Columbia River Project Water Use Plan

Monitoring Program Terms of Reference

Kinbasket Reservoir Fish & Wildlife Information Plan and Mica 5 and 6 Project Commitments

- **CLBMON-57 Addendum #1 to CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources - Mica Project Units 5 and 6 Addendum**

November 2, 2012

CLBMON-57
Addendum #1 to CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources Mica Project Units 5 and 6 Addendum

1.0 MONITORING PROGRAM RATIONALE

1.1 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 enhancing riparian and wetland vegetation, as well as the riparian/wetland interface, as these are the only areas that can be substantially affected by changes in BC Hydro operations.

In lieu of operational changes, the WUP CC supported a reservoir-wide revegetation program for Kinbasket Reservoir compatible with the current operating regime to maximize vegetation growth in the drawdown zone. In accepting the current operating regime of Kinbasket Reservoir, the WUP CC made several assumptions regarding vegetation tolerances to inundation and responses to changes in the hydrologic pattern, based on information gained from studies in the Arrow Lakes Reservoir (Moody 2002a, b). Given differences in the elevation, climate and operating regime between the two reservoirs, the WUP CC recognized the inherent uncertainties of any assumptions related to the response of vegetation to reservoir operating conditions, and acknowledged the importance of long-term data collection for assessing the effects of the operating regime on vegetation at different spatial scales.

BC Hydro therefore implemented a multi year Inventory of Vegetation Resources for Kinbasket Reservoir (CLBMON-10) to provide information on how vegetation communities respond to long-term variations in water levels, and whether changes to the reservoir's operating regime may be required to maintain or enhance existing shoreline vegetation and the ecosystems it supports. Specifically, it seeks to a) assess and map existing vegetation communities by elevation, b) identify riparian wildlife habitats, and c) evaluate the effects of the current operating regime of Kinbasket Reservoir on vegetation communities at the landscape scale. This Inventory study is being conducted as outlined in the Order by the Provincial Comptroller of Water Rights under the Water Act on January 26, 2007. The results of this inventory study will inform on the effects of the current operating regime of Kinbasket Reservoir on riparian and wetland vegetation communities in the drawdown zone. The CLBMON-10 monitoring study is designed to take place over 10 non-consecutive years between 2007 and 2016.

When BC Hydro applied for the addition of two 500 MW units - the Mica 5 and 6 generation upgrade project - an environmental assessment (EA) was completed in accordance with the BC Environmental Assessment Act (BCEAA) (KCB 2009), and environmental assessment certificates were subsequently granted on April 8, 2010. The MCA 5/6 Consultative Committee was concerned that elevation differences resulting

from future operations during the summer refill period could impact the success of vegetation.

Following the Mica 5 and Mica 6 Environmental Assessment process, the Mica Generating Unit 5 and Generating Unit 6 Core Committee recommended to augment the existing Kinbasket Vegetation Inventory program with a modelling exercise to simulate the effects of increased water levels on the upper elevation band (incorporated in CLBMON-10) and with the addition of one extra year of vegetation inventory post Mica 5 in-service date (BC Hydro 2010). This extra year will be implemented in 2018.

The present Terms of Reference therefore constitute a one year extension to the existing program CLBMON-10. Most of the methodology and objectives of that program remain the same. Note however that any subsequent reference to operating regime or strategy should be understood to include any effect of the entry in operation of Mica 5.

1.2 Management Questions

All management questions stated in CLBMON-10 will continue to be addressed in CLBMON-57. The additional year of data will further help to increase the statistical power of detecting any potential effect of Mica 5 on drawdown vegetation.

The primary management questions to be addressed by extending the Kinbasket Reservoir Vegetation Inventory program by one year in 2018 are:

- What are the existing riparian and wetland vegetation communities in the Kinbasket Reservoir drawdown zone between elevations 754 m to 741 m?
- What are the spatial extents, structure and composition (relative distribution and diversity) of these communities within the drawdown zone between elevations 754 m to 741 m?
- How do spatial extent, structure and composition of vegetation communities relate to reservoir elevation and topographic site conditions (aspect, slope, soil moisture, etc.)?
- Does the operating regime of Kinbasket Reservoir, including any changes due to entry in operation if Mica 5, maintain the spatial extent, structure and composition of existing vegetation communities in the drawdown zone?
- Are there operational changes that could be implemented to maintain existing vegetation communities at the landscape scale more effectively?

If results of the monitoring indicate that the operating regime does not adequately maintain the vegetation communities at the landscape level, future decisions about reservoir operations may be affected due of the high value placed on vegetated shorelines by many interest groups.

