Walter Hardman Project Water Use Plan

Revised for Acceptance by the Comptroller of Water Rights

21 March 2006

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BC hydro **Generation** **21 March 2006**

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Operations Manager

Preface

The water use planning process for BC Hydro's Walter Hardman facility was initiated in September 2003 and concluded in May 2004.

The operating conditions proposed in this Water Use Plan reflect the consensus recommendations of the Walter Hardman Water Use Plan Consultative Committee.

BC Hydro thanks all those who participated in the process that led to the production of this Water Use Plan. The proposed conditions for the operation of BC Hydro's facilities will not come into effect until implemented under the *Water Act.*

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1.0 INTRODUCTION

The operating conditions proposed in this Water Use Plan reflect the recommendations of the Walter Hardman Water Use Plan Consultative Committee. The basis for the proposed terms and conditions to be authorized under the *Water Act* for the beneficial use of water at the Walter Hardman hydroelectric project are set out in this document. Future reference to the Walter Hardman Project includes the following: the diversion dam, the diversion pond, the diversion channel, Walter Hardman Dam and Walter Hardman headpond, headpond control structures, the generating station and tailrace.

The proposed conditions will result in changes to current operations, which are expected to benefit fish in Cranberry Creek below the diversion dam.

A monitoring program is also proposed in order to study key uncertainties to enable improved operating decisions in the future. Refer to the *Walter Hardman Water Use Plan: Consultative Committee Report* dated May 2004 for details on the consultative process, interests, objectives, performance measures, key trade-offs, values associated with operating alternatives, expected benefits and the proposed monitoring program. A review period of six years has also been specified for this Water Use Plan.

2.0 DESCRIPTION OF WORKS

2.1 Location

The Walter Hardman hydroelectric project is located within the Columbia-Shuswap Regional District on Cranberry Creek approximately 25 kilometres (km) south of Revelstoke, B.C. The facilities that comprise the project are easily accessible via Highway 23 South. The location and general layout of the project is illustrated in Figure 2-1.

2.2 Existing Works

The Walter Hardman Project was built by the City of Revelstoke in 1961 and purchased by BC Hydro in 1972. Historically, the flows in Cranberry Creek above the diversion dam were regulated by Coursier Dam which stored water in Coursier Lake Reservoir during high inflow periods and released water during lower inflow periods. In October 2003, Coursier Dam was decommissioned for dam safety reasons thereby returning inflows to natural, non-regulated flow patterns.

