

**Peace Project Water Use Plan**

**Monitoring Program Terms of Reference**

**Peace Spill Protocol**

- **GMSMON-6 Peace River Riparian Flooding**

**February 9, 2008**

## **Terms of Reference for the Peace Project Water Use Plan Monitoring Programs Peace Spill Protocol**

### **1.0 OVERVIEW**

This document presents Terms of Reference for the effectiveness monitoring programs for the Peace Spill Protocol (Table 1). These programs will monitor and quantify the environmental effects of spills. Information collected through the Peace Spill Protocol will be used, if appropriate, in the revision of future spill strategies. This document provides detailed Terms of Reference for the following programs:

- 1) **GMSMON-3 Peace River Fish Stranding:** A conditional monitoring program to be implemented immediately following a spill event that will assess the magnitude of fish stranding in the Peace River.
- 2) **GMSMON-4 WAC Bennett Dam Entrainment Study:** A conditional monitoring program to be implemented for a spill event that will estimate the number of fish entrained through WAC Bennett Dam and the rate of mortality experienced by entrained fish. Formerly known as the GMS Entrainment Study. The original project title was misleading as the focus of the study is spillway entrainment and not turbine entrainment.
- 3) **GMSMON-6 Peace River Riparian Flooding:** A conditional 2-year monitoring program to be implemented in Years 9 and 10 of the Peace Project Water Use Plan should a spill event occur during the 10-period.
- 4) **GMSMON-7 Peace River Side Channel Fisheries:** A 10-year required program to provide baseline data on flow, fish use, and substrate changes in side channels as well as to assess the response of trial sites (a physical works project).
- 5) **GMSMON-8 Peace River Side Channel Response:** A conditional monitoring program to assess the response of side channels to spill events in terms of flow, fish use, and substrate.
- 6) **GMSMON-9 Peace River Spill Hydrology:** A conditional program to ensure the collection and reporting of hydrological data associated with a spill event.
- 7) **GMSMON-10 Peace River Spill Photos:** A conditional monitoring program that captures the Peace River at five different flows during a spill event.
- 8) **GMSMON-11 Peace River Spill TGP/Temp:** A conditional monitoring program that monitors TGP and temperature levels of the Peace River during a spill and two weeks following.
- 9) **GMSMON-12 Peace River Wildlife Survey:** A conditional monitoring program that assesses the impact of a spill event on ungulates, beavers, riparian birds, and toads.
- 10) **GMSMON-13 Williston Fish Index:** A study that will estimate the abundance of fish in the pelagic area of the Peace Arm of the Williston Reservoir to assist in assessing the impact of entrainment on fish populations during a spill.

**Table 1 Peace Spill Protocol Monitoring Program Terms of Reference Submission Information**

<b>Name of Monitoring Program</b>	<b>Order Clause Fulfilled</b>	<b>Submitted with this Package</b>	<b>Previously Submitted To CWR</b>	<b>Ordered Submission Date</b>
GMSMON-3 Peace River Fish Stranding	Schedule D 3(a)	Yes	No	February 2008
GMSMON-4 WAC Bennett Dam Entrainment	Schedule D 3(b)	Yes	No	February 2008
GMSMON-6 Peace River Riparian Flooding	Schedule D 3(c)	Yes	No	February 2008
GMSMON-7 Peace River Side Channel Fisheries	Schedule C 4(d)	Yes	No	August 2008
GMSMON-8 Peace River Side Channel Response	Schedule D 3(d)	Yes	No	February 2008
GMSMON-9 Peace River Spill Hydrology	Schedule D 3(e)	Yes	No	February 2008
GMSMON-10 Peace River Spill Photos	Schedule D 3(g)	Yes	No	February 2008
GMSMON-11 Peace River Spill TGP/Temp	Schedule D 3(f)	Yes	No	February 2008
GMSMON-12 Peace River Wildlife Survey	Schedule D 3(h)	Yes	No	February 2008
GMSMON-13 Williston Fish Index	Schedule D 3(i)	Yes	No	February 2008

## Monitoring Program No. GSMON-6 Peace River Riparian Flooding

### 1.0 MONITORING RATIONALE

#### 1.1 Background

Riparian zones are among the most productive and valuable ecological systems. Riparian areas act as a physical transition zone between aquatic and terrestrial ecosystems where strong food web interactions occur between the two systems. The Peace River (PCR) and associated riparian habitat supports a wide variety of wildlife use including birds, mammals, and amphibians (Robertson Environmental Services 1996, TerraMar 2000). Dam construction on the river has resulted in a change in the hydrological system. A hydrological reversal and a reduction in flow rate have occurred (Figure 7-1; BC Hydro 2003). Pre-regulation seasonal flood events of 150,000–300,000 cfs in volume have been replaced by regulated daily flows of 10,000–70,000 cfs (BC Hydro 2003). The absence of any seasonal freshet event reduces the inundation of marginal riparian areas limiting fish habitat and in time changes the climax species of the floodplain vegetation (BC Hydro 2003).

