

Peace Project Water Use Plan

Monitoring Program Terms of Reference

Peace Spill Protocol

- **GMSMON-9 Peace River Spill Hydrology**

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

Name of Monitoring Program	Order Clause Fulfilled	Submitted with this Package	Previously Submitted To CWR	Ordered Submission Date
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-9 Peace River Spill Hydrology

1.0 Introduction

This Terms of Reference describe a hydrology data collection project as part of a larger spill monitoring program within the Peace Spill Protocol. The Peace Spill Protocol is a significant program that was developed under the Peace Water Use Plan (Peace WUP) and endorsed by the Committee for the Peace Project Water Use Plan (WUP Committee). The Peace Water Use Plan water use planning process was initiated in February 2001 and completed in May 2003.

The Peace Spill Protocol is addressed by a separate schedule (D) in the Peace Order (Files No. 76975-35/Peace) issued by the Comptroller of Water Rights on August 9, 2007. These Terms of Reference are submitted in reference to the Schedule D of the Order, specifically:

3. The licensee shall submit, within six months of the date of this order, for approval by the comptroller, terms of reference for the following monitoring programmes to be implemented in the event of a spill:
 - e. spill hydrology and operating conditions prior to, during and after any of the following spill events:
 - i. spill discharge from W.A.C. Bennett Dam that exceeds a daily average of 205 cubic metres per second for at least two days; or
 - ii. spill discharge from the Peace Canyon facility that exceeds a daily average of 2000 cubic metres per second for at least two days or that exceeds a daily average of 500 cubic metres per second for at least seven days.

2.0 Description of Project

2.1 Location

The headwaters of the Peace, a tributary of the Mackenzie River, is located in north-eastern British Columbia (Figure 1). The Peace is formed by the confluence of the Finlay and Parsnip rivers flowing in opposite directions in the Rocky Mountain Trench. At the confluence the Peace flows east and is the only river to cut through the Rocky Mountains. Once out of the Peace Canyon the river maintains an easterly direction, crossing the B.C./Alberta border. The Peace drains into Great Slave Lake and joins the Mackenzie River before it enters the Arctic Ocean.