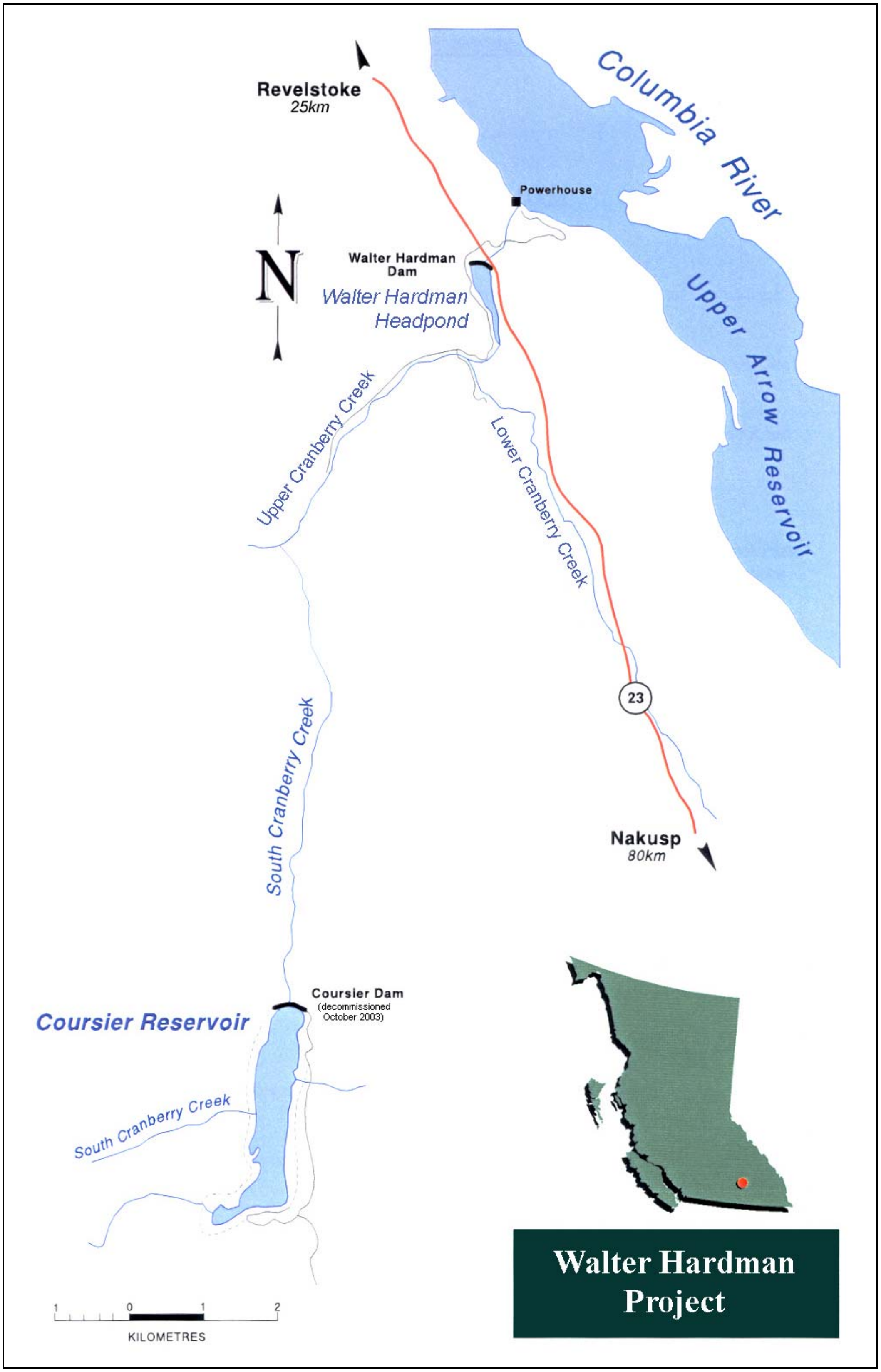

Figure 2-1: Map of Walter Hardman Project

This map appears on page 2-2 of the Consultative Committee Report.