The Peace Water Use Plan Committee (hereafter known as the Committee) recognized the importance of the riparian zone and recommended a riparian habitat assessment that will examine the impact of a spill event on large-scale temporal and spatial trends of the vegetative community along the Peace River. River bars and islands have been identified as areas of key concern by the Committee and will be the focus of the Peace River Riparian Flooding monitoring program. A long-term study similar in nature is underway which extends from the BC section of the Peace River into the Alberta section (Michael Church, 1984 West Mall, Vancouver, BC, University of British Columbia, by pers. Comm.). This study will likely be a useful source of supplementary information to the Peace River Riparian Flooding monitoring program once results are available.

The study will focus on assessing the positive and/or negative impacts to the riparian habitat following the spill. The monitoring program primarily addresses the Peace Spill Protocol and Peace River Flood Pulse Plan, and secondarily for the Peace River Ramping Plan (BC Hydro 2003). The Peace Spill Protocol and the Peace River Flood Pulse Plan were developed to assess the impacts of flood pulse events through a combination of studies. The purpose of the Peace Spill Protocol, specifically, is to quantify the environmental effects of a spill. Information gained from studies under this management plan will aid future decision-making related to spill risk strategies and environmental consequences. The Peace River Flood Pulse Plan was developed to improve downstream fisheries productivity and riparian habitat for flora and fauna by investigating the feasibility of periodic flood pulse events to maintain side channel and riparian habitat downstream of Peace Canyon (PCN) Dam. The PCR Flood Pulse Plan will include assessing characteristics of flushing flows and opportunistic testing of flood pulse flows; however, no planned spill release is proposed. The objective of the PCR Ramping Plan is to improve fisheries productivity downstream of the Peace Canyon Dam. The PCR Ramping Plan includes quantifying risk of fish stranding from flow ramping, exploring flow regime options, and assessing potential flow change programs.

## 1.2 Management Questions

The key management question(s) are:

- 1) What is the present distribution, including species composition and spatial area of riparian vegetation along the Peace River?
- 2) How has the spatial distribution and species composition of vegetation in the riparian zone along the Peace River changed over time?
- 3) What is the effect of a spill on spatial distribution and species composition of vegetation in the riparian zone along the Peace River?

The overall goal is to assess the vegetation community in the riparian zone with respect to changes that have taken place over time as a result of flooding due to a spill from the dam. This assessment will focus on composition and distribution of vegetation including flood-dependent species as well as the advancement/receding of vegetation in river bars and other areas.

## 1.3 Detailed Hypotheses about the Ecological Impacts

The primary hypotheses<sup>1</sup> to be tested are:

H<sub>1</sub>: There is a significant change in the spatial extent of the vegetated areas in the riparian zone of the Peace River following a spill event.

H<sub>2</sub>: There is a significant change in the plant composition of the vegetated areas in the riparian zone of the Peace River following a spill event.

H<sub>3</sub>: There is a significant change in the productivity of the vegetated areas in the riparian zone of the Peace River following a spill event.

Hypotheses will be tested based on the results of this monitoring program and the PCR Riparian Habitat Assessment. Vegetation mapping of the riparian zone of the Peace River should offer a sufficient level of refinement to detect and identify the spatial extent of areas that have experienced a change in composition and productivity. The ground-based surveys will confirm and quantify the extent and magnitude of change.

The study does not include any control sites (i.e., all locations along the river will be impacted by spill), so it will not be possible to directly relate any observed differences in the data to the impact of the spill event; however, it will be important to identify evidence that suggests impacts from a spill. The riparian vegetation is still undergoing significant adjustment to regulation and the 1996 spill; this ongoing transient change will confound results of this monitoring program to detect changes caused by a spill event (Michael Church, 1984 West Mall, Vancouver, BC, University of British Columbia, by pers. Comm.). Therefore, to assess the impact of a spill on the riparian vegetation, monitoring results will have to be contextualized within the historical framework of the trends in riparian condition along the river available through Dr. Michael Church's research (manuscripts currently in development).

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<sup>1</sup> For clarity, the hypotheses are stated as the alternate hypotheses. Analyses will test the null hypotheses of no effect or difference.

