



(02.Ch.06 - 03.Ch.02)



Spawning Pink Salmon - Gorbusha West - August 2003

Cheakamus River Sidechannel Restoration 2003 Gorbuscha East Channel Final Report

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Executive Summary

The Gorbusha project involved the controlled breaching of the Cheakamus River dykes and construction of sidechannel habitats on the river floodplain on both sides of this dyke.

In 2002 the river dyke on the south bank of the Cheakamus River, immediately downstream of the BCH Bailey bridge was breached by a 51 meter (m) long, .92 m diameter steel pipe, controlled by a cast iron gate valve on the downstream end. A flow of water of between 40 and 100 cubic feet per second (cfs) is diverted from the Cheakamus River into the newly created Gorbushca West channel through this intake and pipeline structure. (flow is dependant on mainstem head - min. design head of 1 m)

In 2003, the training dike located on the south bank of the Cheakamus River, approximately 700 metres downstream of the BCH Paradise Valley Road Bailey bridge, was breached by a culvert that releases controlled flows from the newly constructed Gorbushca West sidechannel (Phase I, 2002). A parallel existing sidechannel was stripped of encroaching vegetation and excavated to spawning gravels. Large woody debris features were anchored along the constructed channel. The resulting channel was named Gorbushca East.

This project involved excavation and creation of approximately 480 meters of river-fed sidechannels to restore important pink salmon spawning and chinook salmon rearing habitats. During construction approx. 10,000 cubic meters (m³) of material was excavated creating 3,225 square meters (m²) of new habitat.

In the fall of 2003 the Cheakamus River system experienced the flood of record and these channels were inundated with floodwaters. Post flood, a damaged reach of the nearby Kisutch channel system was repaired, restoring approximately 800 square meters (m²) of prime chum and coho spawning grounds and rearing habitat. Excavated material was placed on the nearby diking system, re-establishing flood protection of the pink and chinook spawn of the late summer and prior to the chum run in November.

Introduction

The North Vancouver Outdoor School (NVOS) has worked with the Department of Fisheries and Oceans Canada (DFO) to develop a number of similar salmon habitat restoration projects on school property over the last two decades and has additional areas it wants to develop as more salmon habitat. These previous restoration projects have been directed at improving spawning and rearing habitats primarily for coho salmon and chum salmon. This project is directed at restoring important spawning and rearing habitats for pink and chinook salmon that were alienated prior to 1972 due to river changes attributed to the hydro-power development on the Cheakamus River including flood control dyke construction (Northwest Hydraulics, 2000)(DFO Report, 1957, Ref. 1&2).

Study Area

The salmon habitat restoration site is on the south bank of the Cheakamus River approximately 700m downstream of the Paradise Valley Road Bailey Bridge (around the riverbend). The property upon which the side-channel is built is part of the North Vancouver Outdoor School, School District 44 (North Vancouver) and is designated as District Lots 1244, 1245 and 7024 within the New Westminster Land District. Maps covering the site are Natural Resources Canada National Topographic System 92G/14 and GeoData British Columbia Terrain Resource Information Management 92G.085 near UTM coordinates of 5519300m N by 487300m E (1927 North American Datum, UTM Zone 10U).

Methods

A 450 m long corridor through the floodplain on NVOS property was laid out utilising existing isolated river braids wherever possible. Overburden was spoiled on site at NVOS. Encroaching trees were carefully placed into the forest along the channel margin and later used to create Large Woody Debris (LWD) refuge areas. Additional wood was brought from off site and anchored in the channel or placed in off-channel refuge "niches" that were created along the channel margins.

This project lies within the floodplain of the Cheakamus River on the North Vancouver Outdoor School. This area lies in the area defined as Zone 1 (Riparian River Edge) of the restrictive covenants owned by the Nature Conservancy of Canada (NCC) that apply to this land. These covenants impacted all areas of construction. All excavated material was end hauled from the construction corridor to maintain the integrity of riparian plant life on the close edge margins. Channel margins that might have contributed silt into the channel were quickly seeded. Special care was taken that any and all terrestrial values adjoining this new aquatic habitat was not unduly impacted.

Excavation was done with Cat 225 and 325 excavators and Cat 966 loaders. Material was moved around site by standard dump trucks.

