Columbia River Project Water Use Plan

Monitoring Program Terms of Reference

Physical Works Terms of Reference

KINBASKET AND ARROW LAKES RESERVOIRS REVEGETATION MANAGEMENT PLAN

- **CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis**

25 January 2008

KINBASKET AND ARROW LAKES RESERVOIRS REVEGETATION MANAGEMENT PLAN TERMS OF REFERENCE

1.0 OVERVIEW

This document presents Terms of Reference for the physical works and effectiveness monitoring programs for the Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan (Table 1). These programs will involve implementation of revegetation physical works, monitoring of representative planting sites under various revegetation treatments, mapping and inventory of vegetation communities at different spatial scales, identification of riparian wildlife habitat and monitoring of wildlife utilization patterns in response to revegetation efforts in Kinbasket and Arrow Lakes reservoirs, and the mid Columbia River.

The Terms of Reference for CLBWORKS-1 Kinbasket Reservoir Revegetation Program Physical Works provide a detailed plan, scope and budge for the second implementation phase (Year 2-5). Leave to Commence for Year 1 (Phase 1) of this program has been received, as has Leave to Commence for Year 1 (Phase 1) of CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program. Leave to Commence has also been received for the monitoring programs CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources and CLBMON-33 Mid Columbia and Arrow Lakes Reservoir Inventory of Vegetation Resources. Terms of Reference for CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program (Years 2 and 3) will be submitted by the revised ordered date of 26 February 2008.

An overview of the two physical works and seven effectiveness monitoring programs, which form part of this management plan, is provided below.

1.1 Physical Works

1) CLBWORKS-1 Kinbasket Reservoir Revegetation Program: a 5-year reservoir-wide revegetation program to enhance sustainable vegetation growth within the drawdown zone of Kinbasket Reservoir to benefit fish, wildlife, archaeological site protection, shoreline stabilization, aesthetics and recreation.

2) CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program: a 5-year reservoir-wide revegetation program to enhance sustainable vegetation growth within the drawdown zone of the mid Columbia River and the Arrow Lakes Reservoir to benefit fish, wildlife, archaeological site protection, shoreline stabilization, aesthetics, dust control and recreation.

Development of the final revegetation program for CLBWORKS-1 has incorporated feedback from public and First Nation consultation processes to ensure that:

a) the plan is not in conflict with other land uses (e.g., motorized and non-motorized recreation, beach areas);

b) revegetation prescriptions are compatible with First Nation archaeological site protection requirements; and,

c) revegetation prescriptions incorporate plant species traditionally valued by First Nations, where possible.

Monitoring Programs

1) CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis: a 10-year program to evaluate plant survival and monitor representative planting sites under the various revegetation treatments in Kinbasket Reservoir. This study will also assess changes in existing vegetation communities at the site (local) level in response to the operating regime of Kinbasket Resevoir.

2) CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources: a 10-year program to assess and map spatial extent, structure and composition of existing vegetation communities at the landscape scale within Kinbasket Reservoir to determine inter-community changes over time in response to ongoing operation of Kinbasket Reservoir. This program also identified riparian wildlife habitat in Year 1.

3) CLBMON-11 Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works: an 11-year program to conduct effectiveness monitoring of wildlife habitat utilization in response to revegetation efforts in Kinbasket Reservoir, and revegetation efforts and wildlife physical works in the mid Columbia River and Arrow Lakes Reservoir.

4) CLBMON-12 Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis: a 10-year program to evaluate plant survival and monitor representative revegetation sites under the various revegetation treatments in the mid Columbia River and Arrow Lakes Reservoir. This study will also assess changes in existing vegetation communities at the site (local) level in response to the soft constraints operating regime of the Arrow Lakes Reservoir.

5) CLBMON-13 Monitoring of Mosquito Populations in the Revelstoke Area: a 2-year program to monitor the distribution and abundance of larval and adult mosquitoes in relation to physical environmental variables (elevation, temperature) and biotic variables (habitat) in the Revelstoke area.

6) CLBMON-33 Arrow Lakes Reservoir Inventory of Vegetation Resources: a 10-year program to assess and map vegetation distribution by elevation and identify riparian wildlife habitat in relation to inundation cycles and revegetation efforts in the mid Columbia River and Arrow Lakes Reservoir.

7) CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation: a 5-year program to evaluate responses of plants of different ages, seedlings to mature plants, and species to inundation cycles in the mid Columbia River and Arrow Lakes Reservoir.

Table 1 Kinbasket and Arrow Lakes Reservoir Revegetation Management Plan Physical Works and Monitoring Program Terms of Reference Submission Information

Name of Monitoring Program or Physical Works	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Submission Date	Leave to Commence
CLBWORKS-1 Kinbasket Reservoir Revegetation Program	Schedule A: 1.a	Yes	Yes	04 April 2007	Yes – Year 1 only
CLBWORKS-2 Mid Columbia River and Arrow Lakes Reservoir Revegetation Program	Schedule C: 1.a Schedule D: 1.a	No[1]	Yes	04 April 2007	Yes – Year 1 only
CLBMON-9 Kinbasket Reservoir Monitoring of Revegetation Efforts	Schedule A: 2.a	Yes	No	25 January 2008	No
CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources	Schedule A: 2.b	No	Yes	04 April 2007	Yes
CLBMON-11A Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir	Schedule A: 2.c	Yes	No	25 January 2008	No
CLBMON-11B Effectiveness Monitoring of Revegetation in the mid Columbia River and the Arrow Lakes Reservoir	Schedule C: 5.a Schedule D: 2.a	No	No		No
CLBMON-12 Mid Columbia River and Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis	Schedule C: 2.a Schedule D: 2.b Schedule D: 2.c	Yes	No	25 January 2008	No
CLBMON-13 Inventory of Mosquito Populations in the Revelstoke Area	Schedule C: 5.b	Yes	No	25 January 2008	No
CLBMON-33 Mid Columbia and Arrow Lakes Reservoir Inventory of Vegetation Resources	Schedule C: 2.b Schedule D: 2.c	No	Yes	04 April 2007	Yes
CLBMON-35 Arrow Lakes Reservoir Plant Response to Inundation	Schedule C: 2.c Schedule D: 2.d	Yes	No	25 January 2008	No

[1] Terms of Reference for the implementation phase (Years 2-3) of CLBWORKS-2 Arrow Lakes Reservoir Revegetation Program will be submitted by the revised ordered date of February 26, 2008.