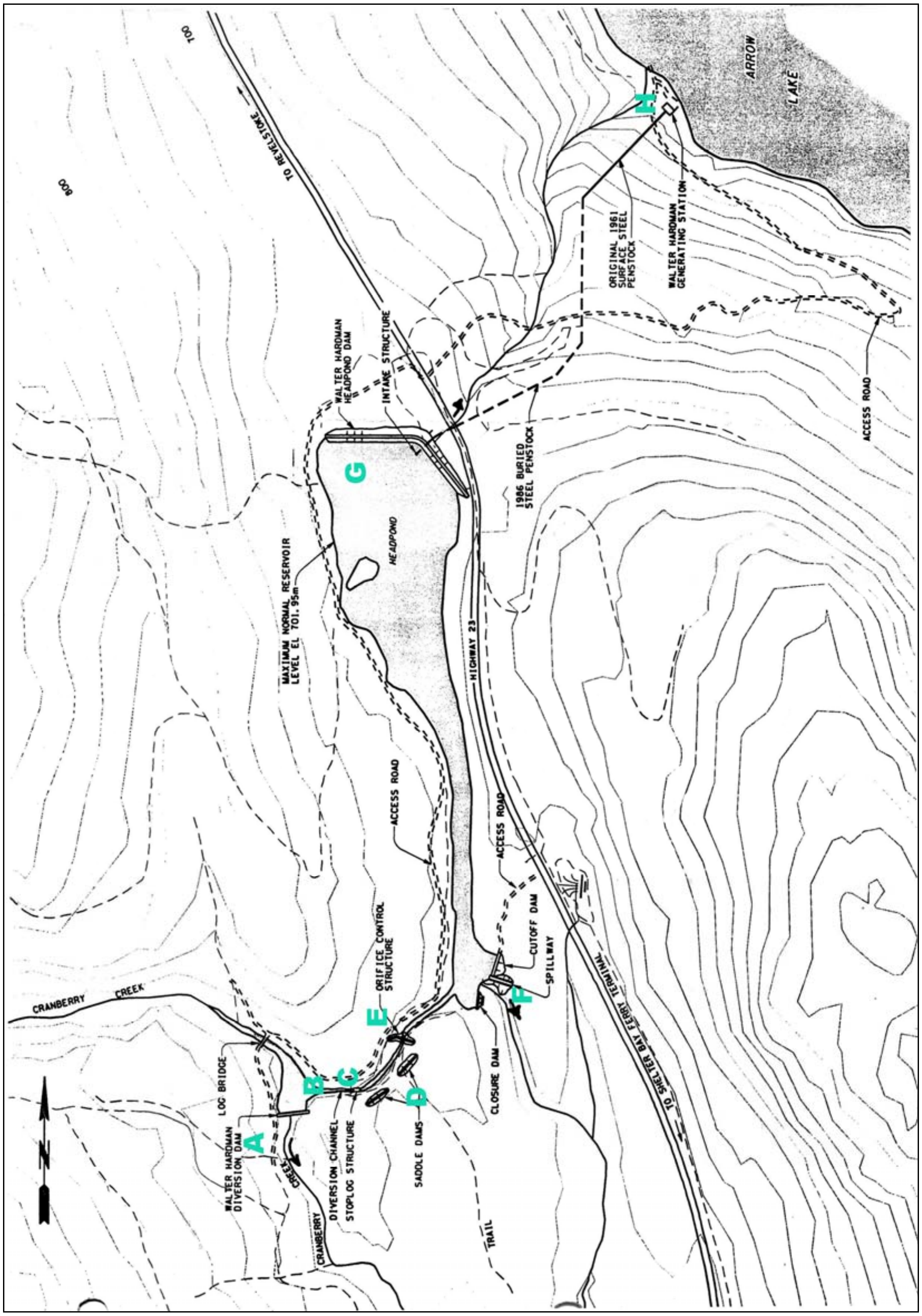

Figure 2-2: Site Plan of Walter Hardman Project

The Walter Hardman Project now consists of the following works outlined below and illustrated in Figure 2-2:

- **Diversion Dam (A):** This concrete dam is 60 metres (m) long, 1.75 m high and has a crest elevation of El. 711.75 m. This dam diverts water from Cranberry Creek into the diversion channel. Under normal operating conditions, flow control structures in the diversion channel limit the maximum diversion to 4.3 m^3/s at El. 701.95. Flows in excess of that spill over the diversion dam and continue along Cranberry Creek. The diversion dam impounds a small pond (~5000 m^2) and has no significant storage.

- **Diversion Channel (B to E):** This excavated, unlined channel is 450 m long with a bottom width that varies between 3.0 and 3.7 m. It is designed to facilitate the transfer of water from the diversion dam to the headpond. During flood conditions the channel has a maximum capacity of 10.5 m^3/s.

- **Stoplog Structure (C):** This concrete structure contains stoplog slots under a timber hoist house. It is located in a 3.05 m wide section of the diversion channel, and because of spillway use restrictions is normally operated as a flow control weir to roughly limit the maximum flow of water to the headpond to 4.3 m^3/s. The stoplog structure can also be used to cut off or reduce the volume of flow diverted to the headpond when required (for example, during maintenance).

- **Upstream and Downstream Saddle Dams in Diversion Channel (D):** These two earthfill dams are made of sand and gravel, and are 73 m and 52 m in length respectively. Both have a crest elevation of El. 713.2 m. They are used for flood relief during extreme inflow events such as the Probable Maximum Flood (PMF). The dams are designed to overtop and fail during extreme inflow events such that all flood inflows are discharged along Cranberry Creek rather than affecting the headpond facilities downstream.

- **Orifice Control Structure in Diversion Channel (E):** This concrete free-overflow spill structure is 0.7 m high, and is located in a section of the diversion channel where the width of the waterway is 2.92 m. The crest elevation is El. 710.37 m and the elevation of the top of the structure is El. 713.54 m. The orifice control structure restricts flow into the headpond to a maximum of 10.5 m^3/s regardless of whether the stoplogs are installed in the upstream control structure or not. It is designed so that during extreme inflow events such as the Probable Maximum Flood (PMF), the structure will back water up the diversion channel, flooding the area near the saddle dams, and causing their failure.

- **Closure and Cut-off Dams:** The closure dam is constructed of glacial till. It runs 25 m in length and has a crest elevation of El. 704.1 m. It was originally installed to mitigate against a low point in the headpond, which in turn, prevents water from escaping down Cranberry Creek. Its primary function is to maintain headpond elevation. The cut-off dam was constructed with a mixture of glacial till, sand, gravel and rock. It is 60 m long and has a crest elevation of El. 704.1 m. Like the closure dam, the cut-off dam is also designed to maintain headpond elevation. Together they are used to maintain headpond elevation forming abutments for the spillway structure.