This new channel is fed by a 5 x 3 (ft) supply culvert under the training dyke. A flapper type flood control valve controls backwater flows from the mainstem Cheakamus River during flood events. Water flows through the channel are controlled by a weir in the Gorbusha West channel, backwatering the supply culvert's headpond.

NVOS partnered with Fisheries and Oceans Canada during all phases of the design and development of this project.

Results

This project has resulted in construction of 480 m of channel totalling 3,225 square metres of enhanced off channel spawning and rearing habitat for pink, chinook, coho, and chum salmon and steelhead trout.

This project also resulted in the restoration of 800 m² of groundwater side channel habitat. Excavated material was used to re-establish flood protection structures for the newly constructed and restored habitats.

It is estimated that over 15,000 pinks and 100 chinook utilized the Gorbusha channels in the 2003 season. Shortly after the pink spawn the Cheakamus system was inundated by the flood of record. It is believed that these protected channels will be pivotal in the survival of the 2003 cycle of pinks as the mainstem spawning beds were heavily scoured. The total escapement of pink fry from the Gorbusha system has been estimated at over 1,400,000.

Discussion

The work has expanded the amount of critical spawning habitat for pink salmon which is believed to limit the ability of this species to recover to the levels of abundance that existed in the Cheakamus River prior to hydroelectric development. Over 15,000 pink utilized the Gorbusha system in 2003. Chinook salmon will also gain benefit from this project and over 100 chinook spawned in the Gorbusha system in 2003.

BCH monitoring of out-migrating salmon smolts in the spring of 2000 identified an eleven-fold decrease in chinook smolt emigration from the Cheakamus River as compared to the out-migration of this species observed in a DFO study in 1966. This decrease in smolt numbers was postulated to be the result of the loss of channel complexity and abandonment of important sidechannels by the Cheakamus River from 1966-2000 because of hydroelectric development in the watershed (Melville and McCubbing, 2000). Coho and chum salmon and steelhead trout will also benefit from the habitat created.

Increased salmon returns to the relatively stable sidechannel habitat will provide improved foraging opportunities for birds such as the Bald Eagle, Great Blue Heron and Belted Kingfisher. Additional marine derived nutrients from the salmon carcasses will provide an important food and nutrient source for both aquatic and terrestrial animals and plants in the Cheakamus River. There has been a marked increase of utilization of salmonids by black bear in the Gorbuscha Channel system.

Limiting Factors

The first limiting factor that will be addressed is the loss of riverine side channel habitat that is critically important for spawning pink and for rearing 0+ chinook salmon juveniles. The restoration site is located on the historic active floodplain of the Cheakamus River that is now largely isolated from direct river flow by the BCH bridge and dyke on the south bank of the Cheakamus River. Spawning surveys carried out in 1955 and 1957 confirm these areas supported important spawning populations of pink, chum and coho salmon prior to hydroelectric development of the river (DFO, 1957, Ref. 1&2). D.B. Lister (2001) summarised the importance of these sidechannel habitats for sustaining pink salmon populations in the Cheakamus River and suggested active restoration of these areas as the only practicable means of recovering these populations (Appendix 2.). Downstream trapping studies on the Cheakamus River in 2000 and 2001 attributed significant declines in chinook smolt abundance since 1966 with loss of channel complexity and loss of sidechannel habitats (McCubbing and Melville, BCH reports in prep.).

The second limiting factor to be addressed is loss of nutrients due to the effects of the Daisy Lake Reservoir and diversion of nutrients out of the basin through the power tunnel to the Squamish River. This project will increase the biomass of salmon produced by the lower Cheakamus River and thereby increase the amount of marine derived nutrients that enter the ecosystem each year.

Applicability to Program Objectives

1. Former spawning and rearing areas have been lost, primarily due to simplification of the Cheakamus River in Reach 4 due to dyke and bridge construction for protection and access to transmission lines, diversion of flows out of the basin directly into the Squamish River and loss of wood and gravel recruitment due to the effects of Daisy Lake created by dam construction (Northwest Hydraulics, 2000). All these impacts are related to the footprint effects of the Cheakamus River power project. These footprint impacts such as altered fluvial processes, caused by reduced downstream flows and controlled flow releases, have resulted in less downstream diversity such as side channels to the main river. This loss of riverine side channels critically limits spawning and rearing habitat for pink and chinook salmon. Migrating pink fry provide a major source of food for other species such as steelhead trout and chinook and coho pre-smolts prior to their migration to saltwater in the spring.