1.3 Management Hypotheses

The primary hypothesis to be tested by this monitoring program is whether the reservoir operating strategy maintains existing vegetation communities at the landscape scale within the drawdown zone of Kinbasket Reservoir. There are also two sub-hypotheses:

H_0: There are no significant changes in existing vegetation communities at the landscape scale in the drawdown zone of Kinbasket Reservoir over the monitoring period under the operating regime.

H_{0A}: There are no significant changes in the spatial extent (number of hectares) of vegetation communities within the existing vegetated zones of Kinbasket Reservoir.

H_{0B}: There are no significant changes in the structure and composition (distribution and diversity) of vegetation communities within the existing vegetated zones of Kinbasket Reservoir.

1.4 Key Water Use Decision Affected

The key operating decision affected by this monitoring program is the operating regime for Kinbasket Reservoir, including any effects of entry in operation of Mica 5. The decision of the WUP CC to support the regime was based on the assumption that existing vegetation conditions could be maintained over the long term. Inferences from this study will provide an assessment of the effectiveness of the operating regime to maintain existing riparian and wetland vegetation communities and associated ecosystems at the landscape scale. Furthermore, by improving the understanding of how vegetation responds to long-term variations in water levels, the program will provide information to support future decision-making around maintaining the operating regime or modifying operations through adjusting minimum or maximum elevations to maintain and enhance vegetation communities in the drawdown zone of Kinbasket Reservoir.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objective and Scope

The objective of this addendum to the Kinbasket Reservoir Vegetation Inventory is to add one more year of data collection to document and quantify the landscape-level responses of existing riparian and wetland vegetation communities within the drawdown zone to the operating regime of the reservoir and to thus reduce the chance of Type II error in testing hypotheses about effects of Mica Generating Unit 5 on drawdown vegetation.

Specifically, the study will:

- Continue to spatially delineate riparian and wetland vegetation communities within the drawdown zone;
- Measure the spatial extent, structure and composition (distribution and diversity) of vegetation communities in the drawdown zone in 2018 (to be added to the existing CLBMON-10 program);
- Assess whether there are changes in the spatial extent, structure and composition of the vegetation communities in the Kinbasket drawdown zone over the whole monitoring period (including that covered by CLBMON-10);
- Assess whether observed changes in vegetation spatial extent, structure and composition are attributable to the operating regime of Kinbasket Reservoir; and,

- Provide information on the effectiveness of the operating regime at maintaining the spatial extent, structure and composition of the vegetation communities in the drawdown zone at the landscape level.

This study is an extension of CLBMON-10, and therefore is coordinated with the objectives of CLBMON-9 Kinbasket Monitoring of Revegetation Efforts, which investigates responses of vegetation at the site (local) scale.

2.2 Approach

The vegetation mapping component of the program involves the use of high-resolution aerial photography in conjunction with the digital elevation model (DEM) for Kinbasket Reservoir to assess the effects of the reservoir operating regime on existing vegetation communities by elevation band. The DEM and vegetation mapping are required for the planning and implementation of several other management plans and monitoring programs being undertaken as part of the Columbia River Water Use Plan.

As this program is an extension of an already existing program, proposals should demonstrate how the study design mesh with that of CLBMON-10 and how it identifies: 1) reservoir-wide mapping of changes in vegetation community patterns over time using aerial photography; and 2) effects of reservoir operations on the observed changes. Specific elements of the study will include:

- Aerial mapping of baseline conditions. This will be based on the final assessment in Year 10 of CLBMON-10 (2016) and will document changes in spatial extent, structure and composition of existing vegetation communities.

- Ground truthing. *In-situ* sampling to provide quantitative measures of vegetation to support the vegetation mapping component through estimation of vegetation polygon characteristics.

- Geographic Information System (GIS) and water level analyses to draw inferences about the overall effect of the operational regime on vegetation conditions.

A crucial component of the program is the definition of attributes by which to measure spatial and temporal changes among vegetation communities. Proponents should refer to the methodology described in recent CLBMON-10 reports, available on-line[1]. Analyses of the GIS data, in conjunction with analyses of reservoir water levels through the DEM, will enable inferences about the overall effect(s) of reservoir operations on vegetation communities.

The CLBMON-10 vegetation inventory involves the mapping of pocket riparian habitats around the reservoir to identify sites with potential for wildlife habitat enhancements through vegetation management. This information is used in the related monitoring program CLBMON-11 (Kinbasket and Arrow Lakes Reservoir Effectiveness Monitoring of Revegetation and Wildlife Physical Works) to evaluate the response of mammals to changes in riparian habitat caused by seasonal water level variations in the Kinbasket drawdown zone and to the implementation of the revegetation program. Field verification

[1] http://www.bchydro.com/about/sustainability/conservation/water_use_planning/southern_interior/columbia_river/kinbasket-revegetation.html

(ground sampling) of vegetation polygons in CLBMON-57 should therefore also encompass these pocket riparian habitats.