- **Spillway (F):** This concrete structure is designed as an uncontrolled freecrest spillway. It has a crest elevation of El. 701.95 m and can accommodate up to 11 m^3/s of flow. Its function is to protect the headpond dam from overtopping during flood inflows (crest elevation of El. 704.15 m). The use of this spillway is avoided under normal operations since spill flows pass through a highly erodible area approximately one km downstream of the spillway, resulting in deposits of fine materials in downstream fish habitat.

- **Walter Hardman Headpond (G):** The normal operating level of the headpond ranges from a minimum elevation of El. 698.0 m to a maximum of El. 701.95 m. At the maximum normal level: the area of the headpond is 15.8 hectares (ha); the total storage is 700 000 cubic metres (m^3); and the live storage is 459,350 m^3. A headpond elevation controller targets a constant level in the headpond, and either ramps up or ramps down generation as needed to maintain the targeted level.

- **Walter Hardman Dam (G):** This earthfill dam was constructed with glacial till, sand, gravel and rock. It is 381 m long and its crest elevation is El. 704.1 m. Its function is to maintain storage elevation of the Walter Hardman headpond.

- **Power Intake:** There are two steel water conduits (1.07 m in diameter) running through the base of the dam, spanning the 50 m from the power intake to the penstock valve house. There is a butterfly penstock inlet valve (1.07 m in diameter) used as a protection and isolation device in the penstock valve house. The other conduit leads to the dispersion valve described below.

- **Penstock:** A single steel penstock delivers the water to the powerhouse. The penstock splits into two sections (each 0.711 m in diameter) each leading to a generating turbine in the generating station.

- **Dispersion Valve and Discharge (Drawdown) Culvert:** The dispersion valve (in combination with the culverts it discharges into) provides an alternative means of drawing down or emptying the headpond, in the event that the penstock cannot be used. The dispersion valve is fitted with a discharge regulator at the outfall of the headpond and is manually operated. When it is operational, it throws water in the form of droplets to dissipate the energy in the water and prevent damage to the drainage area. The maximum discharge capacity of the valve is 5 m^3/s, but for flood and safety reasons, the discharge must not exceed the capacity of the three downstream culverts located: a) under Highway 23, b) under the Walter Hardman Dam access road, and c) beside the Walter Hardman Dam Generating Station.

- **Walter Hardman Generating Station (H):** The Walter Hardman Generating Station contains two Turgo single-jet impulse turbines, each capable of 4.5 megawatts (MW) of output. The combined maximum output of the two units is limited to 8 MW (instead of the potential 9 MW) by the 4.3 m^3/s capacity of the penstock. The water leaving the generating turbines discharges into Upper Arrow

Lakes Reservoir. The generating station (powerhouse) was designed to withstand the worst flood expected over a 200-year period (i.e., the 1:200 year Inflow Design Flood).

3.0 HYDROLOGY OF THE CRANBERRY CREEK BASIN

The Cranberry Creek Basin is 145 square kilometres (km^2), of which 100 km^2 lies upstream of the diversion dam. Coursier Lake is fed by South Cranberry Creek, which originates in an ice field 6 km west of the lake, and by Westside Creek, which originates 4 km to the west of Coursier Lake. Coursier Lake drains at its northern tip into the continuation of South Cranberry Creek.

South Cranberry Creek flows in a north-south direction and joins Upper Cranberry Creek approximately 7 km downstream of Coursier Lake. Upper Cranberry Creek originates on the east slope of the Monashee Mountains in an alpine area dominated by ice fields and year round snow pack. From the confluence of South Cranberry Creek and Upper Cranberry Creek the main stem flows approximately 17 km to its mouth on the Upper Arrow Lakes Reservoir.

3.1 Seasonal Flow Patterns

The seasonal flow pattern in Cranberry Creek is typical of the mountain streams in the area. A single-snowmelt peak dominates flow each spring. Secondary rainfall-generated peaks are common throughout the summer and into the fall. Winter is generally the low flow period as most of the precipitation in the upper basin falls as snow.

