provide the environmental and engineering rationale while identifying environmental, social, and archeological concerns/risks for each site. Sites will be ranked and prioritized based on the results of Tasks 2 to 5.

   iii) Describe the proposed treatment methods and approaches and provide the environmental and engineering rationale while identifying environmental, social, and archeological concerns/risks for each method or approach.

   iv) Propose a schedule and budget for implementing the priority wildlife physical works

   v) Coordinate wildlife physical works projects with the revegetation program (CLBWORKS-2), where possible.

   vi) Describe risks and concerns (environmental, economic, archeological, and social) associated with the implementation wildlife physical works overall.

   vii) Propose an effectiveness-monitoring program to assess whether the wildlife physical works projects achieve their objectives with respect to enhancing wildlife and/or wildlife habitat over time.

   viii) Identify maintenance requirements, describing in the costs and scope of these requirements.

Task 7: Review Process

A review of the draft feasibility study and project identification will be undertaken. This process will include the Wildlife Physical Works Committee, government agencies (Ministry of Environment: Wildlife Branch and Water Stewardship Division, Department of Fisheries and Oceans, Canadian Wildlife Service), local government (Columbia-Shuswap Regional District, Town of Revelstoke), BC Hydro, and First
Nations. Comments received from the public will also be incorporated or addressed. We will endeavor to seek consensus among these parties to determine the selection of wildlife physical works sites to be implemented. Formal letters of support for the final treatment plans will be sought from the regulatory agencies, First Nations, stakeholder groups, and local government.

Upon completion of the draft feasibility study review, a final version will be prepared and submitted to the Comptroller of Water Rights. The implementation of wildlife physical works is conditional upon approval of the feasibility study and will commence only upon receipt of a Leave to Commence by the Comptroller of Water Rights.

**Phase 2**

Following the receipt of Leave to Commence from the Comptroller of Water Rights, habitat restoration plans and/or prescriptions will be developed for projects identified during the feasibility study and be presented in a 10-year implementation plan. The implementation plan will incorporate the findings of detailed engineering, and environmental and archeological assessments⁴, as required. This plan will function as a master plan and as a set of blueprints for implementing the wildlife physical works, between 2010 and 2017.

**Task 8: Restoration Plans, Prescriptions, and Project Designs**

Detailed site-specific habitat restoration prescriptions and/or plans will be developed for areas identified during the feasibility study (Phase 1). Due to the nature and complexity of ecological restoration, there are currently no boiler-plate standards for prescribing, planning, implementing, and monitoring restoration projects (Egan 2002), but general guidelines are available (Clewell et al. 2005; Douglas 2003; Ministry of Environment 2004; Roni et al. 2002; Society for Ecological Restoration International Science & Policy Working Group 2004). These guidelines outline the importance of: identifying and clearly stating realistic and ecologically appropriate goals and objectives, understanding the ecological requirements of target species/community, applying scientific principles, project planning, communication, agency liaison, establishing performance standards and monitoring protocols, and evaluating and reporting on the effectiveness of restoration projects.

Habitat restoration prescriptions will be developed for sites that do not incorporate significant engineering requirements (e.g. revegetation), while comprehensive restoration plans may be required where more detailed engineering, environmental and archeological assessments are required. At a minimum, the habitat restoration plans and prescriptions will:

- Describe the ecological and historical context for the project
- Identify the project site and delineate project boundaries and treatment subunits

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⁴ The details of the archeological assessments will not be included in the plan or made public.
• Identify project goals and objectives and target species/community and reference ecosystems
• Describe current and target habitat conditions and abundances for target species
• Describe the restoration methods, approaches, and engineering specifications
• Coordinate wildlife physical works projects with the revegetation program (CLBWORKS-2), where possible.
• Identify ecological, economic, social, archeological, and engineering concerns and constraints
• Identify the proponents, permitting requirements and strategies for long-term management
• Establish and describe benchmarks for monitoring the projects effectiveness

Design standards for engineering projects and engineering assessments will follow professional standards and will be reviewed by BC Hydro engineering staff.

Task 9: Environmental Assessments

The Standards and Best Practices for Instream Stream Works (Ministry of Environment 2005) and A Users’ Guide to Working In and Around Water (Government of British Columbia 2002) summarizes many of the legal requirements applicable to instream or riparian physical works and habitat restoration. A list of potentially applicable legislation is provided in Table 29A-2.

In reviewing the projects described in Appendix DD of the WUP Report (Appendix A herewith in), environmental assessments and archeological assessments may be necessary. Although comprehensive Environmental Assessments will likely not be required as specified in Table 9 of the Environmental Assessment Act - reviewable projects regulations 2006 (Government of British Columbia 2002), wildlife, riparian and fisheries assessments may be required by the provincial and federal regulatory agencies. These assessments and permitting requirements will be identified during of the feasibility study (Phase 1) and will not be described here, as it is not possible to determine which assessments and permitting requirements will be required at this stage.

