BC hydro

# Coquitlam – Buntzen Project Water Use Plan

## ASSESSMENT OF PINK SALMON PASSAGE IN LOWER COQUITLAM RIVER

**Implementation Year 3**

**Reference: COQMON #4**

**Study Period: August 2011-November 2011**

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**November 2011**

# ASSESSMENT OF PINK SALMON PASSAGE IN LOWER COQUITLAM RIVER

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## EXECUTIVE SUMMARY

The objectives of this study is to firstly conduct an assessment of adult Pink Salmon (*Oncorhynchus gorbuscha*) passage in the lower Coquitlam River by identifying index sites that may have the potential to restrict Pink Salmon migration during summer low flows. A secondary objective is to determine at what flows each barrier is eliminated or reduced. In 2011 it is the third study year of a five year assessment, which started in 2007 and will end in 2015, and is conducted in odd years only to coincide with migrating Pink Salmon. This study represents a component of the monitoring program BC Hydro has undertaken as partial fulfillment of its commitments made during the Coquitlam-Buntzen Water Use Plan (WUP) process. A fisheries technical document was reviewed by the WUP Consultative Committee that indicated main stem passage was restricted at flows below 2.8cms (Jarvis 2001). The 2007 assessment identified seven index sites that had the potential of restricting passage at low stream flows. Since the initial survey in 2007 no other areas have been identified to have possible passage issues. The treatment 2 flow regime from the newly installed Coquitlam Dam gate identified as low level outlet 3 (LLO3) provided a consistent stream flow from August 25th to September 25th, averaging a minimum daily discharge of 3.5cms during the study period (WSC, Port Coquitlam). Due to significant precipitation of 85.6mm over a three day period from September 24 to 26th and unanticipated high lake levels, the discharge was maximized from the LLO3 in conjunction with the spill from the sluice gates, providing increased stream flows from September 26th to October 5th (Figure 3) averaging a minimum daily flow of 41.7cms (Dunkley 2011) (WSC, Port Coquitlam). Observations from BC Hydro adult enumeration crew indicated that significant numbers of Pink Salmon were observed upstream of all index sites after the ramp down on October 5th. During the monitoring period the lowest stream flow occurred on September 3rd and was recorded at 2.62cms of which no Pink Salmon were observed to be impeded or restricted at any of the index monitoring sites as indicated by fish distribution numbers enumerated in the upper reaches Coquitlam mainstem (WSC, Port Coquitlam). During the lowest discharge rate a total of 68 Pink Salmon were observed throughout all reaches and of those, 42 were observed upstream of index site 3b, indicating that flow and depth was adequate for migration as 62% of the population were observed in the upper sections of the river. Precipitation induced flow events (114mm) occurred during late September (21st, 24th to 26th), and in combination with the increase in discharge flow from the dam, migration had peaked on October 17th with 3,700 Pink Salmon observed in the upper reaches (Macnair 2011). Overall, during the lowest daily minimum discharge of 2.62cms the average flow, water depth and velocity were adequate for

passage at all index sites during the monitoring period. Observations indicate the treatment 2 flow regime, with consistent discharge flows, improved the ease of passage at all the index sites. The higher base flows during the summer season increased the availability of spawning habitat and the ability for early returning Pink Salmon to migrate without difficulty, which resulted in better physical condition to hold and spawn successfully. Initial observations indicate that the treatment 2 flow regime has provided greater accessibility to off channel habitat as 43% of the returning Pink Salmon population were enumerated utilizing off channel habitat, which is the highest proportion of off channel use since monitoring began in 2003 (Macnair 2011).

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# 1.0 INTRODUCTION

This 2011 study represents the third assessment year of the a five year monitoring study, commencing in 2007 and ending in 2015, of Pink Salmon migration in the lower Coquitlam River.

## 1.1 Background

A report prepared by Jarvis (2001) provided historical evidence that main stem salmon spawning migration had been restricted in the Coquitlam River during summer low flows when discharges were less than 100cfs (2.8cms). In 2003, 2005 and 2007 Pink Salmon returns were primarily observed in late September to early October although it has been documented that Pink Salmon runs in the Fraser River can access tributaries as early as August (Macnair 2003). With the increased Pink Salmon escapements in recent years, there is potential access issues for migrating adults in late summer during low flows. Based on recommendation from the Coquitlam/Buntzen Water Use Plan (WUP) Consultative Committee and the approved WUP monitoring program, the purpose of this report is to monitor the migration of returning Coquitlam River adult Pink Salmon to determine if there are any flow related migration barriers and at what flows can they be mitigated. With the issue of the revised Coquitlam/Buntzen Water Licence in 2005 the monitoring and assessment study of Pink Salmon migration is to continue in odd year spawning cycles commencing in 2007 and extending through the end of the WUP review in 2015. As a component of the WUP monitoring program the initial 2007 assessment was conducted to monitor Pink Salmon passage and determine if there are flow related migration barriers, either partial or complete, in the lower Coquitlam River during the treatment 1 flow regime, that completed in the fall of 2008 which had been releasing between 0.8-1.4cms since 1999. This flow regime continued until the completion of the Coquitlam Dam seismic upgrade in January 2008 when BC Hydro's transition to the adjusted treatment 2 flow regime of between 1.1-2.7cms commenced on September 15, 2008 (Table 1).

The following table provides details on the annual discharge flows from the Coquitlam Dam as anticipated by BC Hydro.

**Table 1 -** Annual schedule for release amounts from Coquitlam Dam, note: August and September current and targeted discharge amounts (BC Hydro, 2003).

| Coquitlam Dam Release Schedule (CMS) | | | | |
|---|---|---|---|---|
| Date | Treatment 1 Current Minimum | Treatment 2 (CMS) Target | Treatment 2 (CMS) Minimum | Species Driver and Priority for Coquitlam River releases |
| 1-Jan | 1.0 | 5.9 | 3.6 | Chinook Spawning |
| 15-Jan | 1.0 | 2.9 | 2.9 | Chinook Spawning |
| Feb | 1.0 | 2.9 | 1.8 | Chinook Spawning |
| Mar | 0.8 | 4.3 | 1.1 | Steelhead Spawning |
| Apr | 0.8 | 3.5 | 1.1 | Steelhead Spawning |
| May | 1.1 | 2.9 | 1.1 | Steelhead Spawning |
| June | 1.4 | 1.1 | 1.1 | Steelhead Parr |
| July | 1.4 | 1.2 | 1.1 | Steelhead Parr |
| Aug | 1.1 | 2.7 | 1.1 | Steelhead Parr |
| Sept | 0.8 | 2.2 | 1.1 | Steelhead Parr |
| Oct | 0.8 | 6.1 | 3.6 | Chinook Spawning |
| Nov | 1.1 | 4.0 | 1.5 | Chinook Spawning |
| Dec | 1.1 | 5.0 | 2.5 | Chinook Spawning |

## 1.2 Objectives

The assessment will be conducted from late August to no later than October 1st each Pink Salmon migration year (odd year) starting in September 2007 and extended though to 2015.

The two primary objectives of this monitoring study is to:

1) Monitor the migration of early returning Pink Salmon in odd years (2007-2015) to determine if there are any flow related migration barriers in the lower Coquitlam River mainstem corridor**.**
2) To determine at what flows each barrier is eliminated or reduced.

In order to answer the primary objectives above there are two alternative hypotheses that are tested:

1) Early run Pink Salmon migration is not restricted during low inflows to the lower Coquitlam River.
2) Changes in flow do not influence the efficacy of Pink Salmon migration.

## 2.0 STUDY AREA

The study area on the Coquitlam River is 12.9km in length and consists of seven potential passage index sites beginning upstream of the Pitt River Road Bridge and extending upstream to the Coquitlam Dam (Figures 1 & 2). Adult Pink Salmon are typically main stem spawners and generally made use of spawning areas in the upper reaches of the Coquitlam River, but it has also been reported that on average 36% of returning Pink Salmon access off channel habitat since monitoring began in 2003 (Decker 2009). This study primarily consists of main stem passage therefore tributaries or off channel habitat monitoring is not included which may limit the results of this report. The following seven index sites are identified as:

Index Site 1 - (49'15.830 N -122'47.075 W) located off McAllister Ave and Maple Street in Port Coquitlam.

Index Site 2a - (49' 16.276 N – 122' 47.075 W**)** located at the foot of Prairie Avenue east and Shaughnessy Sreet in Port Coquitlam.

Index Site 2b -(49' 16.585 N – 122 46.620 W) extends upstream 30m and downstream 55m of Patricia Street pedestrian bridge in Port Coquitlam.

Index Site 2c - **(**49' 19.621 N – 122' 46.346 W) located 85m downstream of Galette Park access and Pipeline Road, Coquitlam.

Index Site 3a - (49' 19.632 N – 122' 46.344 W) located at Upper Coquitlam River Park, 120m upstream of the diving board hole pool.

Index Site 3b - (49' 20 .251 N – 122' 46.263 W) located 60m upstream of the Al Grist Memorial Hatchery at Metro Vancouver watershed boundary.

Index Site 4 - (49' 21. 041 N – 122' 46.452 W) located at the Coquitlam main stem and Swoboda channel confluence, access south of Grant's Tomb pond.