2.0 PROGRAM RATIONALE

The Columbia River Water Use Plan Consultative Committee (WUP CC) recognized the value of riparian vegetation surrounding Kinbasket and Arrow Lakes reservoirs for enhancing littoral productivity, providing physical, structural and biological character for wildlife habitat, protecting cultural heritage sites, and providing aesthetic benefits (e.g., reduction of dust storms) within the drawdown zone. As a result, the protection and enhancement of high quality riparian vegetation emerged as a key environmental objective for Columbia River Water Use Plan, and operational, as well as non-operational alternatives to maximize vegetation diversity and wildlife habitat were a fundamental consideration throughout the water use planning process.

The WUP CC supported reservoir-wide revegetation programs for Kinbasket and Arrow Lakes reservoirs in lieu of maintaining lower elevations during the growing season than those provided under current operations, to maximize vegetation growth in the drawdown zones. The revegetation approach consists of multi-year programs with intervention over five years to facilitate long-term vegetative cover in those areas that have good potential to become self-sustaining. Key environmental and social objectives of the revegetation program are to:

- maximize vegetation growth[2] in the drawdown zones; and,
- provide benefits to littoral productivity, wildlife habitat, recreation, shoreline erosion and archaeological site protection.

Monitoring programs and physical works Terms of Reference presented herein collectively form the Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan (RMP).

Kinbasket Reservoir Revegetation Program

During the WUP process, the regulation of reservoir filling and changes to minimum annual elevations were explored by the WUP CC as a means of achieving a number of environmental and social benefits for Kinbasket Reservoir; however, modeling of these alternatives revealed that these incremental changes in operations would incur very high costs in foregone power generation (BC Hydro 2005). In addition, preliminary work on developing revegetation strategies for the drawdown zone of Kinbasket Reservoir (Moody and Carr 2003) indicated that the greatest limiting factor to vegetation establishment was not the operation of the reservoir (based on reservoir operation data between 1991 and 2001), but lack of initial vegetation establishment, which could likely be addressed through targeted planting. The WUP CC therefore agreed to reject further analysis of operating alternatives for the purpose of enhancing vegetation potential, and recommended instead a revegetation program for Kinbasket Reservoir, aimed at maximizing vegetation growth in the drawdown zone to meet the environmental and social objectives stated above. This program will be implemented through the revegetation physical works CLBWORKS-1 (Kinbasket Reservoir Revegetation Program).

This document provides detailed Terms of Reference for the implementation phase (Years 2-5) of CLBWORKS-1, based on results obtained during Year 1 of this program[3] (Keefer 2007). Incorporated into the final revegetation program are feedback from public and First

[2] Vegetation growth can be defined as the increase in area of self-sustaining vegetation cover.

[3] Phase 1 work included field verification of revegetation potential and prioritization of revegetation sites, collection of seed and initiation of nursery stock.

Nation consultation processes to ensure that the planned approach does not conflict with other land uses (e.g., motorized and non-motorized recreation, beach areas), and that revegetation prescriptions are compatible with First Nation archaeological site protection requirements and incorporate traditional use species, where possible.

In association with the revegetation physical works, the WUP CC recommended inventory and effectiveness monitoring programs to ensure that the Kinbasket Reservoir revegetation efforts are providing the intended environmental and social benefits over the long term. The monitoring programs include the following Terms of Reference:

- Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis (CLBMON-9)
- Kinbasket Reservoir Inventory of Vegetation Resources (CLBMON-10)

Mid Columbia River and Arrow Lakes Reservoir Revegetation Program

Riparian vegetation in Arrow Lakes Reservoir, and in particular in Revelstoke Reach (mid Columbia), presently extends over an elevation range of about 10 m (430 m to 440 m). Expansion of vegetation into the lower elevations has been largely the result of a fall rye seeding program that began in the early 1990s, which has facilitated the spread of natural vegetation (sedge and grass). A series of low water years during the 1990-1999 period also allowed the establishment of natural vegetation by providing seedlings sufficient growing time to develop into mature plants that are capable of tolerating subsequent extended inundation. These factors have worked in concert over the past decade to allow the establishment and persistence of extensive areas of natural vegetation, which now dominate the drawdown zone of Revelstoke Reach and smaller areas in the main body of Arrow Lakes Reservoir (Moody 2005).

Recognizing the importance of this vegetation as a means of achieving a number of environmental and social benefits for Arrow Lakes Reservoir, the WUP CC explored several operating alternatives, designed to maintain existing vegetation in the mid Columbia (Revelstoke Reach) and Arrow Lakes Reservoir, by imposing lower reservoir elevations for longer periods during the early part of the growing season (late spring and early summer). Modeling of these alternatives showed that stricter elevation constraints would provide varying levels of protection to vegetation, but could incur very high costs in lost power generation in some years. There was also concern around the high level of uncertainty in many of the assumptions used to develop elevation constraints, particularly around the relative importance of timing, frequency, duration and depth of inundation on the distribution, biomass and diversity of vegetation.

To address these concerns, the WUP CC recommended a multi-year revegetation program between elevations 434 m and 440 m in those areas that have a good potential to become self-sustaining after five years of treatment as a more cost-effective means of maximizing vegetation growth in the drawdown zone of Arrow Lakes Reservoir. The goal of the program is to provide benefits to littoral productivity, large river habitat, wildlife habitat, shoreline erosion and archaeological site protection. The program will be implemented through the Mid Columbia and Arrow Lakes Reservoir Revegetation Program Physical Works (CLBWORKS-2). The WUP CC agreed that annual monitoring of the revegetation program would be critical to evaluate the effectiveness of planting efforts, and confirm the effectiveness of techniques for vegetation and wildlife habitat enhancement. The monitoring program includes the following Terms of Reference:

- Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis (CLBMON-12)
- Arrow Lakes Reservoir Inventory of Vegetation Resources (CLBMON-33)
- Arrow Lakes Reservoir Plant Response to Inundation (CLBMON-35)

2.1 Additional Monitoring Programs

Two additional programs are included in the Kinbasket and Arrow Lakes Reservoir Revegetation Management Plan (RMP), specifically:

- Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works (CLBMON-11)
- Monitoring of Mosquito Populations in the Revelstoke Area (CLBMON-13)

CLBMON-11 will monitor the effectiveness of wildlife habitat utilization in the Kinbasket and Arrow Lakes reservoir drawdown zones, with the goal of assessing the benefits of revegetation efforts and physical works (mid Columbia and Arrow Lakes only) to wildlife.

