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Bridge-Seton Water Use Plan

Monitoring Program Terms of Reference

- **BRGWORKS-1 Carpenter Reservoir Drawdown Revegetation Program**

**Revision 1
January 2017**

BRGWORKS-1 Carpenter Reservoir Drawdown Zone Revegetation Program Monitoring Program Terms of Reference

1.0 REVISION OVERVIEW

This revision is based on learnings gained from the BRGWORKS-1 and BRGMON-2 programs and results of long-term vegetation works programs experienced in the Kinbasket and Arrow Lakes Reservoirs (CLBWORKS-1, -2 and CLBMON-9, -12). Results of these extensive planting programs have been less than satisfactory. These programs focused on planting and staking large areas which have not been as successful as initially expected. Reservoirs are dynamic ecosystems, and understanding vegetation ecology within drawdown zones is difficult. The purpose of this revision, in removing limitations on treatment prescriptions, is to increase the possibility of program success.

This revision will largely replace the term “revegetation” with “riparian enhancement,” throughout the document to clarify that the types of treatment prescriptions that can be applied to this program are not limited to planting. The program will include revegetation techniques as well as other site enhancement methods. The overall objective of this program remains the same: to promote natural re-colonization of vegetation.

2.0 REVISION RATIONALE

The original TOR (dated March 10, 2014) identified the need for an intensive short term revegetation program to promote natural re-colonization within the area of the Carpenter Reservoir drawdown zone between Tyaughton Lake Road Junction and the Gun Creek Fan. The purpose of this revision is to provide greater opportunity for program success by shifting the focus of the Terms of Reference (TOR) from relying mainly on using revegetation techniques to using a broader range of techniques.

The original TOR included an ongoing evaluation phase in order to make program decisions based on results about how to proceed and/or to re-evaluate the project. This revision is part of the evaluation and adaptive management approach, to ensure that the best value for effort expended on this project is achieved.

During program evaluation in 2015 (Year 2), alternative treatments (physical terrain alteration of site conditions) were recommended. In 2016 (Year 3) the alternative treatments were implemented on a small scale. Program evaluation in Year 3 concluded that in order to increase chances of program success the length of the program would need to be extended for two additional years, from a five-year to a seven-year program. The additional two years (in conjunction with extending the BRGMON-2 revegetation monitoring program) will give the new physical treatments time to respond to the reservoir conditions, and allow more time to apply additional physical treatments not already completed as part of the trials phase of this Program Years 1 and 2. A “lag” year has been incorporated into the schedule (in Year 5 (2018) or Year 6 (2019)) to allow flexibility for treatment application as well as to account for potential unforeseen conditions in reservoir operations.

Over time, physical terrain alteration methods can be more successful at re-colonizing an area with vegetation and more cost effective than planting treatments alone (David Polster, pers.comm.). Physical treatments are designed to create physical terrain conditions that will foster colonization of native species (i.e., concave or convex terrain that can capture moisture, heat and organic debris verses flatter terrain). Riparian vegetation present within the margins of the drawdown zone will naturally provide seed and root sources, which will colonize the treated areas if the right physical conditions are created.

Table 1: Key changes to the BRGWORKS-1 TOR and rationale for their inclusion

Section	Change	Rationale
Overall	<ul style="list-style-type: none"> • Replaced the term “revegetation” with “riparian enhancement. • Increase the program by two years. 	<ul style="list-style-type: none"> • To remove limitations on the types of treatment prescriptions that can be applied to this program. • To allow sufficient time to see a vegetation response.
2.0 Approach	<ul style="list-style-type: none"> • Updated the section, including management questions and hypotheses, to reflect a focus on riparian enhancement instead of strictly planting. • Removed original subsections 2.1.1, 2.1.2, and 2.1.3 and replaced with a more streamlined ‘Approach’ section, which still outlines the three phases of work. 	<ul style="list-style-type: none"> • As above. • Phase 1 of work (Subsection 2.1.1 Planning) is complete. The Approach section now focuses on Phase 2 (Subsection 2.1.2 Implementation), as that is the current status of the program.
2.1 Schedule	<ul style="list-style-type: none"> • Increased length of program by two years (one treatment year, and one “lag” year). 	<ul style="list-style-type: none"> • To allow sufficient time to see a vegetation response and to allow more time to apply other treatment methods based on adaptive management learnings.