The following watershed information further describes the Coquitlam River basin below the Dam:

- Watershed code: 100-024500-00000-00000-000
- Geo-data BC Trim Map reference: 092G037, 092G027, 092G026
- Watershed size : 237 $km^2$
- River length from mouth to Coquitlam dam: 17 km
- Study area: 12.9 km
- Coquitlam River mean annual discharge: 4.6cms (McPhee 2003)
- Major Tributaries: Or Creek MAD=2.9cms, Scott/Hoy Creek MAD=1.0cm (McPhee 2003)

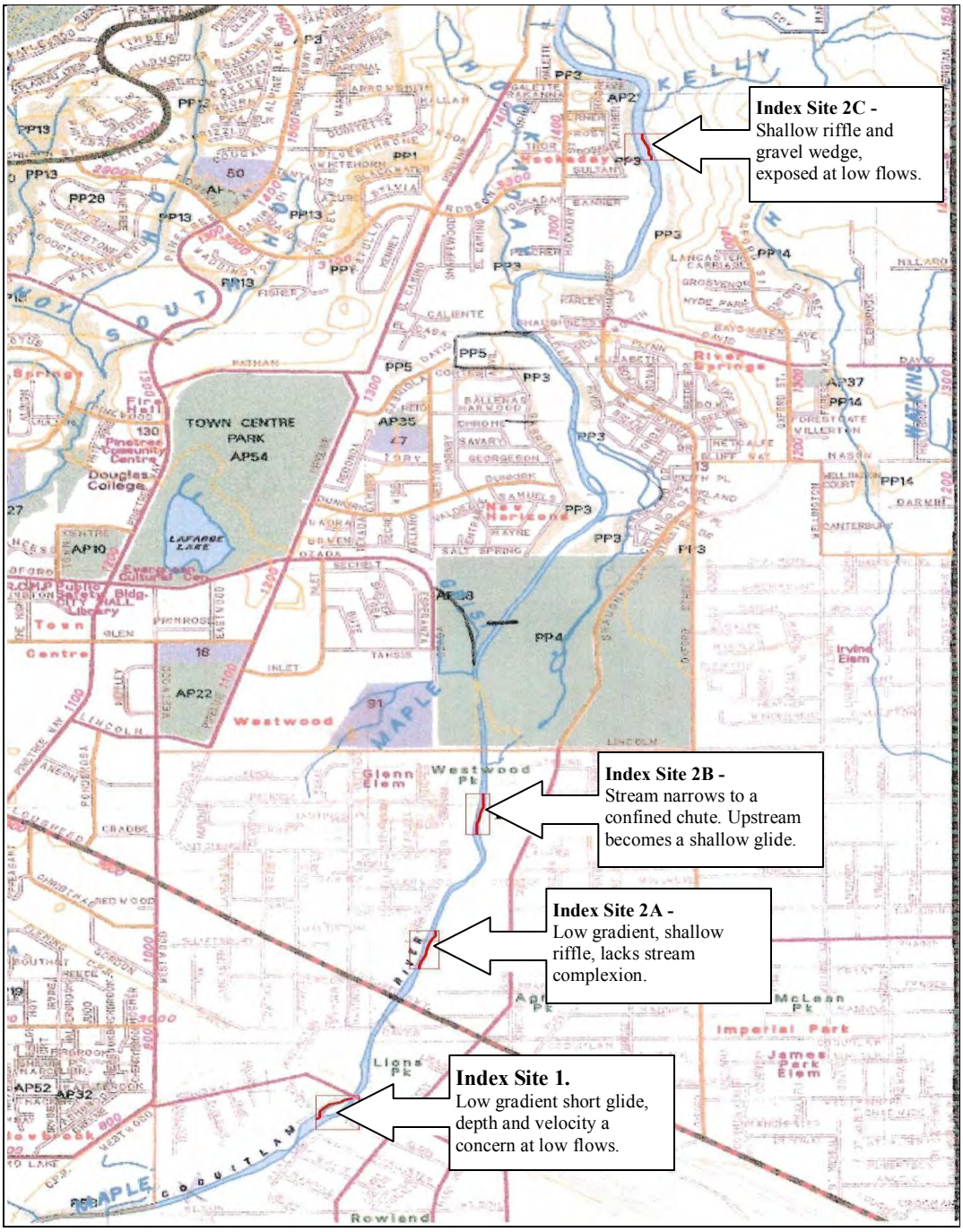



**Figure 1** – Passage index site locations 1, 2A, 2B and 2C located in the lower portion of the Coquitlam River.

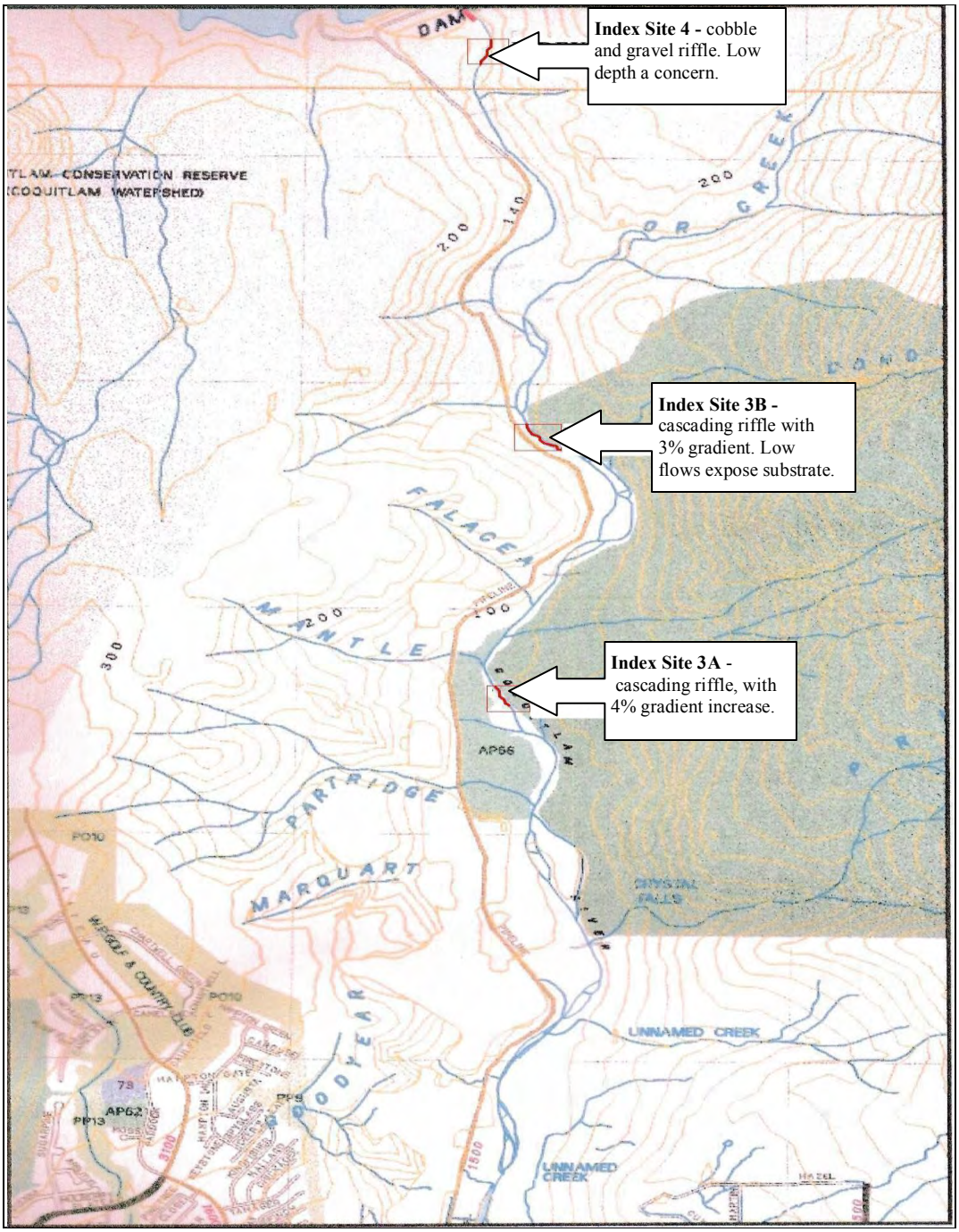



**Figure 2** –Passage index site locations 3A, 3B and 4 located in the upper portion of the Coquitlam River.

# 3.0 METHODS

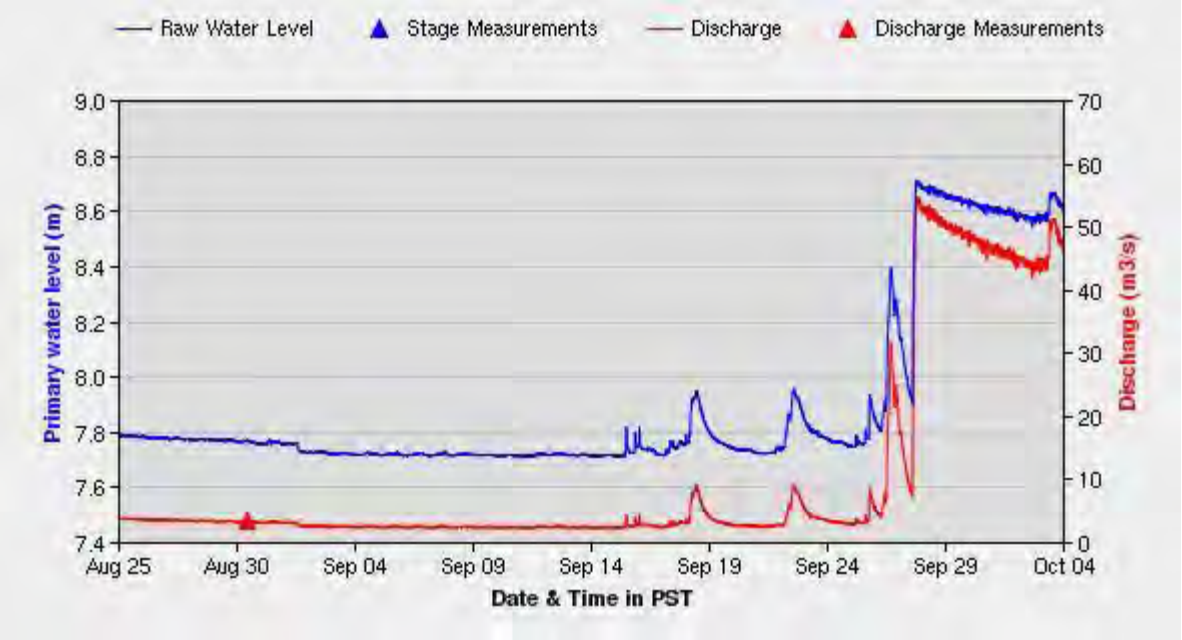
The objective undertaken for the 2011 assessment was to monitor previously identified index sites that had the potential to constrict salmon passage in the mainstem Coquitlam River and to identify any new index sites that could potentially be a barrier to migrating Pink Salmon. In 2007 seven sites were identified and GPS located as monitoring sites as indicated in the study area section of this report. For any new sites the entire river was surveyed at summer low flows, prior to the arrival of the first observed migrating Pink Salmon, and added to the index site list according to the physical parameters suggesting passage could be an issue. The 2011 preliminary assessment did not identify any new sites of concern and after communicating with the BC Hydro adult enumeration program crew it was decided to continue with the seven previously indentified index sites from the 2007 and 2009 assessments. The sites were monitored from August 25th to September 25th, 2011 with a maximum of five surveys conducted to determine if low flows impeded or restricted Pink Salmon passage. For safety reasons site surveys were performed during daylight hours only and observations were considered sufficient from the stream bank . A variety of techniques have been used to assess adult stream passage usually at critical stream reaches such as shallow riffles and low depth glides (Bjornn and Reiser 1991). A site assessment card which provides an overview of each index site on observation days is filled out and kept on record, a blank assessment card can be reviewed in appendix 2. Field assessment data primarily focused on thalweg water depth which is collected with a metric fibreglass folding ruler from and at up to six intervals perpendicular to the width of the channel and is represented as an average wetted stream depth. Stream velocities were collected at each index site using a floating ball, timed over a measured length at intervals dictated by the channel width. A minimum of three data points were collected representing the average velocity of the index site. Temperature data was collected once per index site at a mid depth water level in the center of the channel using a handheld thermometer. Additional data parameters such as wetted width of the stream channel which is the measured distance across the flow bank to bank. Gradient data was collected using a Suunto clinometer and represented as a percent value. Substrate composition and weather conditions as well as photo documentation was also collected. Other physical conditions monitored at the index sites included barrier type, length, width, plunge pool depth and jump height. Observations of holding (sedentary) and or migrating (active) Pink spawners were enumerated below and

upstream of the index site locations and their overall physical condition and health was documented. Visual monitoring of migration attempts were conducted by two trained technicians from the stream bank for a maximum of 30 minute observation period when fish were present.

Daily minimum, mean and maximum discharge data information was provided from Water Survey Canada, site *08MH002* hydrometric data station located at Kingsway Road bridge in Port Coquitlam and operated by Environment Canada. Precipitation data was provided by two sources; 1) Douglas College weather station located at the David Lam Campus Coquitlam and 2) Metro Vancouver weather station located at the base of Coquitlam Dam. Communication and data exchange with other BC Hydro monitoring crews conducting adult salmon assessments of the Coquitlam River were ongoing to determine Pink Salmon numbers, locations and other potential monitoring sites that may restrict or impede passage.