The goal of CLBMON-13 is to gain a better understanding of the species, life history and habitat requirements of mosquito species occupying habitats in the Revelstoke area, to determine the effect that dam discharge and reservoir management have on mosquito levels in the area. Because water pockets that form in revegetated areas and in other vegetated spots when reservoir levels recede may provide additional mosquito breeding habitat, this program will also examine potential effects of revegetation efforts in the drawdown zone on mosquito production (species and abundance).

3.0 REFERENCES

BC Hydro. 2005. Consultative Committee report: Columbia River Water Use Plan, Volumes 1 and 2. Report prepared for the Columbia River Water Use Plan Consultative Committee by BC Hydro, Burnaby, BC. 924 pp.

Carr, W.W. and A.I. Moody. 2003. Mica - Revelstoke - Keenleyside Water Use Plan: Potential areas for vegetation establishment in the Kinbasket Reservoir. Report prepared for BC Hydro. 40 pp.

Keefer, M.E., T. Ross and K. Kettenring. 2007 Kinbasket Reservoir Revegetation Program Physical Works (Phase 1) Site Verification and Seed Collection. Report prepared for BC Hydro. 34 p. plus appendices.

Moody, A.I. 2005. Mica-Revelstoke-Keenleyside Water Use Plan: potential areas for vegetation establishment in the Arrow Lakes Reservoir. Prepared for BC Hydro. 49 pp.

Monitoring Study No. CLBMON-9
Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis

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 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.

Because of the potential to achieve the multiple objectives referred to above, the WUP CC recommended that a reservoir-wide revegetation program, compatible with the current operating regime for Kinbasket Reservoir, be implemented in lieu of operational constraints to enhance and expand vegetation communities within the drawdown zone. The program was proposed as a multi-year project, requiring interventions over five years, to facilitate long-term, self-sustaining vegetation cover.

Field work conducted in Year 1 of CLBWORKS-1 (Kinbasket Reservoir Revegetation Physical Works) has confirmed that approximately 1525 ha between elevations 747 m and 754 m in the drawdown zone of Kinbasket Reservoir are suitable for vegetation enhancement (Keefer et al. 2007). An overview of sites by size and geographic area is provided in Table CLBMON-9-1, and detailed maps of these sites, including proposed reference[4] and control[5] areas, are included in Appendix I. It is expected that additional sites suitable for revegetation are located between 747 m and the revegetation elevation limit of 741 m, will be identified in the spring of 2008. These sites will need to be incorporated into the monitoring program, once they are selected.

Given the considerable uncertainty regarding the potential effects of inundation on riparian and wetland environments, the WUP CC recognized that a monitoring program would be required to assess selected treatment techniques, and evaluate the effectiveness of revegetation efforts over the long term. The monitoring program was to focus on those components of the operating regime assumed to drive vegetation establishment (i.e. inundation depth, duration and timing) by imposing wet stress or dry stress over a defined period of time. Because the assumptions of vegetation tolerances to inundation and responses to changes in the hydrologic pattern were based on information gained from studies in the Arrow Lakes Reservoir (Moody 2005), which is substantially different from Kinbasket Reservoir in elevation, climate and operating

[4] No revegetation has been identified for these sites – they serve to monitor the effects of the operating regime and other environmental variables on existing vegetation communities.

[5] Sites that are identified for revegetation, but will not be revegetated. These sites will act as control areas for the revegetation monitoring, as well as other monitoring programs in the Kinbasket Reservoir drawdown zone (e.g. CLBMON-11 Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir)

regime, the WUP CC recognized that further information would be required to refute or support these assumptions.

Table CLBMON-9-1. Summary of Areas proposed for Revegetation between 747 m and 754 m

Polygon #	Geographic Area	Polygon Size (ha)	Polygon #	Geographic Area	Polygon Size (ha)
3	Canoe Reach	23	80a	Bush Arm	18
8	Canoe Reach	508	80b	Bush Arm	18
12	Canoe Reach	79	80c	Bush Arm	18
15/16	Canoe Reach	59	80d	Bush Arm	307
25	Canoe Reach	8	83	Bush Arm	106
31	Canoe Reach	11	84	Bush Arm	17
34	Canoe Reach	12	87	Bush Arm	21
37	Canoe Reach	1	88/91	Bush Arm	35
39	Canoe Reach	2	92	Bush Arm	69
33	Canoe Reach	24			
36	Canoe Reach	26	119	Beavermouth	25
			120a-b	Beavermouth	21
45,46,47	Wood Arm	32			
48/49	Wood Arm	77	63	Sullivan Reach	8
TOTAL		**862**			**663**

Therefore, the goals of the monitoring program outlined in these Terms of Reference are to:

1) Determine the species composition (i.e., distribution, distribution and vigour) of existing vegetation communities (as identified by Hawkes et al. 2007) to identify species that have been successfully surviving long-term inundation;

2) Evaluate the cover, abundance and biomass of existing vegetation communities (as identified by Hawkes et al. 2007) in relation to elevation in the drawdown zone;

3) Monitor the response of existing vegetation communities at the local (site) level to the continued implementation of the operating regime for Kinbasket Reservoir and other environmental variables;

4) Assess the long-term effectiveness[6] of the revegetation program at expanding the quality[7] (as measured by diversity, distribution and vigour) and quantity (as

[6] Monitoring the long-term effectiveness is the process of obtaining and analyzing repeated samples of the key variables after revegetation treatment to see if these interventions resulted in increased vegetation spatial extent, and/or species abundance, distribution, diversity and biomass in relation to the operating regime and/or other environmental variables.

[7] "Quality" is defined as a measure of how effectively the established/enhanced vegetation meets the interests expressed by the WUP CC, including improving aesthetic quality, controlling dust, protecting cultural heritage sites from erosion and human access, and enhancing littoral productivity and wildlife habitat.

measured by cover, abundance and biomass) of vegetation in the drawdown zone for ecological and social benefits; and,

5) Assess the costs and benefits of the revegetation prescriptions applied under CLBWORKS-1 (Kinbasket Reservoir Revegetation physical works) by monitoring the response of revegetated communities to different treatments in the drawdown zone of the reservoir.