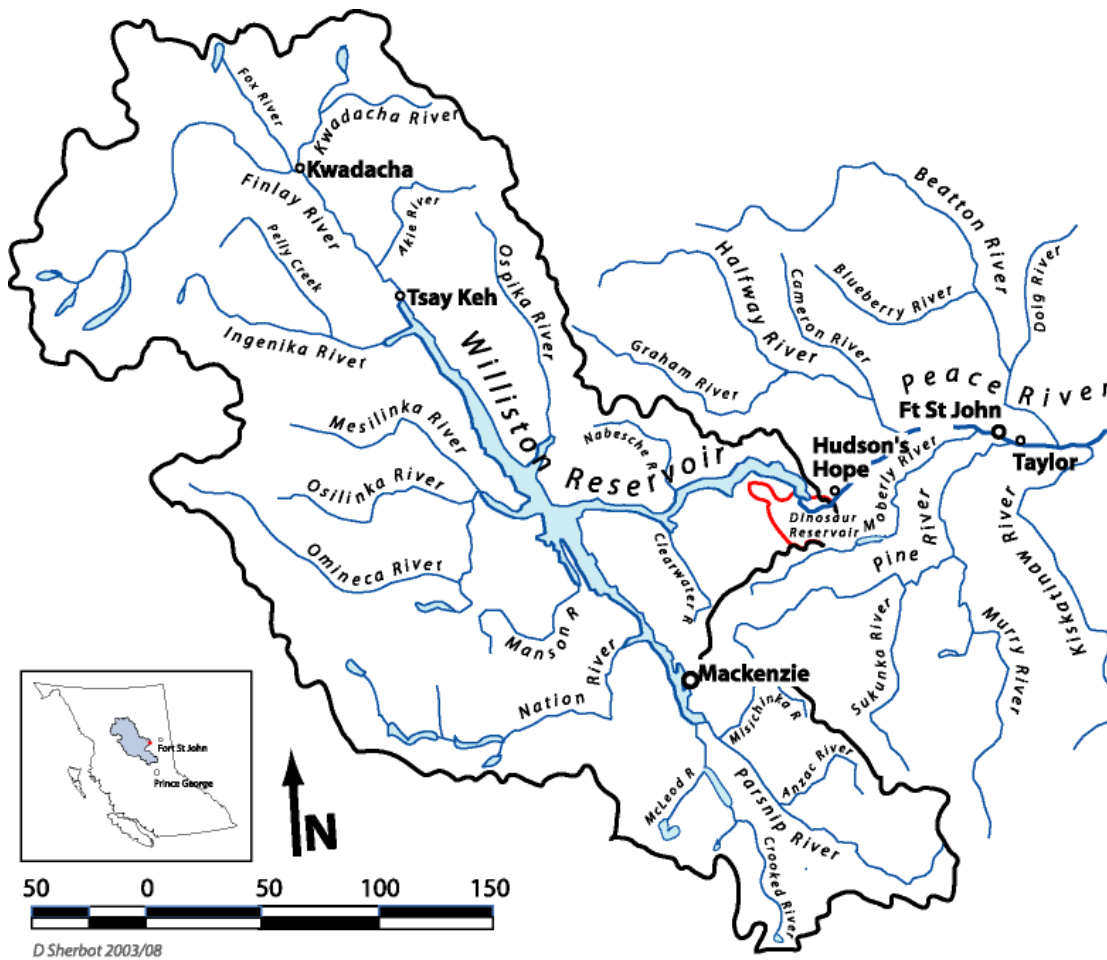


Figure 1: Place Names in Peace Water Use Plan

2.2 Existing Works

The existing works comprising the Peace project include:

W.A.C. Bennett Dam:

- This dam, commissioned in 1967, is located at head of the Peace Canyon forming Williston Reservoir. The earthfill dam is 2040 m (6692.8 ft.) in length at the crest and 183 m (600.4 ft.) high with a crest elevation of 679.7 m (2230.0 ft.) above sea level.
- Williston Reservoir covers approximately 1773 square kilometres (km²) (684.6 square miles (miles²)) at full pool and has an active storage of 393 Million cubic metres (Mm³) (32 Million acre feet (MAF)). The operating range of the reservoir for power generation is between 672.08 m (2205.0 ft.) and 642.00 m (2106.3 ft.).
- The spillway has three radial gates and nine sluice gates. The sill elevation for the radial gates is 653.53 m (2144.1 ft.) and the sluice gates 641.60 m (2105 ft.). The maximum discharge is 9200 m³/s (325,000 ft³/s) using the radial and sluice gates.

- Power Intakes: There is one power intake for each unit. They are located on the left side of the dam. Intakes are 3.96 x 5.94 m (13 x 19.5 ft.). The sill elevation for intakes 1 to 3 is 594.36 m (1950.0 ft.). The sill elevation of intakes 4 to 10 is 627.89 m (2060.0 ft.).

G.M. Shrum Generating Station:

- The underground G.M. Shrum Generating Station has 10 units with a total installed capacity of 2730 MW. Once through the turbines, the water is discharged through two manifolds, one for units G1 to G5 and one for G6 to G10, into the upper end of Dinosaur Reservoir.

Peace Canyon Dam:

- This dam is located at the foot of the Peace Canyon forming Dinosaur Reservoir. The Peace Canyon Dam consists of a concrete gravity dam and earthfill saddle dam on the right abutment. The main dam is 325 m (1066.3 ft.) long and 61 m (200.1 ft.) high with a crest elevation of 507.5 m (1665.0 ft.) above sea level. The saddle dam is 200 m (656.2 ft.) long and 20 m (65.6 ft.) high.
- Dinosaur Reservoir covers approximately 9 km² (3.5 miles²) at full pool. It has limited active storage. The shoreline length is 54.4 km (33.8 miles). The normal operating range is between 502.92 m (1650.0 ft.) and 500.00 m (1640.4 ft.).
- The spillway has six radial gates. The sill elevation for the radial gates is 491.3 m (1611.9 ft.). The maximum discharge is 10 280 m³/s (363,000 ft³/s).
- Power Intake: There is one power intake for each unit. The intakes are 6.7 x 12.4 m (22.0 x 40.7 ft.). The sill elevation is 426.3 m (1516.5 ft.).

Peace Canyon Generating Station:

- The Peace Canyon Generating Station has four units with a total installed capacity of 700 MW. The water is discharged into the Peace.

3.0 Background

There have been spills at WAC Bennett and Peace Canyon dams in eight years since the first project was completed in the early 1970s. Following the most recent spill, in 2002, discussions between BC Hydro and the Department of Fisheries and Oceans lead to the recommendation that a protocol be established for the Peace River projects. The protocol would address issues relating to the operational use of water and the environmental consequences (both positive and negative) of spill events.