# 4.0 RESULTS

The treatment 2 flow regime from the newly installed Coquitlam Dam gate identified as low level outlet 3 (LLO3) provided a consistent contribution to stream flow of 2.3cms from August 25th to September 25th with a average minimum discharge of 3.5cms recorded at the WSC monitoring site. The lowest discharge recorded occurred on September 3rd at 2.62cms and was early into the migration time span (WSC, Port Coquitlam). Five survey days were conducted as high flows prevented access to the index sites during the last week of September. Due to higher than anticipated lake levels the discharge was maximized from the LLO3, in conjunction with a release from the dam sluice gates, providing high stream flows averaging a minimum daily rate of 41.7cms from September 26th to October 5th (WSC, Port Coquitlam) (Figure 3). During the monitoring period the lowest stream flow recorded was on September 3rd at 2.62cms (Figure 3) in which 44 Pink Salmon were observed and of those numbers 31 were enumerated in reach 4 or upstream of index site 4 (WSC, Port Coquitlam) (Macnair 2011). Passage was not impeded or restricted at any of the index monitoring sites during the lowest stream flow as indicated by fish distribution numbers in the upper reaches (upstream of index 4) of the river. Observations from the BC Hydro adult enumeration crew indicated that the higher flows coincided with a precipitation induced flow event that instigated migration. As a result, significant numbers (1790) of Pink Salmon were observed upstream of index site 3a after the ramp down beginning October 5th (Table 2). During the early migration period the treatment 2 flow regime provided adequate passage flows when migration is most critical due to the lack of precipitation and low summer flows that have the potential to impact early returning Pink Salmon. The following figure (Figure 3) is based on the Water Survey Canada (WSC) hydrometric station 08MH002 data operated by Environment Canada and illustrates the discharge and raw water level at Port Coquitlam station during the pink migration monitoring period.




Unapproved data - subject to revision — **WSC - 08Mh 002 Port Coquitlam, BC**

| Date | Daily Mean flowrate (CMS) | | | | | | |
|---|---|---|---|---|---|---|---|
| 25-Aug-11 | 3.57 | 4-Sep-11 | 2.77 | 14-Sep-11 | 3.40 | 24-Sep-11 | 5.70 |
| 26-Aug-11 | 3.44 | 5-Sep-11 | 2.82 | 15-Sep-11 | 3.86 | 25-Sep-11 | 7.02 |
| 27-Aug-11 | 3.32 | 6-Sep-11 | 2.86 | 16-Sep-11 | 4.05 | 26-Sep-11 | 19.35 |
| 28-Aug-09 | 3.27 | 7-Sep-11 | 2.92 | 17-Sep-11 | 4.41 | 27-Sep-11 | 33.58 |
| 29-Aug-11 | 3.19 | 8-Sep-11 | 2.98 | 18-Sep-11 | 8.30 | 28-Sep-11 | 62.12 |
| 30-Aug-11 | 3.15 | 9-Sep-11 | 3.04 | 19-Sep-11 | 5.13 | 29-Sep-11 | 59.58 |
| 31-Aug-11 | 3.22 | 10-Sep-11 | 3.07 | 20-Sep-11 | 4.42 | 30-Sep-11 | 57.49 |
| 1-Sep-11 | 3.01 | 11-Sep-11 | 3.17 | 21-Sep-11 | 4.35 | 1-Oct-11 | 55.83 |
| 2-Sep-11 | 2.73 | 12-Sep-11 | 3.35 | 22-Sep-11 | 8.88 | 2-Oct-11 | 54.10 |
| 3-Sep-11 | 2.72 | 13-Sep-11 | 3.36 | 23-Sep-11 | 6.85 | 3-Oct-11 | 58.77 |

**Figure 3** – WSC Port Coquitlam gage and tabular data, August 25th - October 3rd (source: Environment Canada 2011).

Six days of precipitation were recorded during the monitoring period for a total of 78.6mm recorded at the Douglas College weather station adjacent to the mid river (Index site 2b) area and during the same period186mm recorded at the Coquitlam Dam weather station located at the base of the dam (Figure 4). The peak of the Pink Salmon migration was observed to occur after the ramp down from spill activities ending on October 5th. It is probable that the majority

of Pink Salmon entering the system migrated during the ramp down of flows starting October 5th and did not spend a significant amount of time staging in the mainstem (Macnair 2011). The estimated daily flow contribution from Coquitlam watershed tributary's into Coquitlam main stem during the monitoring period from August 25th to September 30, 2011 averaged 1.76cms (Table 2). The following graph (Figure 4) illustrates the average daily discharge contribution from the Coquitlam dam, its tributaries and precipitation amounts.