The study will focus on monitoring existing vegetation at the *site (local)* scale. Observations on *intra*-community changes in existing vegetation over a 10 year time horizon will support data gathered as part of CLBMON-10 (Kinbasket Reservoir Inventory of Vegetation Resources), which monitors *inter*-community changes of existing vegetation communities at the *landscape* scale over a 10-year period.

The study will also assess the effects of revegetation efforts at the *site* scale through plot-based monitoring. Landscape level monitoring of revegetation efforts is being carried out under CLBMON-10, which utilizes with aerial photography data to detect changes in spatial extent of revegetated areas. Together, data from CLBMON-9 and 10 will inform on the effectiveness of the revegetation program at maximizing vegetation growth in the drawdown zone and facilitating the development of long-term self-sustaining riparian vegetation.

1.2 Management Questions

The management questions for this monitoring program address the intra-community response of existing vegetation in the drawdown zone of Kinbasket Reservoir to the continued implementation of the operating regime at the local (site) level. For revegetated areas, the management questions will address whether the continued implementation of the current reservoir operating regime allows for the establishment and expansion of vegetation at site level through a revegetation program in the drawdown zone of Kinbasket Reservoir.

1.2.1 Existing Vegetation

Primary management questions for existing vegetation communities in the drawdown zone of Kinbasket Reservoir between elevations 754 m to 741 m (approximate[8]) are:

- What is the species composition (i.e., distribution, distribution and vigour) of existing vegetation communities (as identified by Hawkes et al. 2007) in relation to elevation in the drawdown zone?
- What is the cover, abundance and biomass of existing vegetation communities (as identified by Hawkes et al. 2007) in relation to elevation in the drawdown zone?
- How does the current operating regime affect the within-community quality and quantity (i.e., species cover, abundance, biomass, diversity and distribution within existing communities) of existing vegetation?
- Is there a shift in community structure (e.g., species dominance) or a potential loss of existing vegetated communities that is attributable to environmental conditions, including the current operating regime (i.e., timing, frequency, duration and depth of inundation)?

[8] Locations suitable for successful establishment and development of vegetation communities are tied to the average reservoir level and currently occupy a zone in the upper elevations of the reservoir, above 741 m.

- What are species-specific survival rates under current operating conditions (i.e., what are the tolerances of existing plant species to inundation)?
- What recommendations can be made to more effectively maintain existing vegetation at the site level in the future?

1.2.2 Revegetated Areas

Primary management questions for revegetated areas are in the drawdown zone of Kinbasket Reservoir between elevations 754 m to 741 m (approximate):

- What is the quality and quantity of vegetation in revegetated areas between elevations 754 m to 741 m (approximate) compared to untreated areas, based on an assessment of species distribution, diversity, vigour, abundance, biomass and cover?
- What are species-specific survival rates under current operating conditions (i.e. what are the tolerances of revegetated plant communities to inundation timing, frequency, duration and depth)?
- What environmental conditions, including the current operating regime (i.e. timing, frequency, duration and depth of inundation), may limit or improve the restoration and expansion of vegetation communities in the drawdown zone?
- What is the relative effectiveness of the different revegetation treatments, as applied through CLBWORKS-1, at increasing the quality and quantity of vegetation in the drawdown zone?
- Does implementation of the revegetation program result in greater benefits (e.g., larger vegetated areas, more productive vegetation) than those that could be achieved through natural colonization alone?
- Is there an opportunity to modify operations to more effectively maintain revegetated communities at the landscape and site level in the future?

1.3 Management Hypotheses

The following management hypotheses and sub-hypotheses aim to test the scientific understanding of the management questions stated above. It is important to note that, for monitoring intra-community changes in existing vegetation, the study is based on an observational time series approach. Therefore, the contractor has the option to forgo formal testing of the hypotheses in Section 1.3.1, and structure the study design to address the management questions in Section 1.2.1. The proposal shall provide a rationale for this approach, if chosen. This option is not available for monitoring revegetation efforts.

1.3.1 Hypotheses - Existing Vegetation

H_0: Changes within existing vegetation communities between elevations 754 m to 741 m in the drawdown zone of Kinbasket Reservoir, if they occur over the monitoring period, are unrelated to the continued implementation of the current operating regime.

H_{0A}: Changes in the area occupied by specific species assemblages within existing vegetation communities, if they occur, are not related to the operating regime (timing, frequency, duration and depth of inundation)

H_{0B}: Changes in species diversity, distribution and vigour within existing vegetation communities, if they occur, are not related to the operating regime (timing, frequency, duration and depth of inundation).

H_{0C}: Changes in species productivity (cover, abundance and biomass) within existing vegetation communities, if they occur, are not related to the operating regime (depth, duration, timing, frequency of inundation).

1.3.2 Hypotheses - Revegetated Areas

Ho_1: Revegetation treatments between elevation 754 m and 741 m support continued natural recolonization of the drawdown zone.

Ho_{1A}: There is no significant difference in vegetation establishment (based on species distribution, diversity, vigour, biomass and abundance) at control versus treatment locations.

Ho_{1B}: There is no significant difference in the cover of vegetation in control versus treatment areas.

Ho_{1C}: There is no significant difference in the cover of vegetation communities and vegetation establishment (based on species distribution, diversity, vigour, biomass and abundance) arising from different revegetation prescriptions.

Ho_2: Reservoir operating conditions have no significant effect on vegetation establishment in revegetated areas between elevation 741 m and 754 m.

Ho_{2A}: Vegetation establishment (based on species cover, distribution, diversity, vigour, biomass and abundance) is not significantly affected by the timing of inundation at control and treatment sites.

Ho_{2B}: Vegetation establishment (based on species cover, distribution, diversity, vigour, biomass and abundance) is not significantly affected by the frequency of inundation at control and treatment sites.

Ho_{2C}: Vegetation establishment (based on species cover, distribution, diversity, vigour, biomass and abundance) is not significantly affected by the duration of inundation at control and treatment sites.

Ho_{2D}: Vegetation establishment (based on species cover, distribution, diversity, vigour, biomass and abundance) is not significantly affected by the depth of inundation at control and treatment sites.