The former Coursier Lake Reservoir provided partial regulation of inflows to the Walter Hardman hydroelectric facilities, slightly reducing spring and summer flows, and increasing fall and winter flows. However, with the decommissioning of Coursier Dam in October 2003, flows have returned to natural, non-regulated flow patterns. Coursier Lake provides a small amount of natural storage, with higher elevations between April and August as a result of local run-off.

Flow measurements in Cranberry Creek are available from Water Survey of Canada gauge WSC 08NE123, in operation from 1980 to 1986, located just above the diversion dam. Within the six year period of estimated record (flows were estimated because recorded flows were influenced by Coursier Dam regulation), the peak daily inflow above the diversion dam was 48 m^3/s, associated with a July 1983 storm event. On average, the annual peak daily inflow was approximately 21–24 m^3/s, typically occurring between late May or to mid June during freshet. Winter low flows appear to vary between approximately 0.5–2.0 m^3/s, however this portion of the estimated record would be the most sensitive to errors of approximation associated with the simplifying assumptions used to estimate the record.

4.0 OPERATING CONDITIONS FOR FACILITY

4.1 Role of Facility in BC Hydro's System

The Walter Hardman Project is part of BC Hydro's integrated generation system which is described in *Making the Connection* published by BC Hydro in April 2000.

The Walter Hardman Project generates on average a total of approximately 37 GWh of power on an annual basis. The output from the facility can supply the equivalent of approximately 3700 homes.

4.2 Water Use at Walter Hardman Facilities

The Walter Hardman Project is a run-of-river facility with nominal storage capabilities in the headpond downstream of the control structures and the diversion dam. All available water within the physical limitations of the facility are diverted for the purpose of power generation. Water in excess of the diversion capacity is spilled over the diversion dam. Energy production at the generating station varies throughout the year as a function of river flows.

During non-freshet periods, the level of the headpond is kept relatively constant with the use of a headpond controller and most of the inflow is diverted to the generating station. The headpond is held lower than its design capability for power production to minimize risk of spill into the spillway channel, except under extreme hydrological conditions. The Walter Hardman headpond may be drawn down as required for spillway and dam safety inspections. The maximum diversion through the powerhouse for power generation is 4.33 m^3/s.

4.3 Emergencies and Dam Safety

Emergencies and dam safety requirements shall take precedence over the constraints outlined in this Water Use Plan. Emergencies include actual and potential loss of power to customers. Dam safety requirements for operations are outlined in the *Walter Hardman Dam: Operation, Maintenance and Surveillance Manual for Dam Safety (OMS WHN)* issued by BC Hydro's Director of Dam Safety.

4.4 Conditions for the Operation of Works for Diversion and Storage of Water

The conditions outlined in this section are proposed for the operations of the Walter Hardman Project. It is recognized that BC Hydro may not be able to operate within these constraints during abnormal hydrological events.

4.4.1 Diversion Dam and Cranberry Creek Mainstem

BC Hydro will release a minimum flow of 0.1 m^3/s from the diversion dam headpond to Cranberry Creek. If inflow is less than 0.1 m^3/s, all the available natural inflow will be released. In order to provide this flow, a new release facility will be required.

4.4.2 Walter Hardman Headpond

BC Hydro's Water Licences permit storage in the Walter Hardman headpond within the following elevation ranges:

- Minimum elevation of El. 698.0 m
- Maximum elevation of El. 701.95 m

Within that range, BC Hydro will target the following headpond elevations during the stated time periods:

- El. 700.3 m (15 March to 15 November)
- El. 701.0 m (16 November to 14 March)

Target elevations reflect the setting of the headpond controller, which will adjust generation according to headpond elevation changes (inflow changes). Actual transition between target elevations will be completed within two weeks of the cited change over dates. When inflows are less than 0.25 m^3/s the headpond controller allows the headpond to draft in order to keep the generating unit running at its minimum setting. Under the extreme case, the headpond may draft from El. 701.0–698.0 m over a period of approximately 14 to 18 days.

4.4.3 Walter Hardman Spillway Protocol

BC Hydro will continue to operate in a manner that minimizes the risk of spill from the Walter Hardman headpond by limiting inflows to the headpond using upstream facilities, operating the headpond to a target level lower than full pool, and by making adjustments to the headpond control structures as required. The headpond alarm will be set at El. 701.5 m, at which time crews will be dispatched to adjust the headpond control structures.