2.3 Tasks

2.3.1 Task 1: Project Management and Coordination

Project management and coordination will involve the general administrative and technical oversight of the project. This task will be completed by a senior scientist and will include, but not be limited to: 1) budget management; 2) study team management; 3) logistic coordination; 4) technical oversight of field and analyses components; and 5) data transfer among related investigations.

A safety plan must be developed and submitted to the BC Hydro contact, for all aspects of the study involving field work, in accordance with BC Hydro procedures and guidelines. Specific safety training may be required.

2.3.2 Task 2: Sampling Program

The proposed study design must quantify changes in spatial extent, structure and composition in Kinbasket Reservoir riparian and wetland vegetation associated with the operating regime. Variability in reservoir levels will lead to different responses in different plant associations and elevational strata. The statistical design must therefore be sensitive enough to detect differential responses related to hydrologic variability and to the seasonal operating regime, and this over the period encompassing both CLBMON-10 and the present program - 2007 to 2018.

Inferences based on the analysis of vegetation classification and mapping are confounded by factors unrelated to operations (e.g., climatic conditions). The effects of such potential covariates need to be explicitly addressed in the study design. Therefore, the study design and analytical methods will show how to differentiate relationships between operations and trends from confounding factors. This is important to properly address and answer Management Questions and Hypotheses in what will be the final year of the study (see Sections 1.2 and 1.3).

2.3.3 Task 3: Aerial Photography

A Digital Elevation Model (DEM) for Kinbasket Reservoir was last updated in 2010 (Hawkes et al. 2010); the model and any update will be available to the program.

Aerial photography is to be acquired in 2012, 2014 and 2016 in CLBMON-10. It will also be included in 2018 as part of the present study. It is usually conducted at low water levels during the growing season. The aerial survey time takes into account water level data (as provided by BC Hydro) and field observations of site conditions. Aerial photography documents changes in the extent, distribution and diversity of vegetation communities over time under the operating regime, and provides information on potential wildlife habitats.

Aerial photography includes the northern end of Canoe Reach and areas where planting and fertilization efforts are implemented through the revegetation program physical works (refer to CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and CLBWORKS-1 Kinbasket Reservoir Revegetation Program Physical Works).

It is important that vegetation communities attributes be reliably interpreted from the photos, be quantifiable, objective and reproducible, and relate directly to the variables of interest. Any change from the existing methodology will need to identify the attributes that will be interpreted from the air photos, and demonstrate that (a) these attributes can be reliably estimated, (b) they are appropriate for delineating vegetation communities, and (c) they are related to community attributes expected to change.

2.3.4 Task 4: Vegetation Classification, Mapping and Analysis

The objective of this task is to assess the effects of the operating regime on the spatial limits, structure and composition of existing riparian and wetland vegetation communities within the drawdown zone of Kinbasket Reservoir. Low level (1:5,000 scale) spatially geo-referenced colour air photos are used to develop maps of vegetation in the drawdown zone and integrated with the DEM in a GIS platform.

Refer to the latest CLBMON-10 report for details on the classification system and protocols used for vegetation mapping. Particular attention should be paid to changes in the distribution and viability of shrub coverage. The mapping should also focus on identifying changes in the extent (spatial limits) of vegetation communities between years.

2.3.5 Task 5: Field work

To verify vegetation polygon characteristics, sampling of vegetation communities should be carried out according to current RISC VRI standards. The relationship between polygon estimates and *in situ* samples will be used to adjust photo-interpreted polygon estimates. Field work will include collection of any data that may affect attributes of vegetation communities at the landscape level, including gradients in topography, previous disturbances, aspect, slope, elevation, substrate, and soil moisture regime. Specific attention should also be paid to First Nations cultural plant species that are found in the project area by noting information on species, location and abundance.

In the event that rare plants (e.g., federally or provincially listed species) are found during the ground sampling, these data will be provided to the Conservation Data Center (CDC) by the contractor, using appropriate forms. Similarly, noxious weed species, if encountered, should be identified and weed sites should be entered into the Ministry of Forests and Range Invasive Alien Plant Program Application. These sites should also be explicitly identified during the mapping process to determine if spread of these species is occurring over time.

2.3.6 Task 6: Data Analyses

The proposal shall clearly outline how the analytical approach quantifies observed changes in spatial extent, structure and composition of vegetation communities at the landscape level and determines the relationships between documented attributes and the reservoir operating regime (i.e., inundation frequencies, duration and depth). This is essential to ensure that Management Questions and hypotheses are properly addressed.

Statistical results (other than descriptive statistics) stemming from Microsoft Excel are deemed unreliable and their use is discouraged.