1.4 Key Water Use Decision Affected

The key operating decision affected by this monitoring program is the current operating regime for Kinbasket Reservoir. The decision of the WUP CC to implement a revegetation program in lieu of operational changes in Kinbasket Reservoir was based on the assumption that a revegetation program could be successful under the constraints of the operating regime. Inferences from this study, in conjunction with results from CLBMON-10 Inventory of Vegetation Resources, will provide an assessment of:

1) the effectiveness of the current operating regime to maintain existing vegetation communities at the landscape and local scale;

2) methods for restoring or expanding vegetation in the drawdown zone through a revegetation program; and;

3) the potential for vegetation establishment under variable reservoir levels, as dictated by the current operating regime.

Furthermore, by improving the ecological understanding of how vegetation responds to long-term variations in water levels under this operating regime, the program will provide scientifically-based information to identify future options for the operating regime for the reservoir, including (but not limited to) modifying minimum or maximum elevations to maintain and expand vegetation communities in the drawdown zone.

2.0 MONITORING PROGRAM PROPOSAL

2.1 Objective and Scope

Existing Vegetation

This component of the program is focused at the site (local) level, and is designed as a plot-based observational study to address the management questions in Section 1.2.1. Information from this component of the program will serve to quantify changes in the quantity and quality of existing vegetation communities that may occur in response to the operating regime and/or other environmental variables over a 10-year period in the drawdown zone of Kinbasket Reservoir. The objectives of this component monitoring program are:

1) To define and map the boundaries of the study area and define the biophysical and management strata that will structure the sampling methodology and analysis strategy for monitoring existing vegetation communities.

2) To document within-community responses (through monitoring of species cover, distribution, diversity, vigour, biomass and abundance) of existing vegetation communities to environmental conditions, including the current operating regime, through a plot-based assessment.

Revegetated Areas

This component of the program is focused at the site (local) scale, utilizing plot-based monitoring to address the management questions in Section 1.2.2 and the hypotheses in Section 1.3.2. The objectives of this component monitoring program are:

1) To assess the effectiveness of the revegetation program at expanding the quantity (as measured by cover, abundance and biomass) and quality (as measured by diversity, distribution and vigour) of vegetation in the drawdown zone under the current operating conditions (i.e. timing, frequency, depth and duration of inundation) over a 10 year period.

2) To assess the response of revegetated communities and their species assemblages to environmental conditions, including the current operating regime (i.e. inundation timing, frequency, depth and duration) through plot-based monitoring at the site level over a 10-year period.

3) To maintain a data collection and management database for the period of the monitoring program.

These objectives will be accomplished by assessing the specified response variables at sample sites, stratified by primary topographic and biophysical criteria, under the various treatment options relative to control sites (areas of naturally established vegetation and barren sites). Vegetation responses will be monitored over a range of geographic areas within the drawdown zone of Kinbasket Reservoir, based on locations selected for treatment and control under CLBWORKS-1 Kinbasket Reservoir Revegetation Program.

Monitoring will be conducted over a 10-year period: Year 1 of the program will focus on establishing monitoring plots in locations chosen for revegetation and associated control plots, and obtaining data on baseline conditions (e.g. community composition, physical processes affecting the sites). Information on vegetation community classifications at the landscape scale is available (Hawkes et al. 2007), and will form the basis for describing intra-community species assemblages. Additional information required for this study is available from site assessments conducted under CLBWORKS-1 (Keefer et al. 2007), and continuing inventory work under CLBMON-10. The contractor will be required to collaborate closely with these programs to avoid duplication of effort.

The contractor will carry out field assessments of existing vegetation communities and revegetation treatments bi-annually in Years 2, 4, 6, 8, and 10. The contractor will also maintain annual records of the operating regime (inundation timing, frequency, depth and duration), climate data (weekly temperatures: average, max, min; precipitation: total amount) during the growing season and related remote-sensing data.

2.2 Approach

The main approach for monitoring intra-community changes in existing vegetation is a geographically extensive, plot-based observational time series design to document any changes that occur within existing vegetation communities as a result of inundation timing, frequency, duration and depth. An explicit evaluation of effects of environmental (explanatory) variables other than the operating regime (e.g. climate, topography, substrate, and physical processes) will also be incorporated into monitoring program design. The specifications for initial site selection, plot type and other components of a detailed study design will be developed by the contractor and submitted to BC Hydro for review and acceptance prior to study initiation.

The approach proposed for the revegetation monitoring component involves bi-annual repeat observations at randomly stratified control and treatment sites. The goal is to assess the effects of the revegetation treatments relative to natural vegetation establishment/growth in various locations in the drawdown zone of Kinbasket Reservoir between elevations 741 m and 754 m to determine effects of environmental conditions, including inundation timing, frequency, duration and depth, on revegetated areas. A statistically valid design will be used to test the success of various revegetation treatments, site conditions and to partition operational effects from other sources of variation. As part of the approach, an intensive field monitoring program will also be undertaken to monitor the success of revegetation efforts in different geographic areas of the reservoir in relation to site characteristics, physical processes (e.g. erosion/deposition) and hydro-period.

Specifically, revegetation monitoring will involve:

- Evaluation of *a priori* hypotheses and predictions about the response of plant species and vegetation communities to the operating regime and proposed revegetation treatments.

- Documentation of spatial and temporal intra-community changes in the quality and quantity of vegetation within the drawdown zone at control and treated sites.
- Field assessments of vegetation response to the various treatment options.
- Statistical estimation of trends in vegetation survival and growth in relation to operating conditions of the reservoir and other environmental factors at control and treated sites.
- Examination of the effects of the operating regime on the success of different revegetation treatments.

Because the key hypothesized explanatory variable in this study – the current operational regime – cannot be experimentally manipulated, *both* study components should take the approach of identifying *a priori* expected effects on the identified response variables. The goal is to develop an analysis approach that will yield the strongest possible inferences to address the management questions.

Due to the operational regime of the reservoir, field monitoring for both components will need to occur within a narrow time window after vegetation growth has begun, but before water levels inundate the vegetated areas[9].

This monitoring program will be closely linked to the Kinbasket Reservoir Revegetation Program Physical Works (CLBWORKS-1) and to Kinbasket Reservoir Inventory of Vegetation Resources (CLBMON-10). Air photos obtained through the latter study will provide data on the success of the revegetation efforts on a landscape scale. Analysis of aerial photography to determine changes in spatial extent of revegetated areas falls within the scope of CLBMON-10, and close collaboration and data exchange between these related studies is required to avoid duplication of efforts.