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5 The term "environmental assessment" refers collectively to any water quality, fisheries, wildlife, riparian, or any other assessment of the environment. An “Environmental Assessment” may also refer to comprehensive assessment as described by the B.C. Government’s Environmental Assessment Office. The term “Environmental Assessment” will be capitalized and italicized where the former is implied.
Table 29A-2 Legislation potentially applicable to the implementation of wildlife physical works

<table>
<thead>
<tr>
<th>BC Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Drainage, Ditch and Dike Act, Ministry of Environment</td>
</tr>
<tr>
<td>- Environmental Assessment Act, Ministry of Environment</td>
</tr>
<tr>
<td>- Heritage Conservation Act, Ministry of Tourism Sports and the Arts</td>
</tr>
<tr>
<td>- Fish Protection Act, Ministry of Environment</td>
</tr>
<tr>
<td>- Local Government Act, Ministry of Community Services</td>
</tr>
<tr>
<td>- Water Act, Ministry of Environment</td>
</tr>
<tr>
<td>- Weed Act, Ministry of Agriculture and Foods</td>
</tr>
<tr>
<td>- Wildlife Act, Ministry of Environment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Government of Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Fisheries Act, Department of Fisheries and Oceans</td>
</tr>
<tr>
<td>- Migratory Bird Convention Act, Canadian Wildlife Service</td>
</tr>
<tr>
<td>- Navigable Waters Protection Act, Department of Fisheries and Oceans</td>
</tr>
<tr>
<td>- Species at Risk Act, Canadian Wildlife Service</td>
</tr>
</tbody>
</table>

Task 10: Implementation Plan

It is anticipated that project requirements and specifications may change between the completion of the feasibility study and the subsequent environmental, engineering, and archeological assessments. As such, an implementation plan will be produced and will function as a master plan for implementing the wildlife physical works between years 2010 and 2017. This plan will include:

i) A summary of the pertinent background information

ii) Findings of detailed engineering and environmental assessments

iii) Detailed habitat restoration prescriptions and plans

iv) Project design specifications

v) Implications of archeological assessments as they pertain to the site design or restoration prescriptions.

vi) A detailed budget for each project

vii) A detailed implementation schedule for each project

Task 11: Monitoring

Monitoring the effectiveness of wildlife habitat enhancement and restoration projects is key to the success of the project (Block et al. 2001; Ruiz-Jaen & Aide 2005; Society for Ecological Restoration International Science & Policy Working Group 2004). Recommendations for an effectiveness monitoring program will be outlined in the feasibility study (Phase 1) and will be further developed under a separate Terms of Reference (CLBMON-11B). This monitoring program will dovetail and build upon the wildlife monitoring programs outlined in Table 2 (pg. 4). Following the receipt of a Leave to Commence from the Comptroller of Water Rights for the implementation of wildlife physical works in Revelstoke Reach, effectiveness monitoring of the candidate physical works projects will commence. The results of the monitoring
program will be reviewed by BC Hydro, the WPWC, and the partnering agencies at regular intervals.

2.4. Reporting

It is anticipated that the reporting structure for this feasibility study will entail several primary and supplementary documents. Reports will follow the appropriate standard formats for WUP reports, and BC Hydro engineering reports. All reports will be provided in hard copy and as Microsoft Word and Adobe Acrobat (*.pdf) format. All map data, including meta data, will also be provided electronically in ARC GIS compatible format. Raw data will be provided in an Excel spreadsheet or other suitable format acceptable to BC Hydro.

**Primary documents:**

i. Draft and final feasibility reports
ii. An implementation plan

**Supplementary documents may include:**

i. Habitat restoration plan and prescriptions
ii. Engineering site designs
iii. Archeological assessments\(^6\), where required
iv. Engineering assessments, where required.
v. Environmental assessments, where required

**Draft and Final Feasibility Reports**

A report providing the results of the preliminary feasibility assessment will be prepared, as described in Task 6, based on existing information, preliminary environmental and engineering assessments, and from input provided by agencies, stakeholders, First Nations, and the public. The proposed format for the feasibility study will include the following sections in the report:

i) Executive summary
ii) Introduction
iii) Description of the approach taken
iv) Results section summarizing:
   (a) Environmental objectives and assessments
   (b) Preliminary engineering assessments
   (c) Agency, public, stakeholder, and first nations input
v) A matrix of projects ranked by priority as determined from section iv.
vi) Preliminary Recommendations including
   (a) Treatment/study design options
   (b) Preliminary schedule
   (c) Preliminary budget
   (d) An identification of risks
vii) Recommendations outlining an effectiveness monitoring program

