Columbia River Project Water Use Plan

Kinbasket and Arrow Reservoirs Revegetation Management Plan

Physical Works Terms of Reference

- **CLBWORKS-1 Kinbasket Revegetation Physical Works**

Addendum 4

May 26, 2015

A4 Addendum 4 to CLBWORKS-1 Kinbasket Revegetation Physical Works

This Terms of Reference (TOR) addendum covers a trial to test the concept on a small scale. Should the methods prove successful; a new TOR will be submitted in 2016 outlining any further work that might be undertaken through CLBWORKS-1 and will be dependent on the results from CLBMON-9 and other monitoring work associated with this TOR.

A.4.1 Background

During the Columbia River Water Use (WUP) planning process, the WUP Consultative Committee (WUP CC) recognized the value of vegetation in improving aesthetic quality, controlling dust, protecting cultural heritage sites from erosion and human access, and enhancing littoral productivity and wildlife habitat. The WUP CC further recognized that the most significant opportunity for accomplishing these objectives lay in restoring and expanding riparian and wetland vegetation in the reservoir drawdown zone, because the drawdown zone is the only area that can be substantially affected by changes in BC Hydro's operation of the reservoir. Therefore, in order to increase vegetation cover, BC Hydro undertook targeted planting prescriptions throughout the drawdown zone (i.e., 741 m to 754.4 m) from 2008 to 2011 and again in 2013.

Due to the considerable uncertainty associated with revegetation of drawdown zones of reservoirs in general, three monitoring studies were established in 2007 and 2008 to provide information to BC Hydro and help adapt any revegetation efforts: CLBMON-9 (Monitoring of Revegetation Efforts), CLBMON-10 (Inventory of Vegetation Resources), and CLBMON-11A (Wildlife Effectiveness Monitoring of Revegetation). To date, the results from these monitoring studies suggest that planting efforts have been unsuccessful and new methods should be explored if BC Hydro is to maximize vegetation growth in the drawdown zone. The full results of the monitoring studies and suggestions for improvements were presented and discussed at the Revegetation Technical Review held in West Kelowna on December 17, 2014.

A4.2 Revegetation Technical Review – December 2014

BC Hydro hosted a one-day Revegetation Technical Review (RTR) workshop in West Kelowna on December 17, 2014 to review the Revegetation Program results to date, and to discuss other viable options for vegetation growth success in the drawdown zone of Kinbasket (and Arrow Lakes) Reservoir. Participants included representatives from various First Nations, the Ministry of Forest, Lands and Natural Resource Operations, BC Hydro, and consultants.

A4.2.1 Revegetation Trials (2008-2013)

Revegetation efforts through planting in the drawdown zone, monitored through CLBMON-9, have failed to meet the objectives of the program (Hawkes et al., 2013). Planting trials from 2008-2011 were implemented where virtually no deciduous stakes survived over this time frame and transplants fared poorly overall in the drawdown zone of Kinbasket Reservoir. Further monitoring in 2013 confirmed these findings (Adama, D. 2015).

Seedlings and Stakes Transplant Trials (2008-2011)
Most transplanted plants were unable to cope with the combination of inundation timing, frequency, duration and depth, or with the by-products of these factors such as erosion, woody debris scouring, and drought conditions. There was a general decrease in both

total cover and species richness in treatment plots since 2011, mirroring a similar trend in control plots. Based on findings from the monitoring program (CLBMON-9), deciduous stakes have suffered almost complete mortality and transplanted sedge seedlings have a declining survivorship with every consecutive year after planting.

Sedge Plug Trials (2013)
A change in approach was applied in 2013 in planting of sedge plugs; however, the success of this program is not yet clear with only short-term sedge plug survival documented thus far. The most recent planting of sedge seedlings occurred in May 2013; these seedlings were at a more mature stage at the time of planting as the sedges had an additional year of growth at the nursery compared to previous sedge stocks used in the Kinbasket Reservoir. Monitoring indicate that there has been some mortality but less than anticipated given the duration of surcharge conditions in the Kinbasket in the fall of 2013.