BRGWORKS-1

Carpenter Reservoir Drawdown Zone Revegetation Program

3.0 MONITORING PROGRAM

Preliminary evaluation of results from the program have led to the conclusion that the success of the planting treatments in Years 1 and 2 within the drawdown zone have had mixed results. The results of the small-scale planting trials to date vary. Some planted vegetation species have had success in specific locations (i.e. *Carex lenticularis* plugs, and live *Salix* stakes), but not in others. Over the last three years the revegetation program has shifted and expanded to reflect observed successes; however obvious successful revegetation methods have yet to be determined, and the overall success of the planting program to date is uncertain. The addition of large-scale physical terrain treatments is recommended with the aim to increase chances of success for the program to meet its objectives. Treatment prescriptions will shift from a focus on planting to a focus on physical terrain alterations with supplemental planting to create conditions which will foster natural colonization and enhance the riparian ecological community within the drawdown zone in the long term.

3.1 Background

The *Bridge River Water Use Plan* identifies that Carpenter Reservoir under normal operations BC Hydro will target a maximum elevation of 648 m for the end of the snowmelt season in August. Reservoir excursions above 648 m may be required to manage inflows and meet other priority operational constraints.

The Bridge River Water Use Plan Consultative Committee (CC) as stated in Appendix D3 of the *Bridge River Water Use Plan Consultative Committee Report (WUP CC, 2003)*, recommended that a program be initiated to enhance vegetation in Carpenter Reservoir. The CC proposed a vegetation enhancement program as a means to:

- Mitigate the effects of dust storms resulting from reservoir drawdowns (particularly in the western end of the reservoir near the town of Gold Bridge),
- Increase the aesthetic quality and hence expected recreational opportunities in the western end of the reservoir,
- Enhance the quality of riparian habitats to increase their potential to support wildlife populations, and
- Provide localized improvements in the quality and productivity of aquatic habitats in the reservoir.

The intent of the CC for the vegetation enhancement project was to address a trade-off between fish, dust, aesthetic and wildlife benefits on the overall Water Use Plan, specifically related to the maximum elevation target of 648 m during tail end of the snowmelt season in August of each year. The scope of work was intended to be a five-year revegetation strategy that will encourage the establishment of natural vegetation in the area from Tyax junction to the Gun Creek fan (approximately 500 hectares). The original intention was to plant fall rye in barren areas to help provide protection to encourage natural revegetation. Selective planting of other

species was also considered. Annual evaluations were intended to assess the degree of natural re-colonization. The CC expected that there would be ancillary benefits toward mitigating dust, aesthetics, recreational opportunities, local wildlife populations and aquatic habitats.

3.2 Project Objectives

The overall objective of the Carpenter Reservoir Drawdown Zone Revegetation Program is to undertake a program to aid in the establishment of natural vegetation and work toward encouraging natural recolonization through riparian enhancement of the area of the Carpenter Reservoir drawdown zone between Tyaughton Lake Road Junction and the Gun Creek Fan. Information gained from the BRGMON-2 Carpenter Reservoir Riparian Vegetation Monitoring program and other BC Hydro reservoir vegetation enhancement programs such as those in the Arrow Lakes and Kinbasket Reservoir will be used as adaptive management tools in the development of this program. A supportive argument will be made regarding the choice and establishment methods for the species and treatment prescription methods identified based on learning from these programs. Riparian enhancement methods will be adapted based on results of the BRGMON-2 monitoring program.