\(^6\) The details of archeological assessments will not be made public; rather BC Hydro will identify that such studies have been completed and, that while the information can not be shared publicly, the information has been incorporated into the decision-making process as appropriate.
viii) Site-specific descriptions of candidate sites:
   (a) Project background
   (b) Project description
   (c) Project rationale including wildlife habitat and population objectives
   (d) Project budget and schedules
   (e) Summary of permitting requirements

Implementation Plan

An implementation plan detailing the proposed wildlife physical works with accompanying supplementary documents attached will be prepared. The implementation plan shall include the following sections:

i) Executive summary
ii) Background information
iii) Overview of proposed projects with schedules and budgets
iv) Site-specific project details:
   (a) Project background
   (b) Project description
   (c) Project rationale including wildlife habitat and population objectives
   (d) Detailed Project budget and schedules
   (e) Summary of permitting requirements
v) An Appendix with supplementary documents including:
   (a) Engineering assessments, where required.
   (b) Environmental impact assessment, where required
   (c) Site designs, where required
   (d) Habitat restoration prescriptions, where required

2.5. Interpretation of Results

The feasibility report will be forwarded to the Comptroller of Water Rights for consideration in issuing Leave to Commence for implementation of wildlife physical works projects in Revelstoke Reach. The implementation plan will be developed following receipt of a Leave to Commence from the Comptroller of Water Rights to facilitate the commencement of physical works for wildlife in 2010.

2.6. Schedule

The feasibility study and implementation plan will be prepared in 2008 and 2009, respectively (Table 2A9-3 and 4). It is anticipated that the implementation of wildlife physical works will be begin in 2010.

Table 2A9-3. Annual schedule for 2008.

<table>
<thead>
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<th>Tasks</th>
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<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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</thead>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</table>
Table 29A-4. Annual schedule for 2009

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<tr>
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<th>Feb</th>
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<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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<tr>
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<tr>
<td>Implementation Plan</td>
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</tbody>
</table>

2.7. **Budget**

The annual cost of the study is estimated to be $168,379 (in 2004 dollars). The estimated cost to complete Years 1 and 2 of the feasibility study is $124,930 and $83,086 including a 2% inflation and 5% contingency. This estimate is higher than the original budget recommended by the WUP Consultative Committee ($100,000) as it includes the costs of preparing the implementation plan, restoration plans and site-specific prescriptions, environmental and engineering assessments, and site designs in Year 2 (2009). These costs do not include the costs for completing archeological assessments, where required.

A detailed budget breakdown by task and year is provided below in Table 29-5.

2.8. **Study Design Limitation**

Planning the restoration or enhancement of wildlife habitat is a complex, value laden undertaking (Cabin 2007; Clewell & Aronson 2006; Miller & Hobbs 2007) and there are several limitations and risks with the approach described above. Due to the consultative approach proposed and the need for regulatory permits and approval, there is a high risk of not meeting the proposed schedule. To the extent possible, this will be addressed by the hiring of a consultant or consultants to implement the feasibility study and with the participation of Ducks Unlimited, who bring an exceptional degree of knowledge and practical experience in ecological restoration and habitat enhancement. A second concern is that the engineering feasibility of implementing the projects identified in the CC report may be cost prohibitive, however this issue will be addressed in the feasibility study itself. The third limitation is that the monitoring programs outlined in Table 2 (page 4) are limited to 10 years. As it can take ecosystems and wildlife populations many years or even decades to respond to habitat restoration or enhancement (Roni et al. 2002), these monitoring programs may need to be extended beyond their proposed timeframes to determine the effectiveness of the intended wildlife physical works.

3.0 **REFERENCES**


APPENDIX A: PHYSICAL WORKS FOR WILDLIFE IN THE REVELSTOE WETLANDS
(Taken from Columbia River WUP CC Report, Appendix DD)

1.0 Background

At the November 2003 meeting, the Consultative Committee agreed that physical works options needed to be developed to help mitigate impacts associated with nest inundation caused by rising Arrow Lakes Reservoir water levels during the late spring/early summer period. To address this, members of the Fish and Wildlife Technical Subcommittee (Susan Hall, Janice Jarvis) and a BC Hydro natural resource specialist (Brian Gadbois) identified 42 potential sites within the Revelstoke Wetlands (from the Revelstoke townsite to Shelter Bay) where habitat enhancement works could be undertaken to benefit wildlife habitat in general and, more specifically, improve habitat condition for nesting and migratory birds. Four different types of physical works were proposed:

- Stabilization of areas through development of berms.
- Creation of pocket wetland habitat and backchannel habitat through installation of water control structures.
- Protection of nesting habitat through creation of higher elevation points of land.
- Non-traditional terracing.