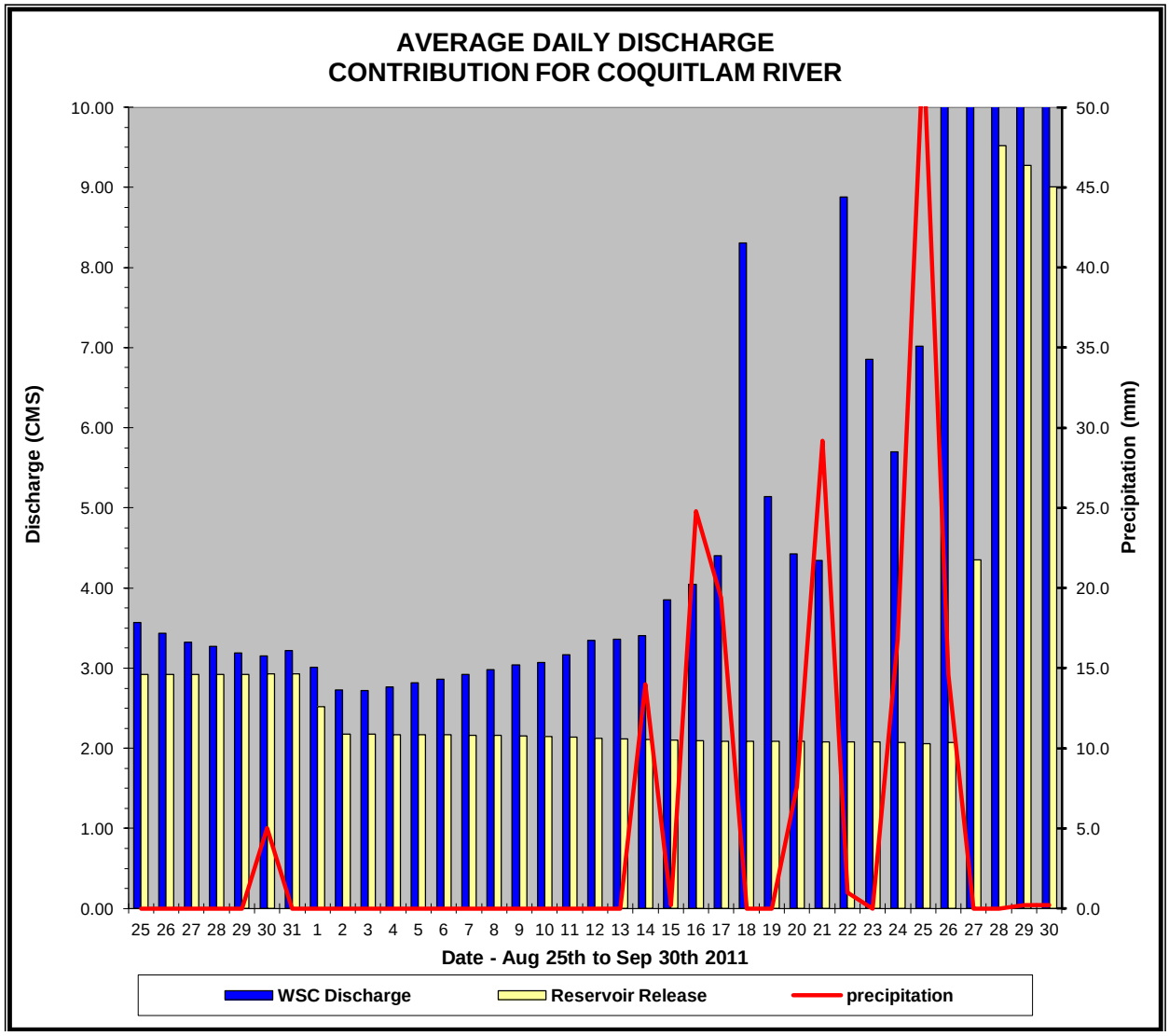



**Figure 4** – Coquitlam Dam valve release, precipitation and average daily river discharge, Aug 25 to Sept 30, (source: WSC Port Coquitlam, Dunkley 2011, Henwood 2011)

The following table provides a summary of field observations at the seven index sites during the assessment period.

**Table 2** – Summary of field monitoring observations at the seven index sites during the August 29th to October 1st 2011 assessment period

| Survey Date | Index Site | WSC Reading Mean(cms) | Coq Dam LLO#3 (cms) | Tributary Contibution (cms) | Days since last RIFE* | Mean Depth (cm) | Mean Velocity (m/s) | COQ.R. Temp (C) | # Pink Holding | # Pink Migrating | # Pink upstream of Site |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29-Aug | 1 | 3.19 | 2.92 | 0.27 | 8 | 17.3 | 0.72 | 14.5 | 0 | 0 | 0 |
| 29-Aug | 2a | 3.19 | 2.92 | 0.27 | 8 | 23.3 | 0.59 | 14.5 | 0 | 0 | 0 |
| 29-Aug | 2b | 3.19 | 2.92 | 0.27 | 8 | 31.7 | 0.53 | 15 | 0 | 0 | 0 |
| 29-Aug | 2c | 3.19 | 2.92 | 0.27 | 8 | 21.5 | 0.73 | 15 | 0 | 0 | 0 |
| 29-Aug | 3a | 3.19 | 2.92 | 0.27 | 8 | 30.7 | n/a | 14.5 | 0 | 0 | 0 |
| 29-Aug | 3b | 3.19 | 2.92 | 0.27 | 8 | 42 | n/a | 14.5 | 0 | 0 | 0 |
| 29-Aug | 4 | 3.19 | 2.92 | 0.27 | 8 | 24.6 | n/a | 13.5 | 0 | 0 | 8 |
| 05-Sep | 1 | 2.82 | 2.16 | 0.66 | 5 | 14.5 | n/a | 14.5 | 0 | 0 | 6* |
| 05-Sep | 2a | 2.82 | 2.16 | 0.66 | 5 | 22.6 | 0.52 | 14.5 | 0 | 0 | 6* |
| 05-Sep | 2b | 2.82 | 2.16 | 0.66 | 5 | 27.6 | 1.19 | 15 | 0 | 0 | 0 |
| 05-Sep | 2c | 2.82 | 2.16 | 0.66 | 5 | 20 | 1.18 | 15 | 7 | 0 | 0 |
| 05-Sep | 3a | 2.82 | 2.16 | 0.66 | 5 | 25.3 | 1.03 | 15 | 0 | 0 | 7 |
| 05-Sep | 3b | 2.82 | 2.16 | 0.66 | 5 | 39 | 1.44 | 15 | 0 | 0 | 32 |
| 05-Sep | 4 | 2.82 | 2.16 | 0.66 | 5 | 23 | n/a | 14.5 | 0 | 0 | 12 |
| 13-Sep | 1 | 3.36 | 2.11 | 1.25 | 13 | 22.1 | n/a | 16 | 0 | 0 | 4* |
| 13-Sep | 2a | 3.36 | 2.11 | 1.25 | 13 | 19.5 | n/a | 15.5 | 0 | 0 | 0 |
| 13-Sep | 2b | 3.36 | 2.11 | 1.25 | 13 | 30.4 | n/a | 16 | 0 | 0 | 4* |
| 13-Sep | 2c | 3.36 | 2.11 | 1.25 | 13 | 21.7 | n/a | 16 | 0 | 1 | 15 |
| 13-Sep | 3a | 3.36 | 2.11 | 1.25 | 13 | 25 | n/a | 16 | 11 | 1 | 12* |
| 13-Sep | 3b | 3.36 | 2.11 | 1.25 | 13 | 40.2 | n/a | 15.5 | 15 | 10 | 43* |
| 13-Sep | 4 | 3.36 | 2.11 | 1.25 | 13 | 31 | n/a | 15 | 0 | 0 | 21 |
| 19-Sep | 1 | 5.14 | 2.09 | 3.05 | 1 | 32.5 | 0.70 | 13 | 0 | 0 | 0 |
| 19-Sep | 2a | 5.14 | 2.09 | 3.05 | 1 | 30 | 0.46 | 13 | 0 | 0 | 0 |
| 19-Sep | 2b | 5.14 | 2.09 | 3.05 | 1 | 31 | 0.61 | 13 | 0 | 0 | 27* |
| 19-Sep | 2c | 5.14 | 2.09 | 3.05 | 1 | 22 | 0.49 | 15 | 5 | 0 | 0 |
| 19-Sep | 3a | 5.14 | 2.09 | 3.05 | 1 | 28.3 | 1.46 | 15 | 12* | 0 | 0 |
| 19-Sep | 3b | 5.14 | 2.09 | 3.05 | 1 | 42.7 | 1.06 | 15 | 0 | 0 | 43* |
| 19-Sep | 4 | 5.14 | 2.09 | 3.05 | 1 | 28.2 | 0.55 | 15 | 0 | 0 | 15 |
| 24-Sep | 1 | 5.70 | 2.07 | 3.63 | 2 | 30.6 | 0.69 | 14 | 0 | 0 | 0 |
| 24-Sep | 2a | 5.70 | 2.07 | 3.63 | 2 | 30 | 0.46 | 14 | 0 | 0 | 42* |
| 24-Sep | 2b | 5.70 | 2.07 | 3.63 | 2 | 35.2 | 0.72 | 15 | 0 | 0 | 22* |
| 24-Sep | 2c | 5.70 | 2.07 | 3.63 | 2 | 33 | 0.60 | 15 | 92* | 0 | 92* |
| 24-Sep | 3a | 5.70 | 2.07 | 3.63 | 2 | 29.8 | n/a | 15 | 141* | 4 | 101* |
| 24-Sep | 3b | 5.70 | 2.07 | 3.63 | 2 | 43.3 | 1.86 | 15 | 0 | 0 | 101* |
| 24-Sep | 4 | 5.70 | 2.07 | 3.63 | 2 | 31.5 | 0.57 | 15 | 0 | 0 | 26 |
| 01-Oct | 1 | 55.83 | 8.72 | 20.28 | 5 | n/a | n/a | n/a | 0 | 0 | 150* |
| 01-Oct | 2a | 55.83 | 8.72 | 20.28 | 5 | n/a | n/a | n/a | 0 | 0 | 120* |
| 01-Oct | 2b | 55.83 | 8.72 | 20.28 | 5 | n/a | n/a | n/a | 0 | 0 | 455* |
| 01-Oct | 2c | 55.83 | 8.72 | 20.28 | 5 | n/a | n/a | n/a | 89* | 0 | 505* |
| 01-Oct | 3a | 55.83 | 8.72 | 20.28 | 5 | n/a | n/a | n/a | 0 | 0 | 1743* |
| 01-Oct | 3b | 55.83 | 8.72 | 20.28 | 5 | n/a | n/a | n/a | 0 | 0 | 47 |
| 01-Oct | 4 | 55.83 | 8.72 | 20.28 | 5 | n/a | n/a | n/a | 0 | 0 | 0 |