## 1.4 Key Water Use Decision Affected

Results of this study in combination with other monitoring programs within the Peace Spill Protocol and PCR Flood Pulse Plan will affect key water use decisions including the revision of future spill strategies, environmental audit procedures, and the necessity of flood pulse events. Ramping regimes may also be affected if this monitoring program, in combination with other studies, indicates that projects within the Peace River Ramping Plan did not improve fish productivity. These decisions have important implications for power generating and ecological values. Results of the monitoring could affect power generation as well as fish, wildlife, and vegetation downstream of the Peace Canyon Dam.

## 2.0 Monitoring Program Proposal

### 2.1 Objective and Scope

The objective of this study is to:

- 1) Determine species composition of vegetation in the riparian zone of the Peace River
- 2) Determine spatial distribution of vegetation in the riparian zone of the Peace River.
- 3) Assess changes over time in species and spatial composition in the riparian zone of the Peace River

The study area includes the riparian area of the Peace River from PCN Dam to the confluence of the Pine River. Vegetation maps for the study area will be developed and a riparian vegetation assessment will occur on the ground. Vegetation maps will be created for the riparian area between the Peace River at normal flows and the river channel elevation during a 120,000 cfs discharge event. Six sites, at a minimum, will undergo a detailed riparian vegetation assessment on the ground. The information will be used to assess trends in the community over time as well as response to changes in flow regimes.

This monitoring program will occur in Years 9 and 10 of the Peace River management plans; however, implementation of this program is conditional on the occurrence of a spill event during the 10-year study period. Total discharge ( $Q_{out}$ ) from the Peace Canyon facility during a spill must exceed 88,287 cfs (2500 cms) for two days or longer in order to proceed with this study.

### 2.2 Approach

Using the air photos taken as part of PCR Aerial Photos, vegetation inventory maps will be produced through riparian interpretation. Air photos will be interpreted in Year 10 and riparian assessment of study sites will occur in Years 9 and 10. An annual report will describe the methods, status of the study, and results-to-date. In the final year, the report will include a complete description of methodologies, results and statistical analyses used to assess changes in vegetation over time.

## **2.3 Methods**

### **2.3.1 Task 1: Project Coordination**

Project coordination will involve the general administrative and technical oversight of the implementation project. This task will include but not be limited to: 1) budget management, 2) study team management, 3) logistic coordination, 4) technical oversight of field and analysis components, and 5) facilitation of data transfer among other investigators associated with the Peace Spill Protocol, Peace River Flood Pulse Plan, and Peace River Ramping Plan.

Coordination will be particularly important between this monitoring program, the PCR Aerial Photos, and the PCR Riparian Habitat Assessment projects to ensure timely acquisition of all necessary data.

### **2.3.2 Task 2: Ground Sampling**

Riparian assessment of vegetation through ground surveys will occur in Years 9 and 10 of the management plan study period. The ground surveys will re-assess the same study sites surveyed as part of the PCR Riparian Habitat Assessment. The assessment will occur at a similar time of year and follow the same methodology as used in the PCR Riparian Habitat Assessment to facilitate statistically sound comparisons between the two projects. Standard procedures for vegetation inventory will be followed and are described in MacKenzie and Moran (2004) and RIC (2004). Standardized field forms will also be used (e.g., Meidinger 1998). The assessment will include site identification and description of site, soil and vegetation characteristics. Samples of unknown species will be collected for proper identification.

Survey sites will be marked and georeferenced. Permanent photo-monitoring points established as part of the PCR Riparian Assessment will be used to capture a photographic record of site-specific conditions. Accurate descriptions (including GPS positions) of sites and photo-monitoring points are essential to ensure that they can be identified and located again for future studies.

In the event that rare plants (e.g. federally or provincially listed species) are found during the ground sampling, this 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 and forwarded to the BCH Hydro Vegetation Specialist. These sites should also be explicitly identified to determine if spread of these species is occurring over time.

Additional sites will be ground-truthed to confirm air photo interpretation in other areas within the survey region.

### **2.3.3 Task 3: Photo Interpretation**

Using aerial photos taken in Year 10 of the management plan as part of the PCR Aerial Photos implementation project, the photo interpretation phase will involve estimating vegetation polygon characteristics from these photographs. Guidelines for photo interpretation are set out in RIC standards for VRI-Vegetation Resources Inventory ([RIC 2002](#)). Briefly, polygons will be delineated from the air photos for similar or "like" vegetated or non-vegetated land covers. Descriptive attributes relating to land and vegetative characteristics will then be assigned to polygons.

Quality assurance for photo interpretation will be conducted throughout the photo interpretation phase to ensure accuracy and consistency (RIC 2006). Quality assurance will be reviewed for polygon delineation as well as graphic and attribute data. As part of the quality assurance, a site visit will be made during the photo interpretation stage to ensure the accuracy of the interpretation.