The intent of the latter works is to try small-scale experimental terracing to create wetland habitat. A number of areas were also identified for potential enhancement based on the fact that they provide high value wildlife habitat. However, it was recognized that without further study of these areas, it remained uncertain what specific works could be reasonably undertaken.

This appendix outlines the intended objective of each of the proposed concepts with estimated costs, and their potential benefits and risks. Location-specific information is provided in an accompanying table, and map set. It should be noted that these concepts are considered preliminary in nature. Further discussions with experts will be required to identify and develop other feasible cost-effective approaches to improving wildlife habitat in the area.

2.0 Proposed Physical Works Options

Berms

A series of berms have been proposed along the east and west banks of mid Columbia River as a means of stabilizing water levels in areas of known/suspected nesting use by waterbirds and general wildlife values (winter and spring ungulate range). The intent would be to delay the ingress of water by about two weeks until late June/early July, with the primary goal of enhancing
small areas of nesting habitat and improving nest survival for early to mid season breeding birds. This would provide for a diversity of wildlife habitat through creation of both elevated lands along the berm itself, as well as productive ponds/riparian habitat behind the berm created by the removal of material for berm construction.

At present, there is considerable uncertainty around the feasibility of such a system given the permeability of the substrates and the effectiveness of the berm in holding water back as reservoir levels rise. There is also uncertainty related to permitting requirements and other regulatory issues associated with its construction. It was agreed by members of the Fish and Wildlife Technical Subcommittee that the berm concept would only be an acceptable enhancement option if use was made of existing structures (e.g., old railbed).

**Water Control Structures**

Some 25 sites have been identified as having the potential for enhancement of wetland, riparian and large river habitats through backflooding using a variety of water control structures (e.g., culverts and other passive designs). The intent would be to retain water in natural backchannel areas that tend to dewater during low water periods and low water years. It is expected that these types of works would provide benefits to fish, birds and other wildlife species.

Unlike berm development that would only protect the small area behind the berm for a short period of time, water control structures would provide more permanent wetland areas. However, these would only be productive if the adjacent grasslands continue to survive and provide the needed associated habitat (i.e., an annual reservoir operation that maintains existing grasslands).

**Creation of Elevated Lands**

It was agreed that major engineered structures would not be a feasible approach to mitigate nesting failure as a result of rising Arrow Lakes Reservoir water levels, and that there was a need to focus on smaller scale works that would be less intrusive than development of nesting islands. A select number of site-specific areas have been identified as high priority sites for protection/enhancement based on either known or suspected nest mortalities in past years or high nesting use, recognizing that further study would likely identify additional opportunities for similar works elsewhere in the mid Columbia River. Numerous areas within the valley could be reshaped to raise some of the land while lowering other portions to benefit bird habitat.

The intent of these proposed works is to create source nesting habitat by increasing the elevation of existing high points of land by several metres. While it is uncertain how many species and birds are likely to benefit from creating higher elevation nesting habitat, it is estimated that only one to two breeding pairs of
Northern Harriers or Short-Eared Owl, or five to six pairs of a smaller waterbird species per site would likely benefit, given the small size of these areas.

3.0 Adaptive Approach to Implementing Physical Works

Given the high degree of uncertainty related to the feasibility of the proposed concepts, it was recommended that an adaptive approach be adopted to provide flexibility and opportunity for ongoing discussions in the formulation and implementation of the wildlife physical works. It was suggested that a committee be established to further develop options for physical works beyond those proposed to date. Further, it was acknowledged that feasibility/risk assessments, detailed planning studies and public consultation would need to be undertaken to address engineering design, questions around soil permeability and potential impacts on other interests (i.e., private lands, recreation, vegetation, wildlife, fish, mosquito production), and regulatory and permitting issues.

If found to be feasible and cost effective, pilot projects could be implemented to determine the success/benefits of these works in providing wildlife, nesting/migratory bird and fish habitat. Sites considered having a high probability of success were identified as potential candidates for the experimental trials; however, it was recognized that alternate more preferable areas might be identified through additional study. These included:

- Sites-9, 10, 19 and 20: Protection of nesting habitat through creation of higher elevation land.
- Site-5: Development of a small section (about 3 km) of berm from Montana Slough to Cartier Bay.
- Sites-12, 15 and 16: Installation of water control structures to demonstrate success in developing/enhancing backchannel habitat.

4.0 Estimated Costs

Construction of Works

BC Hydro Engineering provided cost estimates for construction of each of the proposed physical works options (Attachment 1).