***RIFE ~ rain induced flow event.**

*** indicates enumeration data from BC Hydro adult enumeration program**

**Note: Oct 1, unable to survey index sites due to high flow event.**

## 4.1 REACH 1 ~ INDEX SITE 1

Access to index site 1 **(49'15.830 N -122'47.075 W)** is at the east end of McAllister Avenue on Maple Street located downstream of the Lions Park pedestrian bridge in Port Coquitlam. The monitoring area of index site 1, looking downstream is the right channel on the right bank side of the island (Figure 5). The area is characterized as a glide with low depth, low velocity and zero gradient that lacks in any stream complexity. The substrate is a mix of gravel and small to medium size cobble. This site has the potential to restrict salmon passage at low flows due to a right bank side channel that is shallow with a low gradient (Figure 6 & 7). Access to this side channel is through a confined chute (Figure 5). Low stream flows may have the potential to constrict access for early returning Pink Salmon due to shallow water depth. Although passage access is likely on the left side island channel as this area would have sufficient flow and depth (>10m) for Pink Salmon passage in the Coquitlam River mainstem. The assessment identified an average wetted width of 19.4m and the thalweg depth of the channel at 0.14m during the lowest monitored discharge of 2.82cms (WSC, Port Coquitlam). This area was observed not to be a migration barrier in the current year since discharge flows were at 2.62cms or above (WSC, Port Coquitlam). The following table summarizes observations for the monitoring period:

**Table 3** – Index site 1 data summary

| Monitoring Date | WSC Mean daily Discharge (cms) | Wetted Width (m) | Avg. Wetted Depth (cm) | Velocity (m/sec) | Stream temp (C) |
|---|---|---|---|---|---|
| 29-Aug-11 | 3.19 | 19.4 | 17.3 | 0.72 | 14.5 |
| 5-Sep-11 | 2.82 | 19.4 | 14.5 | n/a | 14.5 |
| 13-Sep-11 | 3.36 | 19.4 | 22.1 | n/a | 16 |
| 19-Sep-11 | 5.14 | 19.5 | 30.6 | 0.7 | 13 |
| 24-Sep-11 | 5.7 | 19.5 | 32.5 | 0.69 | 14 |

Pink Salmon were not observed migrating or holding at index site 1 during the 2011 monitoring period (Table 2) however, the BC Hydro adult enumeration monitoring crew observed migrating Pink Salmon during the study period above this index site in which the main stem flows were at or greater than 2.62cms (Table 2) (WSC, Port Coquitlam).

**Figure 5** – Index site 1- upstream view, Aug.29.11
Discharge rate = 3.19cms (WSC Port Coquitlam)
The arrow indicates access point

**Figure 6** – Index site 1 – upstream view of shallow depth, Sept.5.11
Discharge rate = 2.82cms (WSC Port Coquitlam)

**Figure 7** – Index site 1 – downstream view, Sept.13.11
Discharge = 3.36cms (WSC Port Coquitlam)
The arrow identifies the channel access and gravel bar

## 4.2 REACH 2 ~ INDEX SITE 2A,

Access to index site 2 is from Prairie Avenue east of Shaughnessy Street in Port Coquitlam (**49' 16.276 N – 122' 47.075 W)**. This index site was chosen for monitoring due to its low gradient (0.5%) and shallow depth riffle characteristics that have the potential to impact migration at low flows and secondly human interference with the construction of a weir across the mainstem has the potential to block passage. (Figure 10).The substrate is a mix of small to medium size cobble that is compacted and lacking habitat complexity throughout this site (Figure 8 & 9). The assessment of Index site 2 identified an overall average wetted width of 29m and a thalweg depth of 0.19m. This area was observed not to be a migration barrier in the current year when stream flows were recorded at a low of 2.62cms (WSC, Port Coquitlam). The following table summarizes observations for the monitoring period:

**Table 4** – Index site 2a data summary

| Monitoring Date | WSC Mean daily Discharge (cms) | Wetted Width (m) | Avg. Wetted Depth (cm) | Velocity (m/sec) | Stream temp (C) |
|---|---|---|---|---|---|
| 29-Aug-11 | 3.19 | 28.8 | 23.3 | 0.59 | 14.5 |
| 5-Sep-11 | 2.82 | 29 | 22.6 | 0.52 | 14.5 |
| 13-Sep-11 | 3.36 | n/a | 19.5 | n/a | 15.5 |
| 19-Sep-11 | 5.14 | 29 | 30 | 0.74 | 13 |
| 24-Sep-11 | 5.7 | 29 | 30 | n/a | 14 |

Human interference occurred in 2009 and in 2011 with the construction of a weir (Figure 10) that could result in an potential migration barrier at low flows however, it was not considered to be a barrier to migration at a discharge value of 2.62cms (WSC, Port Coquitlam) as observed during the 2011 assessment period. During the lowest monitored discharge of 2.82cms (WSC, Port Coquitlam) the average plunge pool depth was 0.33m and the average jump height over the weir was 0.19m indicating that the weir was adequate for passage. Pink Salmon were not observed at this index site during the monitoring period, however 130 were observed upstream of this index site after September 10th by the BC Hydro adult enumeration crew during the lowest discharge rate recorded at 2.62cms (WSC, Port Coquitlam) (Table 2). Migrating Pink Salmon are most likely not observed at this index site due to the lack of stream complexity, such as pools, woody structures and shallow water depths. Migrating Pink Salmon would likely navigate through this index site quickly and would not use it as a staging or spawning area.

**Figure 8** - Index site 2a - downstream view of shallow riffle, Aug.29.11
Discharge = 3.19cms (WSC Port Coquitlam)

**Figure 9** - Index site 2a - downstream view, Sept.5.11
Discharge = 2.82cms (WSC Port Coquitlam)
Low depth, riffle area

**Figure 10** - Index site 2a - upstream view of weir, Sept.13.11
Discharge = 3.36cms (WSC Port Coquitlam)
The arrow identifies the constructed weir

## 4.3 REACH 2 ~ INDEX SITE 2B,

Access to index site 2b is from the pedestrian trail on Patricia Avenue east of Shaughnessy Street in Port Coquitlam. This index site extends upstream 10m and downstream 55m of the Patricia Ave pedestrian bridge **(49' 16.585 N – 122 46.620 W)**. This site is characterised by the narrowing of the mainstem channel into a confined chute located on the right bank channel side of the mainstem . There is a 3% gradient increase over the length of the chute and the substrate primarily consists of large cobble, rock and boulder. Upstream the wetted width expands(>39m) into a shallow riffle and low depth glide that extends upstream for 200m (Figure 11). This substrate consists of a mix of compacted gravel and small to medium sized cobble not suitable for staging or spawning habitat due to the shallow depth and lack of habitat complexity. During higher discharge rates, greater than 40cms (WSC, Port Coquitlam), it is possible that passage may be impeded due to stream velocity through this site as indicated by the velocity threshold criteria for passage of 2.13m/sec (Bjornn and Reiser 1991).The 2011 assessment identified an average wetted width of 39m and the average depth of 0.27m during the lowest monitored discharge rate of 2.82cms (WSC, Port Coquitlam). This index site was observed not to be a migration barrier in the current year since discharge flows were at 2.62cms or greater. The following table summarizes observations of the glide and riffle area located upstream of the chute for the monitoring period:

**Table 5** – Index site 2b data summary

| Monitoring Date | WSC Mean daily Discharge (cms) | Wetted Width (m) | Avg. Wetted Depth (cm) | Velocity (m/sec) | Stream temp (C) |
|---|---|---|---|---|---|
| 29-Aug-11 | 3.19 | 39 | 31.7 | 0.56 | 15 |
| 5-Sep-11 | 2.82 | 39 | 27.6 | 1.19 * | 15 |
| 13-Sep-11 | 3.36 | n/a | 30.4 | n/a | 16 |
| 19-Sep-11 | 5.14 | 39.6 | 31 | 0.61 | 13 |
| 24-Sep-11 | 5.7 | n/a | 35.2 | 0.72 | 15 |
| * Velocity recorded at chute | | | | | |

Pink Salmon were first observed upstream of this index site after September 10th by the BC Hydro adult enumeration crew and during the lowest discharge rate recorded at 2.62cms (WSC, Port Coquitlam) (Table 2). Pink Salmon were also observed holding downstream of this index site September 19th with a discharge rate of 5.14cms although none were observed to be migrating on this survey day, velocity was not and issue to passage (WSC, Port Coquitlam).