4.0 SCOPE AND DELIVERABLES

The Bridge River Water Use Plan CC envisioned the scope of the program to be focused on a planting although the overall objective of the CC was to encourage natural re-colonization. This revision will focus more on physical terrain alterations supplemented by planting with the same objective of natural re-colonization. The scope of the revision is as follows:

- 1) To design and implement a reservoir riparian enhancement program for the western end of Carpenter Lake, focusing on the area between Tyaughton Lake Road Junction and the Gun Creek Fan.
- 2) To focus on planting of appropriate native species of vegetation and site specific physical terrain alterations to encourage natural colonization (this will be done using information gained in the BRGMON-2 program. A supportive argument must be made on the choice of species and physical treatment).
- 3) To conduct annual evaluations of the program to assess the degree to which the riparian enhancement program helps to establish natural re-colonization of the area from Tyaughton lake Road Junction to Gun Creek Fan and apply adaptive management strategies to increase enhancement success (evaluations will be conducted under the BRGMON-2 program).
- 4) To conduct evaluations of the program in order to assess the degree to which the riparian enhancement program helps enhance the quality of riparian habitats, increase their potential to support wildlife populations, and provide localized improvements in the quality and productivity of aquatic habitats in the drawdown zone of the Carpenter Reservoir.

4.1 Approach

There are three phases proposed in the Carpenter Reservoir Drawdown Zone Revegetation Strategy: 1) Plan, 2) Implementation and 3) Evaluation. Phase 1

Planning is complete. The program is currently in Phase 2, (Year 3 of the seven-year program).

In Phase 2, the consultant is expected to develop a strategy for riparian enhancement at the beginning of each treatment year. This riparian enhancement strategy will include propagation of selected species from seed, identification of sources and opportunities for vegetative propagation of riparian plant species, and proposed enhancement prescriptions using machinery or other tools and locally sourced materials for topographic treatments, which will aid riparian enhancement of the targeted area. Planning for the enhancement strategy will include developing a schedule, treatment prescriptions, treatment locations, treatment methods, follow-up monitoring, site access and operational logistics, required permits, estimated costs (within the approved budget available under this Terms of Reference), and expected benefits.

Phase 3 evaluation is ongoing to inform the adaptive management of this program. Evaluation will be completed annually under BRGMON-2 and results will be used to inform the next year's enhancement strategy as appropriate.

In order to conduct the evaluation of dust mitigation, aesthetic value and wildlife the following management questions and hypotheses are provided.

Management Questions:

- 1) Will riparian enhancement in the drawdown area mitigate the effects of dust storms resulting from reservoir drawdowns particularly in the western end of the reservoir near the Town of Gold Bridge?
- 2) Will riparian enhancement in the drawdown area increase the aesthetic quality and recreational opportunities in the western end of the reservoir?
- 3) Will the program enhance the quality of riparian habitats to increase their potential to support wildlife populations and provide localized improvements in the quality and productivity of aquatic habitats in the reservoirs?

Null Hypotheses:

- H₁ Riparian enhancement in the drawdown area does not mitigate the effects of dust storms resulting from reservoir drawdowns particularly in the western end of the reservoir near the Town of Gold Bridge.
- H₂ Riparian enhancement in the drawdown area does not increase the aesthetic quality and recreational opportunities in the western end of the reservoir.
- H₃ The program in the drawdown area does not enhance the quality of riparian habitats to increase their potential to support wildlife populations and provide localized improvements in the quality and productivity of aquatic habitats in the reservoirs.

Monitoring Activities (covered by BRGMON-2 Carpenter Reservoir Riparian Vegetation Monitoring):

The monitoring activities covered under BRGMON-2 Carpenter Reservoir Riparian Vegetation Monitoring will continue annually during the implementation of the riparian enhancement program to allow documentation of the time course of changes in spatial extent and density of naturally occurring and planted vegetation, species

composition, and relative productivity (biomass/cover). BRGMON-2 riparian enhancement monitoring will be extended by two years to be consistent with the BRGWORKS-1 program extension. The objective of these surveys is to evaluate the overall success of the riparian enhancement program for improving the spatial extent of riparian vegetation in the drawdown zone.