1. Berms: $4–6 million/km

This was based on the assumption that the structures would need to be protected by rockfill (from a local quarry), which would be delivered to the sites by tow barge from the Revelstoke area.
2. Water Control Structures: $25,000–35,000/site

This assumes that the structures would be in the form of a small berm or dike located at the entrance of inlets of the backchannels, and would be typically no more than 1.5 m high by about 4–5 m wide (although a few areas may require berms 10–15 m in width). It also assumes that the structures would need to be protected by rockfill provided by a local quarry, and that delivery of the rockfill may need to be made by tow barge from the Revelstoke area.

3. Creation of Elevated Lands: $20,000–30,000/1,000 m$^2$ per 1 m of height

Estimated costs assumed use of local materials (i.e., removed from adjacent areas as part of other habitat enhancement works), and the need for protection using rockfill. This would be delivered to the sites by tow barge from the Revelstoke area.

Feasibility and Planning Studies

Based on information provided by BC Hydro Engineering, the planning/feasibility studies are estimated to cost about one to two per cent of the total capital cost of the works if these works are assessed as one package. (Costs could be as high as 15–20 per cent of total project cost if assessed as individual projects.) The study would include engineering (geotechnical, civil and hydrotechnical), environmental, and economic benefit and cost analysis at a minimum.

These cost estimates are based on hard-engineered structures and, therefore, are considered conservative. While effective lower cost options might be identified through the planning/feasibility studies, implementing these physical works for substantially lower costs would only be possible if a third party was to assume responsibility for the construction, maintenance and liability of these works. Rough cost estimates for more soft-engineered structures were provided by Janice Jarvis, Susan Hall and Brian Gadbois, as follows:

Berm: $1–2.5 million/km

Water Control Structures: $5,000–10,000 (depending on the site)

Creation of Higher Land: $5,000–20,000 (depending on the site)

Terracing: $5,000–50,000
<table>
<thead>
<tr>
<th>Importance</th>
<th>Number</th>
<th>Enhancement Option</th>
<th>Potential Benefits</th>
<th>Est. Area (ha)</th>
<th>Est. Length (km)</th>
<th>Risk/Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BERM DEVELOPMENT (Considered works in lieu of keeping reservoir lower for longer)</strong></td>
<td></td>
<td></td>
<td>Create small pond habitat in downstream area by completing dike in area with a water control structure to retain water. Considered works in lieu of keeping reservoir higher longer.</td>
<td></td>
<td>3.5</td>
<td>Need to consider permeability of substrates in determining feasibility of dike. Uncertainty around whether structure would be effective in retaining water. Permit would be required.</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Berm from Illecillewaet River to Greenside Creek - Potential length of 24 km; could be divided into 6 sections for development with first section roughly 4.5 km. Would increase present elevation by about 4 m. Would require managed control structure.</td>
<td>Stabilize the Revelstoke beach area, while providing various elevated lands and productive ponds year round. Berm would delay inundation until late June/early July (about 2 weeks) to improve nesting habitat for early and mid season breeding birds, as well as to create diversity of wildlife habitat. Use material in area to create higher elevations along dike area, while creating ponds. Design would include ponsi/prairie habitat that would benefit all wildlife (e.g., contours that allow access for mammals and habitat for foraging and nesting water birds). Could utilize old railway bed as opposed to following old river bank.</td>
<td></td>
<td>16.7</td>
<td>Engineering feasibility and hydrology review required. Need to consider effect of tributary inflow on water levels, as well as permeability of substrates in determining feasibility of dike. Uncertainty around whether structure would be effective in retaining water. Has not been discussed with the airport authority. Unlikely to get approval to undertake bird habitat enhancement around airport.</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>Berm to protect area - Potential length of 6 km. Would require managed control structure.</td>
<td>Stabilize area while providing various elevated lands and productive ponds year round. Berm would delay inundation until late June/early July (about 2 weeks) to improve nesting habitat for early and mid season breeding birds, as well as to create diversity of wildlife habitat. Use material in area to create higher elevations along dike area, while creating ponds. Design would include ponsi/prairie habitat that would benefit all wildlife (e.g., contours that allow access for mammals and habitat for foraging and nesting water birds).</td>
<td></td>
<td>6.5</td>
<td>Crown land, approval required. Need to consider permeability of substrates in determining feasibility of dike. Uncertainty around whether structure would be effective in retaining water.</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>Berm - Would require managed control structure.</td>
<td>Enhance existing boulder channel.</td>
<td></td>
<td>4.5</td>
<td>Management of cattle grazing in area needs to be examined. Need to consider permeability of substrates in determining feasibility of dike. Uncertainty around whether structure would be effective in retaining water.</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>Berm - Would require managed control structure.</td>
<td>Stabilize willow/grassland complexes, while providing various elevated lands and productive ponds year round. Berm would delay inundation until late June/early July (about 2 weeks) to improve nesting habitat for early and mid season breeding birds, as well as to create diversity of wildlife habitat. Use material in area to create higher elevations along dike area, while creating ponds.</td>
<td></td>
<td>4.7</td>
<td>Little known about the area. Not studied. Need to consider permeability of substrates in determining feasibility of dike. Uncertainty around whether structure would be effective in retaining water.</td>
</tr>
</tbody>
</table>