4.4.4 Walter Hardman Fish Stranding Protocol

There are five fish stranding risks associated with the Walter Hardman facilities:

1. **Minimum flow over the diversion dam to Cranberry Creek going to zero:** With the provision of a minimum flow, stranding in the mainstem downstream of the diversion dam will be the result of natural inflow variation and is acceptable.

2. **Walter Hardman headpond spillway risk and spillway entrainment:** In the case of a spill event over the free spill weir at the Walter Hardman headpond, BC Hydro will stop the spill at the earliest moment, and will implement fish salvage as practicable below the spillway structure. Local provincial and federal fisheries agencies will be notified.

The proposed headpond elevation target between 16 November and 14 March (El. 701 m) is not expected to increase the risk of spillway entrainment because sudden flash inflow events are unlikely to occur during this winter period.

3. **Walter Hardman headpond drawdown:** The effects of headpond drawdown will be studied as part of the monitoring program proposed as part of the Water Use Plan. Fish salvage is not required during headpond drawdown.

4. **Dewatering of the diversion channel between the diversion dam and the Walter Hardman headpond:** Dewatering of the diversion channel could occur as a result of low inflows or maintenance activity. No salvage action is needed for low inflow events, but fish salvage will be done when the canal is dewatered for maintenance.

5. **Dewatering of the diversion dam pond:** Dewatering of the diversion dam pond area could occur as a result of low inflows or maintenance activity (i.e., gravel excavation). No action is needed for low inflows, but salvage will be done if the pond is dewatered for maintenance.

4.4.5 Walter Hardman Gravel Recruitment

BC Hydro will continue the annual placement of gravel into Cranberry Creek from the diversion dam pond area according to best management practices recommended by the federal and provincial regulatory agencies and specific regulations set by the Province.

The total volume of material placed downstream of the diversion dam should not exceed 5000 cubic metres annually.

4.4.6 Walter Hardman Generating Station

There are no specific constraints related to the generation of power at the Walter Hardman Generating Station. Power production will be adjusted as required to meet other operating constraints defined in this Water Use Plan.

5.0 PROGRAMS FOR ADDITIONAL INFORMATION

The operating recommendations of the Consultative Committee are contingent on the implementation of a monitoring program. Upon direction from the Comptroller of Water Rights, BC Hydro will undertake a monitoring program that will:

- Assess expected outcomes of the operational changes being recommended.
- Provide improved information for future operating decisions.

The main elements of the monitoring program are described below. Estimated annual costs for these studies and associated tasks are summarized in the *Walter Hardman Water Use Plan: Consultative Committee Report.*

a) **Kokanee Spawning and Incubation, Lower Cranberry Creek:** There is uncertainty regarding the effect of minimum flow releases on spawning and incubation habitat for kokanee. This monitoring study is habitat-based rather than population based, and will assess changes in habitat resulting from the provision of a minimum flow. Information will be collected over a one year period.

b) **Rainbow Rearing Habitat and Over-wintering:** There is uncertainty regarding the habitat benefits associated with minimum flow releases and the quantity and quality of rearing habitat for rainbow trout. This proposed monitoring study will measure habitat quantity and quality at transects in the middle section of Lower Cranberry Creek.

c) **Walter Hardman Headpond Drawdown Impacts (Fish):** There is uncertainty regarding headpond drawdown and its impacts on fish. Specifically, there is concern about physical stranding and dissolved oxygen concentrations, which may be affected by drawdown. The proposed monitoring study will observe and measure these habitat characteristics in Walter Hardman headpond. The data will be collected within a single year of study. It will be necessary to wait for a year of low inflow during the fall and winter so that extreme conditions can be observed.

d) **Temperature Effects:** There is uncertainty around the effects of the minimum flow and its impacts on water temperature. There are concerns that the warm water temperatures during the summer may exceed critical levels for rainbow trout in the upper and middle sections of Lower Cranberry Creek; and that cool water temperatures during the fall and winter in the lower section of Lower Cranberry Creek may affect the rate of kokanee egg incubation. This proposed monitoring study will measure temperature in Lower Cranberry Creek. It will involve compiling a database of water temperature over the five years of study and analyzing data concurrent with the results of Studies 1 (kokanee incubation) and 2 (rainbow rearing) in year five.

e) **Rainbow Trout Inventory:** There is an information data gap regarding the presence and abundance of rainbow trout in Cranberry Creek. This proposed monitoring study will monitor rainbow trout abundance in the middle section of Lower Cranberry Creek and will provide baseline information against which future monitoring studies can measure a response. This is not a study of population effects – changes in abundance detected during this study cannot be inferred as resulting from flow changes.