2.3 Methods

2.3.1 Task 1: Project Coordination

Project coordination will involve the general administrative and technical oversight of the program, which will include, but not be limited to: 1) budget management, 2) study team management, 3) logistic coordination, 4) technical oversight in field and analysis components, 5) participation in planning processes for other programs under the Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan, and 6) facilitation of data transfer among other investigations associated with the Kinbasket and Arrow Lakes Reservoirs Revegetation Management Plan.

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: Statistical Design

Involvement of a biostatistician will be required for the design of both components of the monitoring program (i.e. monitoring of existing vegetation and revegetated areas) to ensure that the field component and subsequent data analysis utilize statistically valid approaches for testing the management hypotheses (where applicable) and drawing causal inferences to support the management questions. The study design must be

[9] It should be noted that it may not be possible to implement long-term monitoring in the lower elevations of the drawdown zone across all water years due to BC Hydro's obligations under the Columbia River Treaty, weather variability in the Columbia basin and operational load requirements.

statistically robust, and must explicitly consider stratification of topographic and predictive biophysical variables to partition sources of variation in species responses. The biostatistician will therefore be involved at the preliminary design stage of the program and subsequent to the data gathering to ensure that the sample stratification is well defined and feasible, the sample size of sites is adequate without the need for excessive sampling, the criteria for replacing plots (if lost due to unanticipated disturbances or reservoir operation) are known, the criteria for censoring data from plots are defined, and quality assurance protocols are adequate.

Existing Vegetation

The basic goal of the statistical approach will be to design inference models that reflect the biological dynamics of existing drawdown zone vegetation communities in relation to the environmental conditions they experience over time. The model should include parameters to describe the states of existing vegetation communities, the characteristics of the operating regime (inundation timing, frequency, depth, duration) and sources of disturbance[10].

The statistical model must explicitly consider that inferences based on the analysis of community changes at different elevational strata will be influenced by covariates unrelated to operations (e.g., climatic or site conditions). The effect of such potential covariates will need to be addressed in the model, to ensure that any confounded factors are appropriately identified and accounted for in the analysis. Therefore, the study design will describe environmental variables to be measured, identify potential covariates, and demonstrate how the proposed statistical model will account for covariation attributed to environmental variables. Analysis methods selected should aim to differentiate any relationship between operations and the observed trends from covariates.

Revegetated Areas

The statistical approach for this study component is intended to permit inferences about the responses of plants to revegetation treatments in the drawdown zone at two levels: single-species and the local community (site) level. The response variables of interest at the species level are the presence, abundance, and vigour of each species in treatment and control plots. The response variables of interest at the community level are species cover, diversity, distribution, biomass and change in occupancy pattern (i.e. colonization or extirpation) in the reservoir drawdown zone as a factor of treatment, operating regime and/or other environmental variables, as identified *a priori*. These data will be used together in the analysis to infer the success of revegetation efforts within the drawdown zone. Monitoring locations will be chosen to proportionately represent the different climatic and geographic regions of the reservoir, as well as different site conditions, such as slope, aspect and substrate. The design will also account for the effects of different physical and ecological conditions (e.g., erosional/depositional processes, proximity to source plant communities, sources of disturbance (other than inundation), and detectability of species on the plots).

[10] This may include effects of revegetation, as implemented under CLBWORKS-1 Kinbasket Reservoir Revegetation Program, physical processes (e.g. erosion/deposition), land use, etc.

Both Study Components

For both study components, inter-annual variability in reservoir levels is expected to lead to different responses within vegetation communities and elevation zones. The sampling designs must therefore have sufficient power to detect differential responses related to hydrologic variability and the seasonal operating regime, despite the lack of an explicit manipulation of this process. Careful consideration should be given to the definition of a sampling unit within in the context of the spatial scale under investigation and the management questions/hypotheses to be addressed, as well as the need for spatial replication. Sample plots (and adjacent control areas for the revegetation component) will be chosen to assess the full range of physical and geographic locations in the drawdown zone between elevations 741 m and 754 m.

As noted previously, this study is not experimental or manipulative in nature, but is based on an observational time series approach. Consequently, classical paired sampling designs (e.g. before-after-control-impact (BACI)) cannot be used to test for the influence of the operating regime, because designed manipulations of inundation depth, duration, frequency and timing are not possible[11]. However, a treatment-control approach can be used to evaluate the effect of different revegetation treatments, while recognizing that data will be collected as repeated measures. Because of these limitations, model inferences will not be as strong as in a true manipulative study; however, care in the statistical design will permit the strongest possible inferences to address the management questions.

Because the operating regime itself is an environmental condition to which all sites are exposed, the inference procedure should consider the hypotheses as a part of the statistical testing, such that deviations from those expectations can form part of the inference methods. In general this is most clearly done by creating specific state variables (i.e. the proportion of sample plots in which species x occurs) in such a way that 1) changes in the state can reveal a change in the ecological dynamics as a function of the hypothesized causal factors (such as inundation regime); 2) probabilities of each state occurring can be explicitly compared among strata or between years; and 3) any sources of heterogeneity in data (i.e. differences in observers detecting species, or differences in environmental conditions between years) can be explicitly represented in the statistical model and their effects quantified.

2.3.3 Task 3: Vegetation Sampling

For monitoring of existing vegetation communities and revegetated areas, a plot-based sampling design will be developed and implemented in Year 1. Sampling will be repeated bi-annually for five years over a 10-year period to test for change over time. Stratification of plots is deemed an important criterion, and strata should include, at minimum: 1) elevation band; 2) geographic area; 3) current vegetation status (e.g., unvegetated; vegetated), and 4) community type (as per Hawkes et al. 2007). Additional criteria may include consideration of topographic effects (e.g., - slope, aspect), site conditions (substrate, physical processes, proximity to other communities) and sources of disturbance (wildlife, human). Good randomization and replication of field plots at each stratum will be required.

[11] For a given plot and elevation, all individual plants will experience the “treatment” applied through the operating regime, which will vary intra- and inter-annually, depending on weather conditions and constraints under the Columbia River Treaty. Temporal replication of inundation conditions between years is unlikely, since reservoir operating conditions are highly variable between years.

Distribution of plots will utilize a stratified random sampling program, which will be developed with input from a biostatistician. Plot selection must utilize information on the suitability of vegetation treatment sites, obtained through CLBWORKS-1 (Kinbasket Reservoir Revegetation Program) to ensure that both naturally recolonized (control) sites and proposed revegetation (treatment) sites are adequately represented in site selection.