Monitoring Activities (covered by BRGMON-4 Carpenter Reservoir and Middle Bridge River Fish Habitat and Population Monitoring):

The monitoring activities covered under BRGMON-4 Carpenter Reservoir and Middle Bridge River Fish Habitat and Population Monitoring will continue annually during the implementation of the riparian enhancement program to allow documentation of comprehensive information of life history, biological characteristics, distribution, abundance and composition of the fish community in Carpenter Reservoir and the Middle Bridge River. The information collected by BRGMON-4 will be used to support the evaluation of the riparian enhancement strategy with respect to quality and productivity of riparian and aquatic habitats for fish.

Dust Monitoring:

The consultant is expected to come up with a dust monitoring program for pre and post riparian enhancement. The timing of the pre-riparian enhancement sampling needs to be identified as a baseline or a reference point. The consultant will identify the details of the monitoring program in their proposal. Consultation with dust monitoring experts to confirm the efficacy of this part of the program is encouraged to assist with analysis, interpretation and reporting. An example of a monitoring approach has been provided here for consideration; however, the consultant is at liberty to propose a more effective approach in their proposal. The objective of the approach is to provide before and/or after or progressive performance measurement to demonstrate the effectiveness of the program for dust mitigation relating to dust generated from the exposed areas of the drawdown zone.

The example for consideration is a passive dust deposition monitoring technique involving low-tech approaches generally applied in monitoring of nuisance ambient dust assessments. The techniques are based on the principle that coarse particulates suspended in the air will fall out either under the influence of gravity - dry deposition- or in contact with water droplets -wet deposition- (Miro, 2013). Such systems are designed to collect and measure deposited dust over long period of time usually for days, weeks or months to determine dust deposition rates by mass expressed in mg/m² (Miro, 2013). Deposit gauges, such as ISO deposit gauge, Frisbee gauge and glass slides, could be considered to collect dust deposition at selected sites. However, during the planning phase, the contractor is encouraged to research and consider other alternative techniques that might be better suited for the site and scope of the project. Dust collection sites will be selected in areas expected to be affected by dust-storms around the Gold Bridge community and local recreational sites.

Aesthetic Value:

Scenic value is a measure of visual appeal of a landscape using some key factors such as vegetation cover and/or color. During the planning phase, the consultant is expected to develop qualitative rating criteria where scenic value is ranked on a comparative basis for pre and post riparian enhancement periods. As with dust

monitoring, consultation with a visual resource consultant is encouraged to identify appropriate metrics and thus the ability to report on aesthetic objectives being or not being met. The consultant may consider community consultations as a tool for measuring the effects of enhancement efforts on aesthetic perception by the local community; however, the consultant is at liberty to propose a more effective approach in their proposal. The objective of the approach is to provide a before and after performance measurement to demonstrate the effectiveness of the program for improving aesthetics.

Wildlife Populations:

The consultant is expected to lay out a strategic and cost effective survey program that could be implemented over the area covered by the riparian enhancement project. The consultant will identify the details of survey program in their proposal. For scoping purposes, we have provided the following; however, the consultant is at liberty to propose a more effective approach in their proposal:

- 1) As part of the process of laying out a grid using aerial photos within which plantings will be planned, consider laying out a preliminary access path. This would constrain the footprint from pedestrian's/study team members. This access path would provide access to all areas to be studied. This path would also serve as a transect to be walked by a qualified wildlife observer.
- 2) The wildlife survey will target a number of key periods in the wildlife annual cycle, as well as target the bird breeding season (ideally early June and also the fall migration period) as it represents more substantive use relative to the study area.
- 3) Consider monitoring for wildlife sign including feces, tracks and plant utilization in the form of browse. Record anecdotal observations of wildlife.
- 4) Consider establishing a path or gridlines between test plot sites taking recordings of wildlife sign as well as GPS locations. The numbers of tracks per set distance of transect or path could be utilized as a baseline for monitoring wildlife presence.
- 5) Consider also the encounter transect methods outlined by RIC, 1999 and document all wildlife and wildlife sign along the path system.
- 6) The survey protocol could be repeated at other seasons of the year or during additional years as required.
- 7) The results of one or more surveys could then be used as a baseline against which to compare wildlife use at some future period when successful re-colonization by has occurred.