f) **Kokanee Tailrace Habitat:** There is an information data gap regarding releases from the Walter Hardman powerhouse and its effects on fish habitat in the tailrace channel (in Upper Arrow Lakes Reservoir). There is an interest in determining how kokanee, which use an isolated back channel that is influenced by outflow from Walter Hardman powerhouse, may be affected in the fall by changes in flow releases from the powerhouse. This proposed monitoring study will identify the use of the tailrace and back channel by kokanee and show whether kokanee are attracted to powerhouse outflows.

6.0 IMPLEMENTATION OF RECOMMENDATIONS

The proposed conditions and monitoring program in this Water Use Plan will be implemented after BC Hydro receives direction from the Comptroller of Water Rights.

7.0 EXPECTED WATER MANAGEMENT IMPLICATIONS

Implications for the provincial interests considered during the preparation of this Water Use Plan are expected outcomes based on the best available information. After BC Hydro has been directed to implement the operational changes, BC Hydro will be responsible for meeting the operational parameters but not for achieving the expected outcomes.

7.1 Other Licensed Uses of Water

Apart from BC Hydro, there is one other licence holder on Cranberry Creek. The proposed conditions are not expected to affect current licence holders.

7.2 Riparian Rights

The proposed conditions are not expected to impact riparian rights associated with the headpond or along the river below the facility.

7.3 Fisheries

The proposed conditions are expected to benefit fish in Cranberry Creek below the diversion dam.

7.4 Wildlife Habitat

The proposed conditions are not expected to significantly affect wildlife habitat or cause an impact on species at risk.

7.5 Flood Control

There are no facilities in Cranberry Creek for flood control.

7.6 Recreation

The proposed conditions are not expected to affect recreational activities on Cranberry Creek. Recreational activities on the headpond, as well as near the control structures and associated facilities will continue to be discouraged for safety reasons. There are no formal agreements, restrictions or obligations for recreational purposes associated with the operation of the Walter Hardman Project.

7.7 Water Quality

The proposed conditions are expected to reduce siltation of Lower Cranberry Creek.

7.8 Industrial Use of Water

There are no formal agreements, restrictions or obligations for residential, commercial and industrial purposes associated with the operation of the Walter Hardman Project. There are no industrial uses of water in the Walter Hardman system that are affected by the recommended changes in operations.

7.9 First Nations Considerations

The Walter Hardman Project is in the asserted traditional use area of the Okanagan Nation Alliance (ONA) and the Shuswap Nation Tribal Council (SNTC). The traditional territory claimed by the Ktunaxa Kinbasket Tribal Council (KKTC) is just east of the facility. The proposed conditions are expected to benefit fish and wildlife in the Walter Hardman headpond and Cranberry Creek downstream from the diversions dam.

7.10 Archaeological Considerations

The proposed conditions are not expected to affect archaeological sites or traditional use of the area. No archaeological sites were identified.

7.11 Power Generation

The proposed conditions in the Water Use Plan (minimum flow release to Cranberry Creek and Walter Hardman headpond elevation targets) are expected to decrease power generation associated with the Water Hardman power development.

8.0 RECORDS AND REPORTS

8.1 Compliance Reporting

BC Hydro will submit data as required by the Comptroller of Water Rights to demonstrate compliance with the conditions conveyed in the Water Licence. The submission will include data for:

- Minimum flow releases from new infrastructure into Cranberry Creek below the diversion dam,
- Headpond elevations, and
- Spill events from the headpond.

8.2 Non-compliance Reporting

Non-compliance with any operation ordered by the Comptroller of Water Rights will be reported to the Comptroller in a timely manner.

8.3 Monitoring Program Reporting

Reporting procedures will be determined as part of the terms of reference for each study or undertaking.

9.0 PLAN REVIEW

A review of this Water Use Plan is recommended within six years of its implementation. A review may be triggered earlier if significant new risks or opportunities are identified.

10.0 NOTIFICATION PROCEDURES

Notification procedures for floods and other emergency events are outlined in the *Walter Hardman Dam Emergency Planning Guide* and the *Power Supply Emergency Plan Columbia Generation (PSEP).* Both these documents are filed with the Office of the Comptroller of Water Rights.