Selection of proposed monitoring sites for both study components will be initiated in Year 1 through a preliminary sampling program, which will enable determination of the levels of variability in the response variables, and provide information on potential covariates encountered. The number and size of plots required to adequately assess the range of elevations and vegetation diversity, and factors creating heterogeneity in results (i.e. potential access problems to sites, observer differences in sampling, etc.) will also be determined at this time.

It should be noted that maintaining adequate sample sizes (as dictated by the choice of analysis methods) throughout the time period of the study will be a potential challenge. Some plots may be lost, and others become inaccessible through changes in the reservoir's physical conditions or access. To compensate, more sites should be selected at the outset than are needed for year-on-year sampling, and these sites should be used to replace lost sites. Location of field plots must take into account other programs running concurrently in the same area, including CLBWORKS-1 (Kinbasket Reservoir Revegetation Program), CLBMON-8 (Monitoring of the Valemount Peatland), CLBMON-10 (Inventory of Vegetation Resources) and CLBMON-11 (Kinbasket and Arrow Lakes Reservoirs Effectiveness Monitoring of Revegetation and Wildlife Physical Works). Coordination of sampling locations with these other programs is the responsibility of the consultant, with assistance from BC Hydro.

Once monitoring plots have been selected and laid out, plot sampling will commence the following year (Year 2) and will be undertaken bi-annually in the spring (late May to early July), after sufficient plant growth has occurred, but prior to inundation by rising water levels.

Monitoring plot establishment will be initiated prior to any revegetation activities to allow for:

- Establishment of permanent photo-monitoring sites,
- Assessment of site characteristics for control and treatment locations, and
- Quantification of the vegetated area, species composition and relative productivity of existing vegetated sites.

Field monitoring of existing vegetation communities will be conducted bi-annually in Years 2, 4, 6, 8, and 10. Response variables collected during sampling will include species presence, area covered by a given species, species biomass, distribution, diversity and within-community structure and function. Biomass plots will be sampled (clipped) for both above-ground and below-ground constituents. Because of this removal component, plots should have two strata – a non-removal section for inventory, and a removal section in which removals can be carried out. These strata should be separated, so there is no opportunity for the effects of previous removals to cause an effect in the current year of removal. Required analyses for biomass include: dry weight, ash-free dry weight, N, P, K and C. Repetition of the biomass sampling in subsequent years should be undertaken during the same sampling and growth interval to ensure comparability of

results. Evidence of disturbance must be recorded and quantified in a standardized manner.

Field monitoring of revegetation efforts will be conducted bi-annually in Years 2, 4, 6, 8, and 10 to document change in the area covered by a given species, species abundance, diversity, distribution, biomass and vigour of naturally occurring and treated vegetation over time. Surveys will also include documentation of nutrient conditions of substrates and vegetation at each site. Additional field effort will be required in Year 10 to evaluate the overall success of the revegetation program at enhancing vegetation within the drawdown zone. Substrate and plant samples will be collected for nutrient and biomass analysis starting in Year 1, and sampling will be repeated during bi-annual monitoring to evaluate nutrient changes as a result of treatment effects.

For both study components, it is recommended that the basic approach for describing observed vegetation follow the procedures outlined in MacKenzie and Moran (2004) for characterizing wetland components, and include assessment and characterization of site, soil and vegetation community characteristics and types. This methodology was developed specifically for BC wetlands to address the lack of a wetland assessment protocol, and is supplemental to the standard procedures for vegetation inventory (e.g. "Field manual for describing terrestrial ecosystems[12]" (1998)). However, consideration should also be given to classification schemes developed specifically for Kinbasket Reservoir in a related program (CLBMON-10 Inventory of Vegetation Resources), which will be more applicable to vegetation communities encountered in the reservoir drawdown zone.

Establishment of permanent photo-monitoring points within the strata will be undertaken to provide a photographic record of site-specific conditions on an annual basis. The photography should occur within a set timeframe to optimize between-year comparisons, and incorporate a devise for scale, as well as location signage. Locations of photo-monitoring points should be well documented with GPS positions and compass bearings noted. Permanent marking of the photo monitoring locations is essential for repeat documentation; however, the locations in the drawdown zone pose unique challenges for permanent marking of locations, because they may be subject to floating debris, boat activity or ATV damage. Marking of these sites must not pose a hazard for other users of the reservoir but must be sufficiently permanent to be re-locatable. GPS points should be recorded for all sample plots, biomass plots and permanent photo-monitoring locations, using precision GPS to ensure accurate relocation of these sites.

Protection of Archaeological Sites

Several archaeological sites have been identified in the drawdown zone of Kinbasket Reservoir. Locations of these sites will be provided upon contract award. Because of the risk of impacting known and unknown sites, the standard procedure of digging soil pits to identify the mineral soil horizons cannot be carried out. Instead, soil profiles should be identified from cut-banks or restricted to assessment of surficial material only, where sites are known to be present. In areas where no sites have been identified, soil characteristics may be assessed with soil cores of up to 60 cm in depth.

Should sites be encountered accidentally during field work associated with this project, BC Hydro's Field Guide for Archaeological and Heritage Resources (Appendix II) will apply.

[12] http://www.for.gov.bc.ca/hfd/pubs/docs/Lmh/Lmh25.htm

2.3.4 Task 4: Data Analysis

The proposal shall clearly demonstrate how the data analysis will address the management questions and associated hypotheses, while accounting for inherent limitation in the study (e.g. repeated measures, confounded explanatory variables). The proposed data analysis must consider how lack of experimental manipulation of the hypothesized explanatory variables (i.e. the operating regime) and confounded factors may affect analysis results, and how hypotheses testing may be accomplished in light of these challenges. The effects of other sources of variation at the landscape and local spatial scale (e.g. climate variability, disturbance factors, dispersal opportunity) will be accounted for and evaluated using models of the errors attributable to these factors, based on exploratory analysis of the data collected.

A detailed description of the data analysis, including limitations and benefits of the selected method(s) and a discussion of statistical power/sample size, will be provided in the study design submission (part of contract deliverables), which will be submitted to BC Hydro for review and comment prior to project implementation.