Analysis and reporting of this revegetation effort in the CLBWORKS-1 Kinbasket Revegetation Post-Planting Report (February, 2015) indicates that although there was high initial survivorship of sedge plugs after the first growing season, the rate of survivorship is expected to be lower with prolonged inundation. The studies found no statistically significant differences between treatment and control plots either in per cent cover of vegetation, species richness, or species diversity within any plant community, elevation band, or region of the reservoir.

A4.2.2 Debris Removal Trials (2014)

In 2014, BC Hydro implemented a trial to remove and exclude woody debris in response to low rates of vegetation survival in the planted plots. Large volumes of woody debris in Kinbasket reservoir is a primary factor that prevents vegetation from re-establishing in the drawdown zone (Adama, D. 2015); therefore, in 2014, LGL, on behalf of BC Hydro, conducted some debris exclusion trials in the northern area of Kinbasket Reservoir in conjunction with CLBWORKS-16 (Kinbasket Debris Inventory, Management Strategy and Removal). These trials involved the removal of woody debris present in a small inlet located in the Valemount Peatland and the placement of a debris boom at the mouth of the inlet to exclude the future accumulation of debris in an attempt to allow vegetation to naturally regenerate in this area. Preliminary trial results suggest that terrestrial and wetland vegetation have increased where debris was removed (pers. comm. Virgil Hawkes. 2014, LGL Ltd.; Hawkes, Virgil. 2014a. The efficacy of these debris exclusion areas will continue to be monitored through CLBMON-9.

A4.2.3 Alternative Trial Methods

An alternative approach was raised at the revegetation technical workshop to alter the existing physical conditions of the drawdown zone in order to facilitate natural and/or manual revegetation efforts. It is proposed that increasing the topographic heterogeneity of the upper portion of the drawdown zone (i.e., making the flat and uniform surface conditions of the drawdown zone rough and more diverse) will create a diversity of current physical conditions that will provide the opportunity for a diversity of plant species to establish and thus help increase productivity (Polster 2011, Loreau 2010) and will also create microsites into which live stakes can be planted. These ‘rough’ surfaces could be built with existing woody debris (that exists in the Reservoir) and soil in a mound or windrow so as to create small, raised, parcels of land that would be less susceptible to inundation.

These islands and windrows also have the potential to protect riparian vegetation, leeward towards shore, from floating debris. They would have the benefit of using existing debris and debris collection (CLBWORKS-16) and rather than piling and burning this material. However, there would be challenges associated with ensuring they are appropriately anchored to be protected from wave, wind and erosion such that the materials used in construction of the mounds do not float to other locations. Other topics were discussed as alternate trial methods including: seeding reed canary grass (*Phalaris arundinacea*) to control dust in the drawdown zone of Revelstoke Reach in Arrow Lakes Reservoir; creation of wildlife habitat and wetland complexes in acquired land outside reservoirs; and, the value of existing plant communities with a diversity of plant species in the drawdown zone including presence of rare plant species.

A4.3 Approach

Following the adaptive management approach of implementing trials on a small scale and monitoring to determine their success, BC Hydro proposed to continue with the debris exclusion trials initiated in 2014, and to add a small number of trials of woody debris mounds and wood rows in 2015 and early 2016 to create topographic heterogeneity within the drawdown zone and natural vegetation establishment.

The number of structures built will depend on input from CLBMON-9 monitoring the debris exclusion structures (windrows and/or debris exclusion booms).

Each trial is described below.

1) Woody Debris/Soil Mound Trials

   Woody debris/soil mounds would entail a roughly, circular structure built of woody debris and local soil in lifts (or layers; see illustrated example in Figure 1). For example, a layer (0.5 to 1 m thick) of woody debris would be laid down then covered with 0.5 m of soil, and then another layer of woody debris covered with soil. This process is repeated until the desired height and length of the windrow is reached (the mounds would be irregularly shaped and willow and balsam poplar stakes can be planted on top of and around the edges of the mounds to provide vegetative cover and prevent erosion as the roots establish). Where ecologically appropriate, cattails could also be transplanted from a local source and placed around the mounds at the base, to prevent erosion and increase species diversity.