*BC Hydro Project Team and the Columbia River Water Use Plan Consultative Committee*
**Consultative Committee Report**

**Columbia River Water Use Plan**

<table>
<thead>
<tr>
<th>Importance</th>
<th>Number</th>
<th>Enhancement Option</th>
<th>Potential Benefits</th>
<th>Est. Area (ha)</th>
<th>Est. Length (m)</th>
<th>Risks/Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td></td>
<td>Burn – Would require managed control structure.</td>
<td>Create protect vital river valley bottom habitat.</td>
<td></td>
<td>3.2</td>
<td>Need to consider permeability of substrates in determining feasibility of site. Uncertainty around whether structure would be effective in retaining water.</td>
</tr>
</tbody>
</table>

**WATER CONTROL STRUCTURES** (Considered a works in lieu of operation to keep reservoir higher longer)

| 1         | 1      | Two water control structures (culverts) – Area has two channels that allow flooding/de-watering of area. Structures would retain water in the backchannel. | Create wetland/sidechannel habitat in this area year round for fish, birds and other wildlife. Currently there is some fish stranding that occurs in this area, which could also be mitigated through backflooding. Neither sedimentation or erosion should be an issue. |               | 3.6            | Ownership and maintenance – recontouring of existing land required. Crown land, approvals required. |
| 4         |        | Install water control structure at downstream end to return water in channel | Create more wetland/sidechannel habitat by providing constant water in area. Would provide permanent year round wetted area for fish and waterfowl habitat. |               |               | Has not been discussed with the airport authority. Unlikely to get approval to undertake bird habitat enhancement around airport. |
| 6         |        | Stabilize road with culvert. | Area dewatered at 2-3 locations where old roadbed has washed out. Wetland area, decreases in low water years. Culvert on roadbed would retain water to enhance pond habitat. |               | 132.2         | Has not been discussed with the airport authority. Unlikely to get approval to undertake bird habitat enhancement around airport. |
| 7         |        | Culvert to hold water. | Enhancement of existing ponds through stabilization of water levels during dry years. |               | 15.8          | Has not been discussed with the airport authority. Unlikely to get approval to undertake bird habitat enhancement around airport. |
| 8         |        | Culvert to hold water. | Stabilize ponds in dry years. Potential to create backchannel through recontouring of outflow channel to hold back water. |               | 2.6           | Uncertainty around permeability of substrates. |
| 12        |        | Water control structure – Placement of passive control structure in existing culvert to return water. | Area naturally fed by drainage from around airport (lake water and local inflow). Control structure would protect and enhance wetland by keeping water in area in low water years. |               | 12.1          | Uncertainty around permeability of substrates. |
| 13        |        | Water control structure – At old railway bed to hold water back. | Protect and enhance wetland by managing water in low water years. |               | 94            | |
| 15        |        | Water control structure with potential to undertake some experimental terracing in area. | Natural backchannel fed by small tributaries in spring, but dewatered in low water years. Control structure would provide for more stable water levels and enhance wetland in area. |               | 54.4          | Some privately owned land in south corner of site. |
| 16        |        | Water control structure – At old railway bed to hold water back. | Natural backchannel fed by small tributaries in spring, but dewatered in low water years. Control structure would provide for more stable water levels and enhance wetland in area. |               | 28.6          | |

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*BC Hydro Project Team and the Columbia River Water Use Plan Consultative Committee*
## Consultative Committee Report
### Columbia River Water Use Plan