#### **2.3.4 Task 4: Data Entry and Analysis**

All data will be entered into a Microsoft Access database. Air photo analysis will simply consist of polygon delineation of unique vegetation communities, which would include descriptive summaries regarding composition and spatial extent. Statistical analysis will follow that of a before-after study where results of this monitoring program will be compared to the data in the PCR Riparian Habitat Assessment to assess for changes in species richness, community structure, and spatial distribution over time. Potential linkages of the changes to the spill event should be explored which will include an examination of flow records and species composition/abundance. However, no control sites are part of the experimental design, so it will not be possible to directly relate any observed differences in the data to the impact of the spill event. To differentiate changes in riparian vegetation due to a spill from on-going transient changes due to regulation and the 1996 spill, monitoring results will have to be contextualized within the historical framework of the trends in riparian condition along the river (described by Dr. Michael Church's research, manuscripts currently in development).

#### **2.3.5 Task 5: Reporting**

Project reporting will consist of an annual data report and a single final report at the conclusion of the monitoring program. The data report will simply document the findings of the year and include a discussion of the results in context of the management questions.

A final report will be compiled following the conclusion of the monitoring program that collates all of the data and includes:

- a) an executive summary of the project;
- b) field methods, including maps that indicate sampling locations, and site photos;
- c) description of steps taken as part of quality assurance and sources of error;
- d) vegetation map of the study area;
- e) environmental data collected, presented in tabular and graphical form;
- f) description of statistical analyses and results;
- g) an assessment of the findings as they relate to the management question and objectives;
- h) any recommendations towards future monitoring (if any) needed

A report will be provided in hard-copy and as Microsoft Word and Adobe Acrobat (\*.pdf) format. The required maps and figures will be included as embedded objects in the report. All maps and figures will also be provided in their native format as separate files. Raw data will be submitted in a Microsoft Access database. All photos will be submitted electronically.

### **2.4 Interpretation of Monitoring Program Results**

This monitoring program will provide insight on the importance of spill/flood pulse events to maintain floodplain vegetation community and delay succession of the

community to a terrestrially-dominated (non-flood dependent species) species structure along the Peace River. The program may also discern the size of spill/flood pulse events required to control the encroachment of vegetation in side channels. Failure to link the spill to changes in the riparian habitat may be a result of the spill event being of inadequate spill discharge to impact vegetation, timing of the spill relative to the riparian assessment (i.e., too much or too little time has passed between spill and assessment), and/or potentially inadequate sample size.

## 2.5 Schedule

The implementation of the PCR Riparian Flooding monitoring program is conditional on a spill event occurring where total discharge ( $Q_{out}$ ) is greater than 88,287 cfs (2500 cms) for two days or longer. If the spill criterion is satisfied then, the post-spill site survey will take place in the summer (~June-August) of Years 9 and 10 and the development of vegetation maps in Year 10.

## 2.6 Budget

The estimated total cost for the project is \$195,060. Table 7-1 summarizes the budget estimated in 2007 dollars.

**Table 7-1 Estimated costs for the Peace River Riparian Flooding monitoring program.**

Sub-total		\$150,450
Inflation	2%	\$35,321
Contingency	5%	\$9,289
<b>Total</b>		<b>\$195,060</b>

## 2.7 References

MacKenzie, W.H. and J.R. Moran. 2004. Wetlands of British Columbia: a guide to identification. Research Branch, Ministry of Forests, Victoria, B.C. Land Management Handbook Number 52.

Meidinger, D.V. 1998. Field manual for describing ecosystems in the field. B.C. Min. Env. and B.C. Min. of For., Victoria, B.C. Land Management Handbook Number 25.

Robertson Environmental Services. 1996. Peace River Waterfowl Survey Winter 1996. Prepared for BC Hydro.

Resources Inventory Committee. 2002. Vegetation Resources Inventory Photo Interpretation Procedures. [http://ilmbwww.gov.bc.ca/risc/pubs/teveg/vri-photointerp2k2/photo\\_interp2k2.pdf](http://ilmbwww.gov.bc.ca/risc/pubs/teveg/vri-photointerp2k2/photo_interp2k2.pdf).

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Resources Inventory Committee. 2004. Vegetation Resources Inventory Ground Sampling Procedures. Version 4.5. [http://ilmbwww.gov.bc.ca/risc/pubs/teveg/vri\\_gs\\_2k4/vri\\_gs\\_2k4.pdf](http://ilmbwww.gov.bc.ca/risc/pubs/teveg/vri_gs_2k4/vri_gs_2k4.pdf)

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