2) Windrow Trials

   Windrows would be built in the same way as the mounds (described above), but would be a long, linear structure that is curved and/or irregularly shaped. Willow and balsam poplar stakes from a local source can be planted on top of and within the windrows to provide vegetative cover and prevent erosion as the roots establish.

3) Debris Exclusion Structures (e.g., log booms, long windrows)

   As described previously and in Addendum 3, (BC Hydro, 2014) all woody debris would be removed at selected sites, and following their removal, we would place log booms and/or long windrows in appropriate locations to block woody debris from accumulating at these sites in future years. Log boom sites would be selected with recreational boater access in mind.

Implementation of the proposed trials would be planned such that their effectiveness can be monitored through CLBMON-9 (Kinbasket Revegetation Effectiveness Monitoring). The number of structures to be built and site selection for each structure would reflect

reservoir conditions, access, timing, and number of required site replicates necessary for analysing treatment success.

Selected treatment sites would target areas within the reservoir where woody debris are readily available or easily barged to; however, where possible, a variety of different sites would be chosen in order to gain the most knowledge from these experimental trails. Specifications and size of trial structures would be site specific and tailored according to site conditions. Communication with CLBWORKS-16, and CLBMON-9 would be required in order to design and coordinate successful experimental trials.

CLBMON-9 as the monitoring program for CLBWORKS-1 will be central to guiding placement of mounds and associated borrow pits such that they avoid environmentally or archeologically sensitive sites through pre-construction vegetation and soil collection. Consideration of other values (e.g., nesting birds, amphibians, reptiles, dust) will assist in managing environmental risks.