<table>
<thead>
<tr>
<th>Importance</th>
<th>Number</th>
<th>Enhancement Option</th>
<th>Potential Benefits</th>
<th>Est. Area (ha)</th>
<th>Est. Length (km)</th>
<th>Notes/Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Water control structure – At old railway bed to hold water back.</td>
<td>Natural backchannel of the Columbia River. Control structure would limit outflow of water to maintain permanent wetted area during low water years. Would create wetland/sidechannel habitat.</td>
<td>42.3</td>
<td></td>
<td></td>
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<tr>
<td>18</td>
<td>Water control structure.</td>
<td>Backchannel outflows under the old railway tracks through an old wooded culvert. Control structure would maintain permanent wetted area during low water years. Would create wetland/sidechannel habitat.</td>
<td>6.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Water control structure.</td>
<td>Elevation of site is below 434 m. Control structure would create wetland/sidechannel habitat during low water years. Deep backchannel along the base of the mountain.</td>
<td>5.1</td>
<td></td>
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<tr>
<td>23</td>
<td>Water control structure.</td>
<td>Small drainage area fed by Bimbit Creek, which receives considerable use by staging waterfowl. Control structure would maintain wetted area.</td>
<td>9.8</td>
<td></td>
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<td>27</td>
<td>Water control structure – Linked with #28 to backwater area.</td>
<td>Backwater area to create wetland/sidechannel habitat.</td>
<td>42.3</td>
<td></td>
<td></td>
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<tr>
<td>28</td>
<td>Water control structure – Linked with #27 to backwater area.</td>
<td>Backwater area to create wetland/sidechannel habitat.</td>
<td>1.9</td>
<td>1.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Water control structure – Old railway bed along the east side of reservoir. Needs to be done in conjunction with #30.</td>
<td>Backwater area to create wetland/sidechannel habitat.</td>
<td>2.3</td>
<td>2.3</td>
<td></td>
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<tr>
<td>30</td>
<td>Water control structure – Old railway bed along the east side of reservoir. Needs to be done in conjunction with #29.</td>
<td>Backwater area to create wetland/sidechannel habitat.</td>
<td>2.2</td>
<td>2.2</td>
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<tr>
<td>32</td>
<td>Water control structure.</td>
<td>Control structure would provide for more stable water levels and enhance existing wetland in low water years. Considered a works in lieu of operation to keep reservoir higher.</td>
<td>4.5</td>
<td></td>
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<tr>
<td>33</td>
<td>Water control structure.</td>
<td>Control structure would improve riparian area through backwatering. Considered a works in lieu of operation to keep reservoir higher.</td>
<td>17.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Water control structure.</td>
<td>Natural backchannel along side of the mountain. Control structures would create a more permanent wetted area.</td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Water control structure.</td>
<td>Natural backchannel along side of the mountain. Control structures would create a more permanent wetted area.</td>
<td>11.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*BC Hydro Project Team and the Columbia River Water Use Plan Consultative Committee*
### Consultative Committee Report
Columbia River Water Use Plan

<table>
<thead>
<tr>
<th>Importance</th>
<th>Number</th>
<th>Enhancement Option</th>
<th>Potential Benefits</th>
<th>Est. Area (ha)</th>
<th>Est. Length (km)</th>
<th>Risk/Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>Water control structure.</td>
<td>Control structure would create a more permanent wetted area in a natural backchannel area during low water years.</td>
<td>1.4</td>
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<tr>
<td>39</td>
<td>Water control structure.</td>
<td>Control structure would create a more permanent wetted area in a natural backchannel area during low water years.</td>
<td>3.8</td>
<td></td>
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<tr>
<td>40</td>
<td>Water control structure.</td>
<td>Control structure would create a more permanent wetted area in a natural backchannel area during low water years.</td>
<td>8.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Water control structure and shoreline profiling.</td>
<td>Water management technique to elevate water levels in existing basin over short term. Shoreline profiling to improve development of wetland vegetation. Area used extensively by waterfowl during migration period.</td>
<td>19.4</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>44</td>
<td>Partial stream diversion.</td>
<td>Partial diversion of the Illecillewaet to elevate water levels in some existing basins to provide conditions for wetland development.</td>
<td>15.1</td>
<td>Illecillewaet Overbecht Society holds Crown lease. Would require regulatory approval and permitting.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### RAISE LEVEL OF LAND (Considered works in lieu of keeping reservoir lower for longer)

<table>
<thead>
<tr>
<th>Importance</th>
<th>Number</th>
<th>Enhancement Option</th>
<th>Potential Benefits</th>
<th>Est. Area (ha)</th>
<th>Est. Length (km)</th>
<th>Risk/Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Increase elevation by 1-2 m to achieve target of 440 m.</td>
<td>Raise level of existing high elevation land to protect important nesting habitat for short-cycled owls (area of past nesting mortality). Less intrusive than nesting islands.</td>
<td>6.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Increase elevation by about 1 m to achieve target of 438 m.</td>
<td>Enhance nesting area for ground nesting owls, raptors and other birds. Less intrusive than nesting islands.</td>
<td>4.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Raising level of land.</td>
<td>Could create nesting habitat for ground nesting birds (e.g., owls, sparrows, meadowlarks). Less intrusive than nesting islands. Riprap may not be necessary as site is in backchannel area where wind and wave action may not be as much of a concern. Could provide habitat for one owl nest or 3-6 nests of smaller birds.</td>
<td>13.6</td>
<td>Uncertainty around number of nesting pairs this would benefit. Need for breeding bird surveys.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Raising level of land.</td>
<td>Could create nesting habitat for ground nesting birds (e.g., owls, sparrows, meadowlarks). Less intrusive than nesting islands. Riprap may not be necessary as site is in backchannel area where wind and wave action may not be as much of a concern. Could provide habitat for one owl nest or 3-6 nests of smaller birds.</td>
<td>10.4</td>
<td>Uncertainty around number of breeding pairs this would benefit. Need for breeding bird surveys.</td>
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</table>