Within the BC Hydro system there are two classes of spills; system spills and project spills. System spills are required when projected inflows exceed the capacity of the entire BCH system because the system may be operating at reduce capacity due to maintenance or demand. Spill is necessary but the spill can be transferred between projects and almost always targets the project where the cost of the spill, in economic, environmental and infrastructure terms, is minimized. Project spills, on the other hand, are project specific and cannot be transferred. They arise when inflows to the project exceed the ability of the project to store and/or discharge the inflow through normal operations. Project spills may also arise in order to test spillway infrastructures. Some projects within the system spill on an annual basis due largely

to an inability to store large inflows. Williston Reservoir has a very large storage capacity and as a result it reduces the likelihood of project spills on the Peace system. However, when spills are required the impact can be significant.

During the Water Use Planning process, there was insufficient time and data to properly scope and investigate the influence of spill events on the environment of the Peace River. The alternative, recommended by the WUP Committee, was a plan to manage and monitor spill events at PCN and GMS to develop the information necessary to develop more refined operational procedures for spilling.

The Peace Spill Protocol will address the following impact hypotheses:

- **Spill releases at GMS cause acute fisheries mortality from entrainment and may contribute TGP impacts downstream of GMS and PCN.**
- Spill down-ramping may strand fish in areas above 70,000 cfs between PCN and the Pine River.
- Spill up-ramping may isolate wildlife on river bars and islands above 70,000 cfs between PCN and the Pine River.
- The seasonal timing of spill events eliminates edge habitat for birds and mammals above 70,000 cfs between PCN and the Pine River.
- *Significant spills scour the river bed and improve mainstem and side channel fishery habitat between PCN and the Pine River.*
- *Significant spills inundate riparian areas and maintain floodplain vegetation between PCN and the Pine River.*

In support of this protocol and the impact hypotheses that it hopes to address, this Spill Hydrology Project will insure that the appropriate hydrology data is being collected and analyzed.

4.0 Benefits Monitoring Spill Hydrology

The objective of this monitoring project is to compile and analyze the hydrology data that will be useful for investigating the effects of spill events on the aquatic systems downstream of GMS and PCN. Without a proper understanding of the hydrology of the spill in the context of pre-spill hydrology conditions and post-spill hydrology conditions, it will be difficult to understand the responses observed in the aquatic ecosystem during and after the spill.

5.0 Design and Deliverables

- A database for each spill event including pre-spill and post-spill data for both GMS and PCN.
- A detailed report on the hydrology of each spill event with a focus on presenting the data in formats relevant to other spill protocol monitoring projects.

6.0 Work Plan

Environmental effects of spills are a generally function of the magnitude and duration of the spill, maximum discharge into the river and the rate of change of the total discharge, tributary flow into the river, and the seasonal timing of the spill event. Spill monitoring programs within the Peace Spill Protocol may require some or all of these

data but vary in the degree of data resolution that is required to evaluate impacts of the spill event. A proper understanding of the data requirements of the various programs will be necessary in order to develop a widely useful spill hydrology program and deliver a spill event analysis with which other programs can work. Communication and coordination with other monitoring programs in the Peace Spill Protocol will be important.

Much of the hydrology data that would be useful to analyze a spill event is already collected by BC Hydro and Water Survey Canada. At a minimum this data includes: Williston Reservoir volume and water level; GMS spill flow, turbine discharges and tributary flows and change in flow over time; PCN spill flows, turbine discharges and tributary flows and change in flow over time; and Peace River data. Consideration should be given to the frequency with which this data is collected. Additional gauging may be necessary on some tributaries to increase data resolution or make the data more accessible. As well, other projects within the Peace WUP, such as the Mainstem Stage Discharge project or the Peace River Hydraulic Model may provide important spill hydrology data (cross sections, water level gauges).

The first stage in the Spill Hydrology project, then, will be assessing the kinds of data that are being collected and the additional data requirements. If a gap exists between needs and availability an assessment will have to be made on whether or not there is value in closing that gap. Based on this assessment the second stage may be to augment existing data with additional gauging or updating the existing gauges. A data collection framework should be constructed to show the kinds of data to be collected, how the data will be reported, and the end use of that data. This framework would essentially be an outline of the report analyzing the spill event. Developing this report framework ahead of time can reduce the time, post spill, for the report to be produced and thus improve its utility to other spill monitoring programs.

Clearly, all data collection protocols and gauges need to be in place prior to the start of any spill event. The entire cycle of the spill event (pre-spill, spill, and post-spill) has to be captured for analysis to be complete. The spill event will be analyzed and report once the spill event has past and all the data has been collected. The analysis should include a review of the data and a discussion of the relevance of data or additional data needs such that the next spill event can be refined.

7.0 Cost Objectives

The WUP Committee proposed a budget of \$50,000 for the Spill Hydrology Project. This budget includes assessment of data collection requirements, development of the framework and the analysis of the spill event. If additional data collection platforms are deemed to be necessary in order to improve the coverage of a spill event, additional funds would be required to purchase and install the instrumentation.