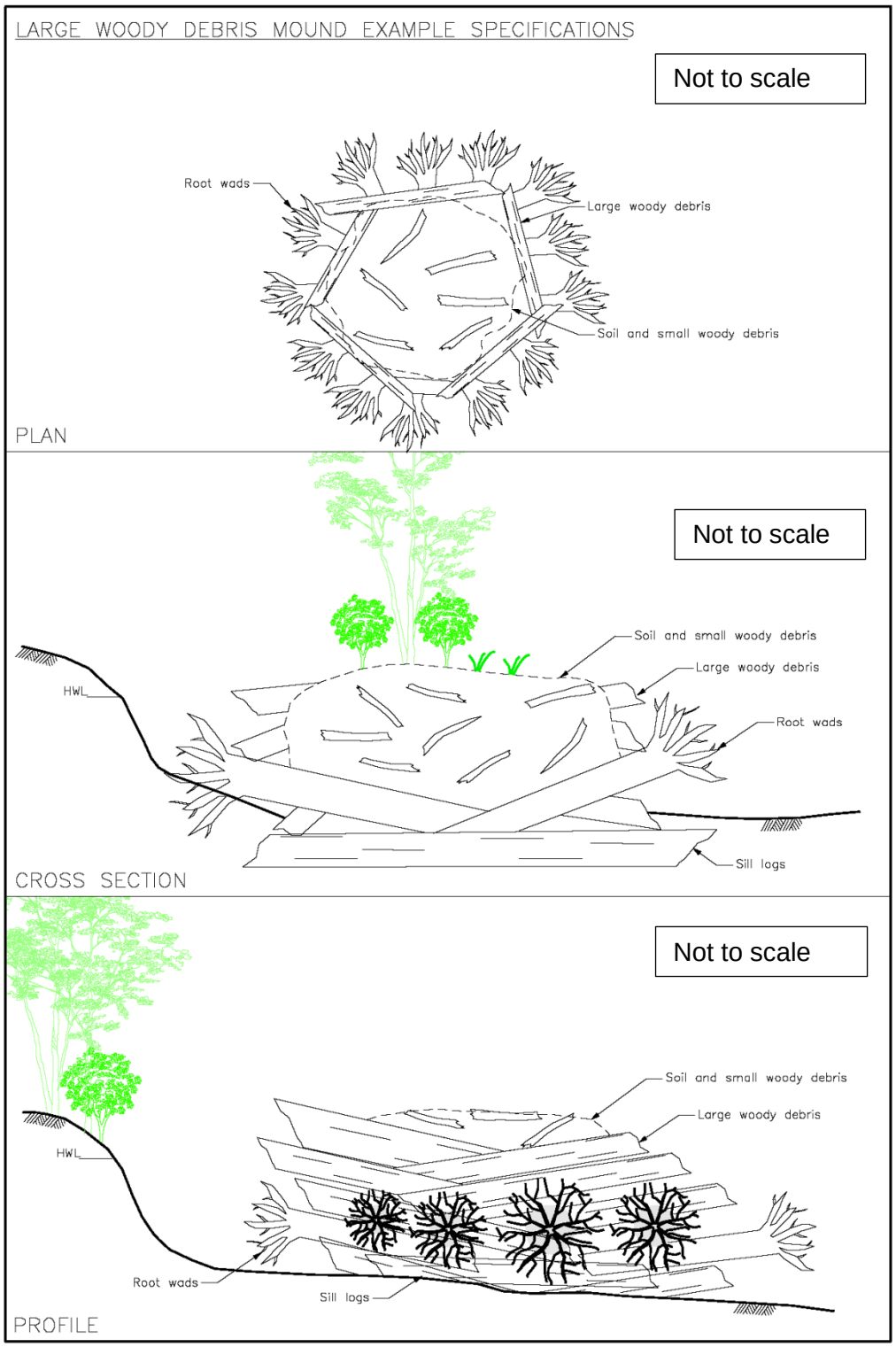

Figure 1. Example illustration of Woody Debris Mound

A4.4 Key Tasks

Task 1: Project Coordination and Planning

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

- Budget management;
- Program team management;
- Logistics coordination;
- Technical oversight of fieldwork;
- Data analysis and report preparation;
- Permit applications;
- Liaison with regulatory agencies as required;
- Safety planning, training, and management; and
- Stakeholder relations and communication planning and management.

Task 2: Site Selection and Treatment Method Planning

A risk-based approach will be used to the select the physical works and associated monitoring sites. The risks will be assessed from the initial project conceptual design phase, through project definition and then addressed in project implementation/execution phases.

Planning will include a risk assessment (e.g., site access, safety, archeology risk, existing recreational use and lake/ watercourse hydrodynamics), and will include the selection of treatment sites, treatment methods, and number of treatment replications required to analyze success. Incorporation of existing reports and mapping is considered key to the success of these physical works.

Specific planning activities will include, but not necessarily limited to:

- Determine sites and the recommended prescription;
- Baseline data survey (log and surficial material/soil quality, material erosion/deposition);
- Archeological assessment and First Nations engagement;
- Consideration of recreational use;
- Vegetation assessment including potential species at risk occurrence; and
- Wildlife assessment including migratory breeding bird habitat survey.

There are several elements that would determine whether or not to construct a mound or a windrow. The movement of runoff from rain and snowmelt through the upper portions of the drawdown zone is one important consideration in this choice. A windrow has the potential to impound water uphill from it which would create a fish stranding risk; therefore, orientation of windrows to avoid this will be important, while runoff may be more likely to flow around a mound. Windrows with a chevron or shallow v-shape with the point of the v at the upslope are envisioned to allow runoff from higher in the

drawdown zone to flow freely to the reservoir water level. Wave action coupled with floating woody debris could erode mounds and windrows. The pilot project goal is to determine how mounds and windrows persist in the face of these factors and whether the round shape of mounds is more resilient to wave action than the linear form of a windrow.

Control sites will be used to monitor effects adjacent to constructed mounds and windrows to assess biophysical characteristics of the site.

Task 3: Construction of Trials

Two main factors need to be considered and bring a degree of uncertainty in the construction timing of the physical works. These factors are:

- Reservoir water levels and rate of water level increase and;
- Availability of wood debris.

Additional considerations are the timing of construction of physical works include transportation of the two crews, equipment and material between distant work sites (i.e., Bush Arm to Canoe Reach) to maximize efficiency and maintain cost effectiveness. The physical works duration is approximately one month with two possible scenarios depending on reservoir levels:

- Late spring 2015 construction timing prior to reservoir full pool or;
- Late fall 2015 construction following the drop in reservoir water levels.

Wood debris availability and rate of reservoir filling this spring are the key drivers in the timing of construction. Fall construction synergies with CLBWORKS-16 are possible using wood debris barged at full pool to the pre-determined locations in the Kinbasket Reservoir. This wood debris would then be anchored in place until the time of construction in the late fall if reservoir levels decline sufficiently or the following spring of 2016 if water levels do not decline sufficiently by late fall.