Existing Vegetation

A digital elevation model (DEM) for Kinbasket Reservoir, accurate to 25 cm, is available, and may be used to interpret observed patterns in species abundance, biomass, distribution, diversity and within-community structure and function. Changes in patterns must be linked to causal factors, including inundation timing, frequency, duration and depth resulting from implementation of the current operating regime. The proposal shall outline how this may be accomplished, and a detailed description of analytical methods will be provided in the study design.

Revegetated Areas

To interpret effects of revegetation treatments, the DEM may be used in conjunction with aerial photography (available through CLBMON-10) and ground sampling to quantify observed changes in vegetation spatial extent, species abundance, distribution, diversity, biomass and vigour. Changes in patterns must be linked to causal factors, including vegetation treatments and inundation timing, duration and depth resulting from implementation of the current operating retime. The proposal shall outline how this may be accomplished, and a detailed description of analytical methods will be provided in the study design. A general linear modeling approach, which allows specification of a) hierarchical models and b) different error distributions for each predictor and response variable, is recommended.

2.3.5 Task 5: Reporting

A brief technical report will be prepared each year of the monitoring program to summarize the methods employed during the program, preliminary data analyses and study findings. A comprehensive report will be prepared at the conclusion of Year 10 of the study, which will include:

- an executive summary;
- a description of sampling and analysis methods;
- a summary of data collected;

- analysis results and a comparison of results among years in relation to the observed operating regime, revegetation treatments and other explanatory variables observed in each year;
- a detailed summary of the findings as they relate to the ecological hypotheses and the management questions; and
- any recommendations for operational changes and/or continued intervention as a result of observed changes in existing and enhanced vegetation communities.

Specifically, the report will include a quantitative assessment of how revegetation activities affect the relative quality and quantity of vegetated areas within the drawdown zone in Arrow Lakes Reservoir. It will also provide an evaluation of the extent to which objectives[13] for the vegetated areas, as identified by the WUP CC, were met by the revegetation program under the reservoir's operating regime.

Reports will follow the standard format that has been developed for WUP monitoring programs. All reports will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (*.pdf) format, and all maps and figures will be provided either as embedded objects in the Word file or as separate files. All map data, including meta data, will also be provided electronically in ARC GIS compatible format. Data (including photographic time-series) will be maintained in a relational database with a full description of the contents of each attribute.

2.4 Interpretation of Monitoring Program Results

The monitoring data will be used to assess the response of existing vegetation communities to the current operating regime of Kinbasket Reservoir to provide a better understanding of the relationship between water levels and the maintenance of these communities at the local spatial scale. For revegetated areas, the data will be used to identify linkages at two different spatial scales (landscape and site level) between operations, revegetation activities and vegetation quality and quantity in the drawdown zone. Results of the data analysis should provide a better understanding of the relationships between water levels (inundation timing, frequency, duration and depth), vegetation establishment and types of treatments that provide the best results under the current operating regime of Kinbasket Reservoir.

Overall, results of the monitoring program will inform on whether: a) the current operating regime is effective at maintaining levels of existing vegetation, and b) active intervention to enhance vegetation in lieu of operational changes for Kinbasket Reservoir can meet the management objectives[13] for the revegetation program, defined by the WUP CC. This information will be critical for decision making during the full review of the Water Use Plan after 13 years.

2.5 Schedule

The monitoring study will be conducted over six non-consecutive year of the implementation of the Columbia River Water Use Plan, as shown in Table CLBMON-9-2. Selection of inventory plots for existing vegetation, as well as establishment of control and treatment plots will occur in Year 1 of the monitoring program, after revegetation sites have been determined under CLBWORKS-1 Kinbasket Reservoir Revegetation Program. Monitoring of existing vegetation communities and revegetation efforts will be

[13] Objectives include improving aesthetic quality, controlling dust, protecting cultural heritage sites from erosion and human access, and enhancing littoral productivity and wildlife habitat.

initiated in Year 2 and will be repeated bi-annually in Years 2, 4, 6, 8, and 10. In each of these years, the field program will be undertaken at a time when sufficient growth of the plants has occurred, but before rising reservoir water levels prevent effective sampling and observations.

Table CLBMON-9-2. Schedule of tasks for Arrow Lakes Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis

Task/Year	2008	2009	2011	2013	2015	2017
Study Design and Refinement	√	√				
Plot Selection and Baseline Sampling	√					
Vegetation Sampling		√	√	√	√	√
Data Analysis		√	√	√	√	√
Reporting	√	√	√	√	√	√

2.6 Budget

The total annual cost of the monitoring program, as an average across all six years, is estimated at $95,419 (including inflation and contingency). This cost is higher than the original WUP CC estimate ($50,000 average across six years) due to the inclusion of a biostatistician during the study design and data analysis, as well as inclusion of a travel budget. Because many of the areas are not road accessible, the budget also includes use of a boat and helicopter to access to the more remote sites around Kinbasket Reservoir. Table CLBMON-9-3 provides annual budget estimates assuming a 2% rate of inflation and a 5% contingency for the duration of the program.

3.0 REFERENCES

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Appendix I
Maps of Proposed Revegetation Areas and Control/Reference Sites in Kinbasket Reservoir

Appendix II
BC Hydro Field Guide for Archaeological and Heritage Resources

BC Hydro FIELD GUIDELINES

Archaeological and Heritage Resources

If you come upon evidence of past human occupation, such as:

- human bones
- stone tools
- shell deposits (middens)
- pithouses
- rock paintings
- culturally modified trees

You should:

STOP WORK IMMEDIATELY, and notify your manager, as soon as possible. AVOID disturbing the site.

Why?

You may have discovered unrecorded archaeological resources which are protected under the Heritage Conservation Act. Under this Act, all BC Hydro employees and contractors are responsible for protecting archaeological resources uncovered during the course of our work.

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If you come upon suspected human remains, you should:

STOP WORKING IMMEDIATELY and notify the RCMP, and your manager, as soon as possible. AVOID disturbing the site.

Why?

1. You may have discovered a crime scene. Any disturbance may hamper the police investigation.
2. You may have uncovered an archaelogical site. The burial remains and any related artifacts are protected by the Heritage Conservation Act.
3. It shows respect for the human remains.

Who To Call

Environment & Sustainability, Engineering	604 528-1770
Aboriginal Relations	604 528-2805
Regional Enviro. Coordinator -	_____
RCMP/Police -	_____

BC hydro