All data obtained through this monitoring program will be compiled and interpreted to provide a current understanding of the dynamics of the drawdown zone ecosystem of Kinbasket Reservoir and effects of operations on this ecosystem. Results will thus be shared among several studies.

2.3.7 Task 7: Reporting

This study constitutes the last year of a seven year program (being the extension of CLBMON-10) and is thus expected to generate a full report.

The report will include:

a) An executive summary;
b) An introduction, clearly stating project objectives and history of the project;
c) A description of the study area;
d) Maps of the study area(s) and locations of the monitoring sites.
e) Point locations if relevant, are to be provided with UTM coordinates in an appendix.
f) A thorough description of the methods employed, with emphasis on replicability;
g) Full analysis of results with emphasis on the effects of reservoir operations on vegetation communities. Test results should be put in appendices unless they are essential to the narrative.
h) A discussion of the findings as they relate to management questions, hypotheses and objectives;
i) A section addressing reporting requirements for any Federal (e.g., SARA) or Provincial (e.g., research permits) permits obtained for the study, if applicable;
j) Recommendations for operational changes, especially in the case of rejection of management hypotheses.

The report will follow the standard format developed for WUP monitoring programs[2] and will be provided in hard copy and as Microsoft Word and Adobe Acrobat (*.pdf) format; all maps and figures will be provided either as embedded objects in the Word file or as separate files. The writing must be grammatically sound, with correct spelling, and generally free of errors. Avoid convoluted sentence structure, informal style, jargon, or colloquial terms. Define acronyms and any abbreviations not used as standard measurement units and use them consistently. Microsoft Word documents should be less than 8 MB[3], including photographs and figures. Photographs (if necessary) and maps should be embedded in the document; photographs should be reduced from their original size to approximately 500 K before being embedded in the Word document.

All databases using for GIS measures should be compatible with BC Hydro's databases (shape files are acceptable).

A photographic database will also be provided of the monitoring sites, significant or unusual geographical or biological features, and species. A database of all archived photos will be provided with suitably descriptive titles, tags and keywords.

2.3.8 Task 8: Attendance to workshops

Investigators will likely be requested to participate in a one day workshop at a location to

[2] An instructions to authors manual and a BCH style guide are available upon request.
[3] Or any size judged easily transferrable via email at that time.

be determined by BC Hydro, likely in the Columbia basin area. The purposes of the workshop would be to: 1) disseminate results associated to the area of influence of either the Mica 5 and 6 project or Revelstoke Dam, including analytical methodology development, and, 2) to discuss results and provide recommendations for other ongoing investigations.

As the Columbia WUP will likely be reviewed in 2019, investigators may be requested to further participate in the WUP review and present the results of their study to other researchers, regulatory agency staff, selected other scientists, and BC Hydro staff. The cost of attending these workshops should be included in the total cost estimate for the work.

2.4 Interpretation of Results

The data will be used to identify linkages between the reservoir operating regime (including entry in operation of Mica 5) and changes in spatial extent, structure and composition of vegetation communities at the landscape scale. Analysis of these relationships will provide a better understanding of the interactions between water levels, inundation frequency and duration, and vegetation survival and distribution.

Data collected will be used to assess the extent to which management objectives are met by the operating regime. This information will be essential for future decision making regarding the need for operational or non-operational works to maintain and enhance vegetated areas within the drawdown zone.

The inventory will also determine vegetation status and trends in relation to revegetation efforts undertaken in association with the Kinbasket Reservoir Management Plan (CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and CLBWORKS-1 Kinbasket Reservoir Revegetation Program Physical Works).

2.5 Schedule

This monitoring program will only be implemented in 2018. Field work will occur after vegetation growth has begun, but before water levels inundate the vegetated areas. Field work must be carefully planned to coincide with projected water levels and climatic variability. Refer to past CLBMON-10 reports for planning purposes.

2.6 Budget

The total annual cost of the monitoring program is estimated at **$213,635.**

3.0 REFERENCES

Hawkes, V.C., P. Gibeau, and J.D. Fenneman. 2010. CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources. Annual Report – 2010. LGL Report EA3194. Unpublished report by LGL Limited environmental research associates, Sidney, BC, for BC Hydro Generations, Water License Requirements, Castlegar, BC. 86 pp + Appendices.

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Moody, A.I. 2002a. Long-Term Monitoring of Vegetation Expansion and Trials in the Dust Control Treatment Areas of Revelstoke Reach – Upper Arrow Reservoir. Prepared for B.C. Hydro Strategic Environmental Initiatives Program.

Moody, A.I. 2002b. Long-Term Monitoring of Vegetation Expansion and Trials in the Dust Control Treatment Areas of Revelstoke Reach – Upper Arrow Reservoir. BC Hydro Contract Report.