The soils and material to construct the mounds and windrows will be sourced from the reservoir bed in the upper drawdown zone. The material will be excavated with the base of the wood debris being placed in the excavation (keyed-in). The soil material stockpiled adjacent will then be placed over the wood debris to seal the excavation from fish entry into the base of the mound when the reservoir level reaches the mounds and windrows. Additional soil material, if required to complete the mounds and windrows, will need to be sourced from other locations in the drawdown zone, and excavated using shallow lifts such that depressions that could strand fish are not created. Additional materials from off site would not likely be required for these trials with the exception of cable and anchors for log boom construction.

Timing for planting of willow stakes on the constructed mounds and windrows is expected to be spring 2016 to allow the mounds and windrows constructed in fall 2015 to stabilize through the winter season.

Fall planting is envisioned for 2015 following a summer season of high reservoir conditions to test the mound integrity in the face of wave action. Willow and poplar staking can be completed in the fall, although the window of time to do the work can be short with rapid freeze-up being a possibility (Polster, D pers. com.). The planting stakes and material would be collected at the time when plants are going into dormancy (early October in the Kinbasket Reservoir area). Settling of mounds is expected to primarily

occur while in full reservoir pool conditions this summer; however, further mound settling in winter is a possibility due to frost, snowfall and snowmelt. Monitoring the differences between spring and fall planting survival and establishment is a key component of the pilot project.

Task 4: Live Staking

Planting of live stakes involves the placement of cuttings (i.e., willow, cottonwood) into the constructed mounds and windrows. The cuttings are planted when plants are dormant and the soil is unfrozen (i.e., early October to mid November) to decrease mortality risk. Planting will be dependent on structural stability of mounds, soils on the mounds not being not deeply frozen, snow depth and reservoir levels.

The reason for a planting season in the fall is to allow the mounds and windrows to be subjected to a season of full pool reservoir conditions to determine if they persist, are eroded substantially. In addition the pilot project is designed to determine if pioneering plants become established on the mounds prior to planting. The reservoir levels fall to levels below where the physical works are planned in mid to late October. Vegetation is entering dormancy at that time, thus is a suitable time to harvest and plant willow and poplar stakes and allow them to start rooting prior to winter. The following spring, there are several months of growing season before the reservoir levels will be high enough such that the mounds and windrows become islands.

Task 5: Reporting

Reporting on the physical works over time is important to address whether the key objectives of the physical works have been met, document key learnings, successes, failures, changes leading to recommendations for further implementation or change in course of the program. Specifically a post-construction report would include:

- A site map and layout showing locations of mounds, windrows and debris booms;
- Diagrams showing dimensions of the mounds, windrows and;
- Diagrams of the live staking.

The post-construction report should answer:

- Did you build what was planned?
- Did you meet the project objectives?
- Have outstanding risks been identified?
- How can the outstanding risks (residual risks) be mitigated?

A4.5 Schedule

Timing of construction in 2015 would depend on water levels within the reservoir and is expected to occur during low water in the spring (mid June to July) and in the fall (October –November). As this timing does not coincide with the appropriate time for local stake harvesting and planting (April to early May), staking will be completed in spring 2016.

Table A4-1: Proposed Schedule of Activities*

	F16											F17		
	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16
Task 1: Project Coordination														
Task 2: Site Selection and Treatment method planning														
Task 3: Construction of Trials														
Task 4: Live staking														
Task 5: Reporting														

*to be finalized as information becomes available

A4.6 Budget and Assumptions

A portion of the previously approved budget will be allocated to planning and for trial construction. A new TOR will be submitted once an assessment of works has occurred to determine key outcomes such as rate of vegetation survival.

A4.7 References

Adama, D. 2015. CLBWORKS-1 Kinbasket Reservoir Revegetation Program, 2014 Post-planting Report. Unpublished report by LGL Limited environmental research associates, Sidney, BC, for BC Hydro Generations, Water License Requirements,Burnaby, BC. 20 pp + Appendices.

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