**Figure 11** - Index site 2b - upstream view, Sept.5.11
Discharge = 2.82cms (WSC Port Coquitlam)

**Figure 12 -** Index site 2b - upstream view, Sept.13.11
Discharge = 3.36cms (WSC Port Coquitlam)

## 4.4 REACH 2 ~ INDEX SITE 2C

Access to index site 2c is located on Pipeline Road and east Galette Ave. in Coquitlam. Access the to the index site is located 65m downstream of the Galette Park entrance **(49' 19.621 N – 122' 46.346 W)**. This site was identified to potentially constrict migration due to the main flow narrowing around a gravel bar in the center channel of the main stem (Figure 13) and a shallow riffle on the right channel side of the gravel bar may have the potential to impede access with shallow depths at low flows. The substrate is characterized as a mix of small to medium size gravel, cobble and large scattered boulders that narrow the river and form a small scour pool and staging habitat at the tail out of the chute. During the lowest monitored discharge rate of 2.82cms (WSC, Port Coquitlam) the average wetted width of the main stem was 22.5m and a thalweg wetted depth of 0.20 m (Figure 13). Discharge rates greater than 5.0cms increased the wetted width to 29m and provided an average depth of 0.33m (Figure 14). The following table summarizes observations for the monitoring period:

**Table 6** – Index site 2c data summary

| Monitoring Date | WSC Mean daily Discharge (cms) | Wetted Width (m) | Avg. Wetted Depth (cm) | Velocity (m/sec) | Stream temp (C) |
|---|---|---|---|---|---|
| 29-Aug-11 | 3.19 | 22.7 | 21.5 | 0.73 | 15 |
| 5-Sep-11 | 2.82 | 22.5 | 20 | 1.18 | 15 |
| 13-Sep-11 | 3.36 | 22 | 21.7 | n/a | 16 |
| 19-Sep-11 | 5.14 | 29 | 22 | n/a | 15 |
| 24-Sep-11 | 5.7 | 29 | 33 | n/a | 15 |

BC Hydro adult enumeration crew first monitored migrating Pink Salmon upstream of this site on September 3rd (Table 2).The first Pink Salmon observed migrating at this site was on September 13th at a stream flow of 3.36cms (WSC, Port Coquitlam). There was a significant increase in numbers to 505 holding upstream of this index site after the September 25th rain induced flow event and max discharge releases from the dam. Observations over the monitoring period indicated that there were no impediments to migration at the lowest discharge rate of 2.62cms (WSC, Port Coquitlam), and the general health and condition of holding / migrating Pink Salmon was observed to be good. The majority of Pink Salmon migrated through this index during late September and were heavily pressured by recreational anglers.

**Figure 13** – Index site 2c - upstream view, Sept.5.11
Discharge = 2.82cms (WSC Port Coquitlam)
The arrow identifies the access channel

**Figure 14** – Index site 2c - downstream view, Sept.13.11
Discharge = 3.36cms (WSC Port Coquitlam)
Arrow identifies access route

**Figure 15** - Index site 2c - downstream view, Sept.24.11
Discharge = 5.7cms (WSC Port Coquitlam)
View of gravel bar and LB channel

## 4.5 REACH 3 ~ INDEX SITE 3A

Index site 3a is located on Pipeline Road at the Upper Coquitlam River Park gate. Access to this site is 40m upstream of the diving board hole pool **(49' 19.632 N – 122' 46.344 W)**. This index site is characterised as a shallow cascading riffle with a 4% grade over 25m (Figure 16). Adjacent to the index site the mainstem flow is split around a mid channel island with the dominant flow on the left bank side across the riffle. During low flow the cobble and rock is unstable and becomes exposed splitting the channel flow between the riffle and the left channel chute. Dominant flow is in the center of the channel but at lower stream flows below 2.62 cms, passage can potentially be impeded at the upstream end of the chute due to shallow water depth and a barrier of gravel/cobble at the top end of channel (WSC Port Coquitlam). The substrate consists of medium to large size cobble and rock. The downstream substrate of this index site is suitable as a staging area and spawning habitat. An average depth of 0.25m and wetted width of 11m was recorded at the lowest discharge rate of 2.82cms (WSC, Port Coquitlam). High flows do not seem to impact the migration of pink thru this index site as a significant number of Pink Salmon (1790) were observed upstream of this site after the spill event that took place

September 26th to October 5th. The following table summarizes observations for the monitoring period:

**Table 7** – Index site 3a data summary

| Monitoring Date | WSC Mean daily Discharge (cms) | Wetted Width (m) | Avg. Wetted Depth (cm) | Velocity (m/sec) | Stream temp (C) |
|---|---|---|---|---|---|
| 29-Aug-11 | 3.19 | 11.3 | 30.7 | n/a | 14.5 |
| 5-Sep-11 | 2.82 | 11.3 | 25.3 | 1.03 | 15 |
| 13-Sep-11 | 3.36 | 13.3 | 25 | n/a | 16 |
| 19-Sep-11 | 5.14 | 13.7 | 28.3 | 1.46 | 15 |
| 24-Sep-11 | 5.7 | n/a | 29.8 | n/a | 15 |

Four to five Pink Salmon were first observed holding below this site on September 19th during a discharge of 5.14cms (WSC, Port Coquitlam). A Pink Salmon carcass was also observed September 24th upstream of the cascade. No Pink Salmon were observed migrating through the index site during the field surveys, although approximately 50 Pink were observed upstream of index site 4 in late August during the preliminary reconnaissance. Observed fish distribution upstream of this index site indicates that passage was adequate during the lowest discharge value of 2.62cms (WSC, Port Coquitlam).

**Figure 16** - Index site 3a - upstream view, Sept.13.11
Discharge = 3.36cms (WSC Port Coquitlam)
The arrows indicate the chute and exposed gravel bar

**Figure 17** - Index site 3a - upstream view, Aug.29.11
Discharge = 3.19cms (WSC Port Coquitlam)
The arrow indicates the chute which is accessible at present flow

**Figure 18** - Index site 3a - downstream view, Sept.19.11
Discharge = 5.14cms (WSC Port Coquitlam)

## 4.6 REACH 3 ~ INDEX SITE 3B,

Index site 3b is located north on Pipeline Road adjacent to the Al Grist Memorial Hatchery **(49' 20 .251 N – 122' 46.263 W)**. This index site was originally identified as having the potential to constrict migration access at a narrow right bank side channel adjacent to the hatchery. During the 2011 monitoring study, it was observed that the dominant flow had narrowed to the left bank channel of the mainstem, leaving the right bank side channel dry and inaccessible at flows below 8.0cms (WSC, Port Coquitlam).With the change in flow patterns and stream morphology the 2011 assessment concentrated on an upstream cascading riffle located 130m upstream of the right bank side channel and has been initially monitored throughout the study period. The substrate is comprised of medium to large size cobble and boulder with a 3% gradient over the 40m length of the cascade. The lowest flow recorded was at 2.82cms (WSC, Port Coquitlam) providing an adequate depth of 0.39m which is sufficient for Pink Salmon passage.
The following table summarizes observations for the monitoring period:

**Table 8** – Index site 3b data summary

| Monitoring Date | WSC Mean daily Discharge (cms) | Wetted Width (m) | Avg. Wetted Depth (cm) | Velocity (m/sec) | Stream temp (C) |
|---|---|---|---|---|---|
| 29-Aug-11 | 3.19 | 8.5 | 42 | n/a | 14.5 |
| 5-Sep-11 | 2.82 | 8 | 39 | 1.04 | 15 |
| 13-Sep-11 | 3.36 | 8.9 | 40.2 | n/a | 15.5 |
| 19-Sep-11 | 5.14 | 8.9 | 42.7 | 1.06 | 15 |
| 24-Sep-11 | 5.7 | n/a | 43.3 | 1.67 | 15 |

Fifteen Pink Salmon were observed holding downstream of the index site mid channel on September 13th at a discharge rate of 3.36cms. This index site is primarily influenced from Coquitlam Dam releases and Or Creek. The BC Hydro adult enumeration crew first observed 44 Pink Salmon upstream of this index site on September 4th. Although no Pink Salmon were observed migrating at this index site, fish distribution upstream throughout the monitoring period indicated that at a discharge flow of 2.62cms (WSC, Port Coquitlam) or greater, migration was not impeded.

**Figure 19** – Index site 3b - upstream view, Sept.5.11
Discharge = 2.82cms (WSC Port Coquitlam)
The arrow indicates the channel outlet, lower portion presently wet from hatchery effluent

**Figure 20** – Index site 3b - downstream view, Sept.24.11
Discharge = 5.7cms (WSC Port Coquitlam)
At upstream end of Channel

**Figure 21-** Index site 3b - upstream view, Sept.19.11
Discharge = 5.14cms(WSC Port Coquitlam)

**Figure 22-** Index site 3b - downstream view, Sept.24.11
Discharge = 5.7cms (WSC Port Coquitlam).

## 4.7 REACH 4 ~ INDEX SITE 4,

This index site is located in the Coquitlam watershed at the Coquitlam River main stem and Swoboda channel confluence **(49' 21. 041 N – 122' 46.452 W)**. Since the river flow is primarily influenced from dam releases the discharge rates within this section are referenced from dam release data. Access to this site is at the base of the dam downstream of Grant's tomb rearing pond and Swoboda channel. This site is characterized by a cobble and gravel riffle that is 10m wide which becomes shallow and exposed with flows below 2.62cms (WSC, Port Coquitlam). At a discharge rate of 2.82cms the thalweg wetted depth is 0.23m and provides a jump height of 0.15m to 0.22m with an adequate plunge pool depth of 0.38m to 0.53m (Figure 23). The substrate is a mix of loose gravel and small to medium size cobble. The lowest flow observed in the main stem channel was 2.1cms (Dodd 2011) limiting depth and flow distribution across the riffle (Figure 23 & 25). This index site is primarily influenced by Coquitlam Dam releases (Figure 4) and discharge from Swoboda channel effluent and although there is a short unnamed tributary entering the river on the upstream left bank side, tributary flow contribution during the study period was observed to be minimal. The following table summarizes observations for the monitoring period:

**Table 9** – Index site 4 data summary

| Monitoring Date | WSC Mean daily Discharge (cms) | Wetted Width (m) | Avg. Wetted Depth (cm) | Velocity (m/sec) | Stream temp (C) |
|---|---|---|---|---|---|
| 29-Aug-11 | 3.19 | 10.6 | 24.6 | n/a | 13.5 |
| 5-Sep-11 | 2.82 | 9.75 | 23 | n/a | 14.5 |
| 13-Sep-11 | 3.36 | 10.2 | 31 | n/a | 15 |
| 19-Sep-11 | 5.14 | 10.2 | 28.2 | 0.55 | 15 |
| 24-Sep-11 | 5.7 | n/a | 31.5 | 0.57 | 15 |

The first Pink Salmon observed upstream of this index site was on August 25th with a discharge rate of 2.9cms (Dodd 2011). During the lowest discharge of 2.1 cms (Dodd 2011) on September 13th, 33 Pink Salmon were observed upstream of index site 4, indicating that stream flow and water depth was adequate for passage. The BC Hydro adult enumeration data also indicated that Pink Salmon had successfully accessed Swoboda channel and the main stem of the Coquitlam River upstream of index site 4 throughout various discharge levels from 2.1 to 5.7cms indicating unimpeded access (Table 2). During the October 5th ramp down from

40+cms (WSC, Port Coquitlam) BC Hydro adult enumeration crew observed Pink Salmon in significant numbers (233) upstream of this index site.

**Figure 23 -** Index site 4 **-** upstream view, Sept.5.11
Discharge = 2.16cms (Dodd, BC Hydro)


**Figure 24** - Index site 4 **-** downstream view, Sept.24.11
Discharge = 2.07cms (Dodd, BC Hydro)
Arrow identifies, access point and jump.

**Figure 25** – Index site 4 - upstream view, Sept.19.11
Discharge = 2.09cms (Dodd, BC Hydro)
Arrow identifies access point at low flow

# 5.0 DISCUSSION

The first objective of this study is to conduct an assessment of adult Pink Salmon passage in the lower Coquitlam River by identifying index sites that may have the potential to restrict Pink Salmon migration during summer low flows. The second objective is to determine at what flow each barrier is eliminated or reduced.

## 5.1 OBJECTIVE 1 - LOW FLOW PASSAGE ISSUES

The first objective was to assess if there were any Pink Salmon passage issues during low flows due to migration barriers in the lower Coquitlam River mainstem corridor. To test this objective studies were performed to analyse the low flows throughout the study period and determine if early run Pink Salmon were restricted at any of the index sites that had the potential to cause passage barriers. Monitoring of the index sites began on August 25th when the first Pink Salmon was observed and was completed on September 26th, which was a week earlier than expected as the high stream flows hampered visual observations and safety of personal.
The results show that throughout the 2011 study period the lowest minimum daily flow was 2.62cms which occurred on September 3rd, and was early into the migration run with a total of 44 Pink Salmon observed in the system (WSC, Port Coquitlam) (MacNair 2011). Of the 44 Pink Salmon, 31 were observed upstream of index site 4 indicating that flow and water depth was adequate for passage to the upper reaches of the Coquitlam mainstem. Velocity, water depth and temperature (Table 3 to 9) at all index sites were identified to be adequate for Pink Salmon passage and fell within the threshold limits for Pink Salmon migration (Appendix 2) (Bjornn and Reiser 1991). During the field assessment the highest recorded velocity was measured at 1.86m/sec (Table 2) on September 24th at index site 3b during a mean daily discharge of 5.7cms which coincided with a rain induced flow event (49mm between September 21st and September 24th). Although no Pink Salmon were observed migrating at this velocity on the survey day, observations of 4 Pink Salmon migrating through a high velocity chute (>3.0 m/sec) downstream at index site 3a. This indicates that the velocities were passable during that period also, based on the assumption, that there is enough available high velocity refuge for Pink Salmon to hold (Table 2) (WSC, Port Coquitlam). The DFO Habitat Management Unit has adopted a flow velocity value of 1.0 m/sec as a guideline for defining

maximum discharge flow suitable for upstream salmon migration (Levy and Slaney 1993). In contrast, earlier publications indicated that a maximum velocity of 2.13 m/sec is the threshold limit for successful migration (Bjornn and Reiser1991).

Prior to the high flows, that occurred from precipitation and spilling from the dam on September 26th to October 5th, a total of 398 Pink Salmon were observed in the system of which 25% of the population were enumerated upstream of index site 3b during a mean daily flowrate of 4.1cms (WSC, Port Coquitlam) (MacNair, 2011). Early season fish distribution numbers (Table 2) indicated that migration was achieved upstream of all index sites demonstrating that at the lowest discharge value of 2.62cms throughout the study period provided adequate flow for early migrating Pink Salmon (WSC, Port Coquitlam). In addition to flow, temperature can also be a concern at the index sites due to areas where depth is reduced during summer low flows. Stream temperatures fluctuated with rain events but fell within the threshold range of 7.2C to 15.6C and was recorded at a daily average of 14.5C during the monitoring period which is below the maximum temperature range for successful salmon migration (Bjornn and Reiser 1991).

Water depth at three of the four monitoring sites averaged 0.25m during the field assessment with the lowest monitored flow of 2.82cms which falls within the acceptable range of minimum depth requirements of 0.18m for Pink Salmon passage (WSC, Port Coquitlam) (Bjornn and Reiser 1991). The exception is at index site 1 which recorded the lowest depth of 0.14m, however Pink Salmon were not observed migrating at index site 1 during the monitoring days and most likely choose the left mainstem channel route which had significantly more flow and water depth (0.21m).

The 2011 Pink Salmon assessment observed the flow regime from the newly installed Coquitlam dam gate identified as low level outlet 3 (LLO3) averaged a daily discharge value 2.3cms, (Dodd, 2011) consistent with targeted releases anticipated by BC Hydro during the assessment period and contributed an average daily mean flow rate of 4.1cms in the system from August 25th to September 25th (WSC, Port Coquitlam).

Overall, early migrating Pink Salmon were not restricted during low flows in the Coquitlam River during the 2011 study year at the lowest flow of 2.62cms. Treatment 2 flows (1.1 - 2.2 cms) were in effect for the first time during the Pink Salmon monitoring study since the flow regime began in 2008. The 2009 study year had significantly higher flows and did not represent

treatment 2 flow regimes in the river during early Pink Salmon migration due to higher than expected discharge from the recently replaced knife gate lower level outlet 3 (LLO3). It was confirmed by BC Hydro engineers that the flow rating curve for the new gate (LLO3) was not accurate leading to flow releases during the period being approximately 2.0cms above the 1.1 to 2.2cms target flows during the early Pink Salmon migration (Hunter 2009). The 2011 flow contribution was indicative of expected discharge targets of 1.1 - 2.2cms from LLO3 during the treatment 2 flow regime with an mean daily flow of 2.1cms to 2.9cms, maximizing stream flow contribution during the early part of the migration which occurred the first week of September (Dodd,2011).

## 5.2 OBJECTIVE 2 - AT WHAT FLOWS ARE PASSAGE ISSUES REDUCED

The second objective of this report was to assess at what flows the potential passage restrictions would be improved for ease of migrating Pink Salmon. To test this objective information was obtained to determine the range of flow that did not influence the efficacy of migrating Pink Salmon and to determine what the minimum and maximum flows would be for successful migration.

The 2011 enumerated Pink Salmon total population was 3,700 by October 17th which had increased by 18% from the 2009 enumerated value of 3,135 (Macnair 2011). The following table recognizes the Pink Salmon distribution by reach for the 2011 study year.

**Table 10 - 2011 Coquitlam Pink Salmon Distribution by Reach**

| Date | Reach 1 | Reach2a | Reach 2b | Reach 3 | Reach 4 | Total |
|---|---|---|---|---|---|---|
| 04-Sep | 6 | 0 | 0 | 7 | 31 | 44 |
| 10-Sep | 4 | 0 | 1 | 3 | 41 | 49 |
| 17-Sep | 27 | 3 | 11 | 12 | 43 | 96 |
| 24-Sep | 42 | 22 | 92 | 141 | 101 | 398 |
| 10-Oct | 550 | 75 | 89 | 505 | 1753 | 2972 |
| Total | 629 | 100 | 193 | 668 | 1969 | 3559 |

Source: (Macnair 2011)

The increased numbers coincided with the significant numbers of returning Fraser River Pink Salmon stock which can be attributed to strong marine survivals and a low fishery interception (Foy 2011). The 2007 population estimate was the lowest number enumerated in the Coquitlam

River since 2003 but it may not be indicative of flow rates as the overall Fraser River Pink Salmon population was low.

There was also an increased proportion of Pink Salmon using natural and enhanced off-channel habitat (Macnair 2011). The 2011 study period observed the highest percentage of off-channel use since 2003 and of all the off channel sites nearly 85% of Pink Salmon were observed in the Swoboda channels upstream of index site 4 (Macnair 2011). The 2007 study which occurred during the first year of Pink Salmon monitoring with the treatment 1 flow regime (0.8 - 1.4 cms) demonstrated that at a low flow of 1.1cms only 28% of the population was enumerated in the off channel sites (Table 11). Observations of increased numbers to the off channel sites can be attributed to the higher treatment 2 flow regime indicated by 43% of the estimated population enumerated in the upper reaches and in off channel habitat (Table 11) (Macnair 2011). The 2009 study under treatment 2 flow regime although higher than anticipated (2.0 cms above the target) provided Pink Salmon easier access to off channel habitat and increased the amount of available habitat in some constructed off channel sites and natural side channels (Decker 2010). The 2011 flow regime continued that trend providing greater access to off channel habitat, specifically in the Swoboda channels located upstream of Index site 4, which presented a greater area of quality spawning habitat (Table 11). The following table recognizes the percentage of enumerated Pink Salmon in off channel habitat since 2003.