4.2 Schedule

The proposed schedule for the program is provided in the table below. The program has been extended two additional years, from a five-year to a seven-year program. One of the additional two years will not involve riparian enhancement treatments ("lag" year).

The "lag" year has been incorporated into the schedule (in Year 5 (2018) or Year 6 (2019)) to allow flexibility for treatment application as well as to account for potential unforeseen conditions in reservoir operations.

After the completion of the evaluation of Phase 1 Trials under BRGMON-2 Carpenter Reservoir Riparian Vegetation Monitoring, a plan will be developed for additional enhancement activities.

If the Phase 1 Trials are found to be ineffective, there will be a re-evaluation and a decision made about how to modify or potentially defer the project before proceeding with the subsequent year of planting (as part of Phase 3 Evaluation). This revision incorporates the findings of the evaluation and applies adaptive management. This approach is intended to ensure that we are getting the best value on the project. Monitoring of the effectiveness of the project including dust, aesthetic, and wildlife will be conducted according to Table 1 below.

Evaluation and adaptive management as appropriate will occur on an annual basis during all years of the project to monitor the annual success of the program and allow changes as required. The evaluation will be conducted by BRGMON-2 Carpenter Reservoir Riparian Vegetation Monitoring. The consultant is expected to indicate how the objectives and measures of BRGMON-2 will adequately evaluate the BRGWORKS-1 program and identify any gaps that may require consideration.

Mapping and transect evaluation will occur in the final year of BRGMON-2 Carpenter Reservoir Riparian Vegetation Monitoring to allow determination of the extent to which the program successfully promoted natural colonization of the riparian area between Tyaughton Lake Road Junction and the Gun Creek Fan.

4.3 Reporting

Annual reports and a final synthesis report will be prepared that outline the findings from the program as they relate to the primary components described above. All reports will be in a simple table format.

Annual reports will include in tabular format:

- a summary of the status of the management questions and hypotheses;
- a catalogue of treatments applied in the current year; and
- the planned revegetation strategies for the next year of treatments based on results of the BRGMON-2 monitoring program.

Data management, analysis and interpretation (including management questions and hypothesis analysis) will be completed under BRGMON-2. Results from BRGMON-2 will be used to inform the status of the management questions and hypotheses under this program.

The final report will include in tabular format:

- a comprehensive overview of all treatments applied during the program; and
- answer the management questions and hypotheses (based on analysis results from the BRGMON-2 program).

Reports will follow the standard format that has been developed for WUP studies. All data will be provided electronically to BC Hydro, in an agreed upon compatible format.

4.4 Budget

There is no change to budget as part of this revision; however, line items and annual budgets have been adjusted. The “lag” year will be either Year 5 or Year 6, and will be determined based on program results and consultation with BC Hydro. Year 8 is a reporting year.

Table 1: Schedule BRGWORKS-1 (showing Year 5 as the “lag” year for an example).

Task		Year 1 2014	Year 2 2015	Year 3 2016	Year 4 2017	Year 5 2018	Year 6 2019	Year 7 2020	Year 8 2021
1	Plan Development	X	X	X	X	X	X	X	
	a Phase 1: Trials	X	X						
	b Phase 2: Riparian Enhancement Implementation			X	X		X	X	
	c Dust/Aesthetic Monitoring	X	X	X	X	X	X	X	
	d Wildlife Monitoring	X	X	X	X		X	X	
2	Analysis and Reporting								
	a Annual Report	X	X	X	X		X	X	
	b Final Report								X