### NON-TRADITIONAL TERRACING

<table>
<thead>
<tr>
<th>Importance</th>
<th>Number</th>
<th>Enhancement Option</th>
<th>Potential Benefits</th>
<th>Est. Area (ha)</th>
<th>Est. Length (km)</th>
<th>Risk/Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non-traditional terracing.</td>
<td>Raise land around existing terrace and deepen to create wetland.</td>
<td>Enhance wetland in area. Considered a works in lieu of operation to keep the reservoir higher.</td>
<td>20.2</td>
<td></td>
<td></td>
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</tbody>
</table>

See also Site #15.
<table>
<thead>
<tr>
<th>Importance</th>
<th>Number</th>
<th>Enhancement Option</th>
<th>Potential Benefits</th>
<th>Total Area (ha)</th>
<th>Total Length (km)</th>
<th>Risks/Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL ENHANCEMENT</td>
<td></td>
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<tr>
<td>3</td>
<td>11</td>
<td>Deepen channel.</td>
<td>Create more wetland/side channel habitat by providing constant water in area. Would provide for fish and waterfowl habitat.</td>
<td>2.1</td>
<td></td>
<td>Requires RCMP review. RCMP have proposed works in efforts to reduce access and vandalism to area.</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Enhance pond (to be done in conjunction with Sites 19 and 19).</td>
<td>Improve riparian habitat. Material removed from could be used to increase elevation of Sites 9 and 10 for enhancement of owl nesting habitat.</td>
<td>3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Enhance pond (to be done in conjunction with Sites 19 and 19).</td>
<td>Improve riparian habitat. Material removed from could be used to increase elevation of Sites 9 and 10 for enhancement of owl nesting habitat.</td>
<td>3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>Enhancement of area – Work with BC Hydro lease holder to encourage wildlife use of area.</td>
<td>High elevation terrace of land that does not flood. High wildlife valued area, but uncertain what can be done.</td>
<td>32.6</td>
<td></td>
<td>BC Hydro, Private and Crown lands. BC Hydro has leased land for grazing. Off-site enhancement – outside scope of Water Use Plan.</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>Enhancement of area.</td>
<td>Low elevation grassland and backwater area that could possibly be enhanced through installation of water control structures, elevating some land, or vegetation enhancement. Equivalent to Mackenzie Island. Considered to be a higher priority area. No public use of this area.</td>
<td>102.8</td>
<td></td>
<td>Uncertain around what habitat enhancement works could be undertaken. Needs further study.</td>
</tr>
<tr>
<td>34</td>
<td></td>
<td>Enhancement of area.</td>
<td>Create better riparian zone, which is used by numerous wildlife at various times of year.</td>
<td>21.7</td>
<td></td>
<td>Uncertain around what habitat enhancement works could be undertaken. Needs further study.</td>
</tr>
<tr>
<td>41</td>
<td></td>
<td>Enhancement of area.</td>
<td>High value grassland area for wildlife. Potential to work with landowner.</td>
<td>7.4</td>
<td></td>
<td>Private land owners. High wildlife value, but uncertain what potential opportunities exist for enhancement. Needs to be studied further. Inaccessible for most of the time.</td>
</tr>
<tr>
<td>42</td>
<td></td>
<td>Enhancement of area.</td>
<td>High value wildlife area. Potential to work with landowner to enhance wetland area through re-design of banks or creation of backwater area.</td>
<td>14</td>
<td></td>
<td>Private land owners. High wildlife value, but uncertain what potential opportunities exist for enhancement. Needs to be studied further. Inaccessible for most of the time.</td>
</tr>
<tr>
<td>43</td>
<td></td>
<td>Enhancement of area.</td>
<td>Downie Mill.</td>
<td>19.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td></td>
<td>Enhancement of area.</td>
<td>Illecillewaet Greenbelt.</td>
<td>15.1</td>
<td></td>
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</table>