**Table 11 - Coquitlam River Pink Salmon Off Channel Habitat Use**

| Date | Mainstem | Natural Off channel Sites (%) | Off Channel Restoration Sites (%) | Off Channel Sites Combined (%) |
|---|---|---|---|---|
| 2003 | 55.2 | 18.8 | 26 | 44.8 |
| 2005 | 64.8 | 21.8 | 13.4 | 35.2 |
| 2007 | 71.2 | 20.3 | 8.5 | 28.8 |
| 2009 | 71.5 | 13.4 | 15.1 | 28.5 |
| 2011 | 57 | 23 | 20 | 43 |

Source: (Macnair 2011)

Changes in flow may influence the efficacy of early returning Pink Salmon migration however, observations indicate the treatment 2 flow regime with a consistent contribution from LLO 3 (2.2 cms) improved ease of passage at all the index sites as indicated by early season fish distribution in the upper reaches of the Coquitlam mainstem. The higher base flows provided by

the treatment 2 flow regime increased the availability of spawning habitat and the ability for early returning Pink Salmon to migrate without difficulty, which resulted in better physical condition to hold and spawn successfully. Pink Salmon migration was not influenced at flows of 2.62cms, which was the minimum discharge rate during the 2011 study period. The treatment 2 flow regime from LLO3 if utilized at the upper maximum target requirement of 2.2cms has provided greater accessibility to upper reaches and off channel habitat. During the 2011 assessment 43% of the returning Pink Salmon population was utilizing the off channel habitat, which reverses the previous trend of 28% of the population accessing off channel sites during the 2007 and 2009 monitoring study (Macnair 2011). Therefore it is recommended that off channel access may be considered for potential monitoring sites as part of the 2013 and 2015 assessment. Continued monitoring through 2013 and 2015 will provide a better understanding to answer the theory that flows affect the overall efficacy of the early returning Pink Salmon population.

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# APPENDICES

## APPENDIX I

## [Salmon Passage Criteria Table]

| Species | Temperature range (C) | Min. depth (m) | Max Velocity (m/s) |
|---|---|---|---|
| Chinook Salmon | 10.6 - 19.4 | 0.24 | 2.44 |
| Chum Salmon | 8.3 - 15.6 | 0.18 | 2.44 |
| Coho Salmon | 7.2 - 15.6 | 0.18 | 2.44 |
| Pink Salmon | 7.2 - 15.6 | 0.18 | 2.13 |
| Sockeye Salmon | 7.2 - 15.6 | 0.18 | 2.13 |
| Steelhead | 7.2 - 15.6 | 0.18 | 2.44 |

# APPENDIX II

## [Site Assessment Card]

**Pink Salmon Migration Assessment Data Form**

Crew: _____ Photo # _____

Date: _____

Air temp: _____ C

Start Time: _____

End time: _____

Survey # _____ Index Site : _____

WSC _____ $m^3/sec$ Stream Temperature _____ C

# Pink observed: _____ at index site

_____ upstream of index site

_____ dowstream of index site

_____ migrating (30minute observation limit)

Over all condition / appearance: _____

Comments: _____

**Assessement Data:**

Barrier type _____

wetted width (R-L): _____ m _____ m

| wetted depth (cm): | R - L | | | | | | |
|---|---|---|---|---|---|---|---|
| | R - L | | | | | | |

| Dominate substrate: | Type | sands | gravels | cobbles | boulder | bedrock | |
|---|---|---|---|---|---|---|---|
| | % | | | | | | |

Velocity: time (sec) _____

distance (m) _____

Gradient: _____ % length surveyed: _____ m

Comments: _____

# APPENDIX III

## [WSC Tabular Data]

| Water Survey Canada Station 08 MH002 Port Coquitlam, BC. | | | |
|---|---|---|---|
| Date | Minimum **cms** | Mean **cms** | Maximum **cms** |
| 25/08/2011 | 3.356 | 3.57 | 3.725 |
| 26/08/2011 | 3.245 | 3.44 | 3.57 |
| 27/08/2011 | 3.155 | 3.32 | 3.504 |
| 28/08/2011 | 3.025 | 3.27 | 3.391 |
| 29/08/2011 | 3.021 | 3.19 | 3.324 |
| 30/08/2011 | 2.991 | 3.15 | 3.293 |
| 31/08/2011 | 3.029 | 3.22 | 3.42 |
| 01/09/2011 | 2.652 | 3.01 | 3.299 |
| 02/09/2011 | 2.679 | 2.73 | 2.768 |
| 03/09/2011 | 2.626 | 2.72 | 2.785 |
| 04/09/2011 | 2.69 | 2.77 | 2.885 |
| 05/09/2011 | 2.724 | 2.82 | 3.039 |
| 06/09/2011 | 2.744 | 2.86 | 2.997 |
| 07/09/2011 | 2.831 | 2.92 | 3.124 |
| 08/09/2011 | 2.857 | 2.98 | 3.17 |
| 09/09/2011 | 2.992 | 3.04 | 3.093 |
| 10/09/2011 | 2.943 | 3.07 | 3.123 |
| 11/09/2011 | 3.08 | 3.17 | 3.303 |
| 12/09/2011 | 3.257 | 3.35 | 3.467 |
| 13/09/2011 | 3.282 | 3.36 | 3.449 |
| 14/09/2011 | 3.33 | 3.40 | 3.542 |
| 15/09/2011 | 3.439 | 3.86 | 5.955 |
| 16/09/2011 | 3.651 | 4.05 | 6.345 |
| 17/09/2011 | 3.651 | 4.41 | 5.268 |
| 18/09/2011 | 4.907 | 8.30 | 11.694 |
| 19/09/2011 | 4.459 | 5.14 | 6.214 |
| 20/09/2011 | 4.194 | 4.42 | 4.573 |
| 21/09/2011 | 4.179 | 4.35 | 5.026 |
| 22/09/2011 | 4.592 | 8.88 | 13.005 |
| 23/09/2011 | 5.938 | 6.85 | 8.717 |
| 24/09/2011 | 5.284 | 5.70 | 6.106 |
| 25/09/2011 | 5.191 | 7.02 | 12.387 |
| 26/09/2011 | 7.351 | 19.353 | 37.812 |
| 27/09/2011 | 11.528 | 33.576 | 66.224 |
| 28/09/2011 | 59.95 | 62.117 | 64.517 |
| 29/09/2011 | 57.674 | 59.582 | 61.685 |
| 30/09/2011 | 54.31 | 57.488 | 59.578 |
| 01/10/2011 | 53.71 | 55.833 | 57.611 |

# APPENDIX IV

## [Precipitation Data Table]

| *Rainfall Data - Coquitlam Dam - Douglas College Weather Stations, 2011* | | |
|---|---|---|
| August 25 - Oct 1, 2011 | | |
| | **COQ DAM** | **Douglas** |
| Date | mm | **College** |
| 25/08/2011 | 0.00 | 0 |
| 26/08/2011 | 0.00 | 0 |
| 27/08/2011 | 0.00 | 0 |
| 28/08/2011 | 0.00 | 0 |
| 29/08/2011 | 0.00 | 0 |
| 30/08/2011 | 5.00 | 0 |
| 31/08/2011 | 0.00 | 0.8 |
| 01/09/2011 | 0.00 | 0 |
| 02/09/2011 | 0.00 | 0 |
| 03/09/2011 | 0.00 | 0 |
| 04/09/2011 | 0.00 | 0 |
| 05/09/2011 | 0.00 | 0 |
| 06/09/2011 | 0.00 | 0 |
| 07/09/2011 | 0.00 | 0 |
| 08/09/2011 | 0.00 | 0 |
| 09/09/2011 | 0.00 | 0 |
| 10/09/2011 | 0.00 | 0 |
| 11/09/2011 | 0.00 | 0 |
| 12/09/2011 | 0.00 | 0 |
| 13/09/2011 | 0.00 | 0 |
| 14/09/2011 | 14.00 | 0 |
| 15/09/2011 | 0.20 | 8.2 |
| 16/09/2011 | 24.80 | 0 |
| 17/09/2011 | 19.40 | 7.6 |
| 18/09/2011 | 0.00 | 7.8 |
| 19/09/2011 | 0.00 | 0 |
| 20/09/2011 | 7.60 | 0 |
| 21/09/2011 | 29.20 | 2.8 |
| 22/09/2011 | 1.00 | 14.6 |
| 23/09/2011 | 0.00 | 0.2 |
| 24/09/2011 | 16.80 | 0 |
| 25/09/2011 | 53.80 | 6.2 |
| 26/09/2011 | 14.60 | 24.4 |
| 27/09/2011 | 0.00 | 3 |
| 28/09/2011 | 0.00 | 0.2 |
| 29/09/2011 | 0.20 | 0 |
| 30/09/2011 | 0.20 | 0.4 |
| 01/10/2011 | 0.00 | 0 |
| **Total** | 186.80 | 76.20 |

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