2. Loss of nutrients due to the effects of the Daisy Lake reservoir and diversion tunnel will be addressed by increasing the source of marine derived nutrients to the lower Cheakamus River. The proposed sidechannel habitat will increase salmon returns to the river and have the ability to hold salmon carcasses through winter floods and prevent them being swept out of the watershed. This will maximize the value of the marine derived nutrients to the local ecosystem.

3. Added value benefits will include informational signs placed at the site for interested members of the public. The site is adjacent to the North Vancouver Outdoor School which sees hundreds of students each year pass through the area on educational field trips. This area provides excellent nature viewing opportunities and supports high densities of bald eagles each winter which earns this site international recognition.

Monitoring Plan and Evaluation

1. *Ongoing* - Physical monitoring of water flows in the habitat and its use by spawning and rearing salmon will occur on a daily basis by NVOS staff.

2. *Ongoing*- Formal adult counts of spawning pink salmon are carried out by Golder and Associates and Squamish Nation under contract to Fisheries and Oceans as part of an annual monitoring program for salmon escapements in the watershed. NVOS staff provide a weekly count of channel utilisation by salmonids during the spawning seasons.

3. *September 2002-March 2005-*

DFO has agreed to monitor and assess fish populations in the developed habitat area over a three-year period to document fish use. This monitoring would include minnow trapping in early spring to document use by rearing salmonids such as chinook, coho and steelhead.

4. *August - October 2003*

In mid-August 2003 InStream Fisheries Research installed a temporary Logie 2100C resistivity counter at the d/s exit of Upper Paradise, and the newly constructed pink channels. The Logie counter was operated from August 21 to October 15, 2003 when it was taken off line due to the large flood that occurred October 18, 2003.

Counter estimates (without video validation) of pink adult escapement into the channels was 15,429 based on average count efficiency of 80% as observed on the Keogh River during pink salmon migration (McCubbing and Ward 1998). A total of 110 chinook adults were also estimated to have entered the channels based on signal strength (a measure of fish size) on the counter.

5. *Feb - June 2003*

InStream Fisheries Research Inc and BC Hydro did an assessment of pink fry escapement from the channels in conjunction with the juvenile monitoring being conducted by BC Hydro.

Pink fry yield was estimated in the channels by using fyke nets on a Mark-Recapture basis. Two fyke nets were deployed in each channel. One near the downstream end of each channel (within 30m of the two channels confluence's), the second ~200m upstream. The upstream fyke was operated only 4 days per week as a marking trap. All fry captured in the upstream trap were batch marked using Neutral Red Dye and released immediately downstream.

The downstream trap in each channel was used to estimate the population by using Petersen mark/recapture estimate, resulting in an estimated escapement of 1,472,639 pink fry.

6. *Ongoing* - The Cheakamus River Technical Committee is developing a Water Use Plan monitoring program that will look at the relative contribution of restored habitats to overall river productivity and the proposed project could be included in that study (S. MacFarlane, DFO, Pers. comm.).

7. *September 2003 - March 2006*

F&O has agreed to monitor and assess fish populations in the developed habitat area over a three-year period to document fish use. This monitoring would include minnow trapping in early spring to document use by rearing salmonids such as chinook, coho and steelhead. The project design provides a controllable outlet allowing for independent enumeration and marking. By coordinating the local monitoring program with the Water Use Planning Fish Technical Committee river monitoring program, the data from this project will be separated from the overall river monitoring studies. Monitoring for an extended period is contingent upon future funding availability.

8. *March 2006-* a report summarising the fish populations and statistics from the ongoing counts of spawners, children, and water flows, as well as updated photographs, will be provided to BChydro and all partnership groups.

Risks and Benefits

The risk of potential negative impacts is nil.

Non-target benefits will include the high value bird and mammal habitat provided by the wetted areas and the salmon produced from those areas. It is known that common predators of salmon such as mink, bear, otter, Bald Eagle, Great Blue Heron, Belted Kingfishers, Common and Hooded Mergansers and American Dippers will all make use of salmon bio-mass as a seasonal food source. During extreme flood events, protected sidechannel habitats are used by all species of fish found in the Cheakamus River.

Acknowledgements

This project would not have been possible without the financial support of BC Hydro Bridge Coastal Fish and Wildlife Restoration Program and the technical and supervisory support of Fisheries and Oceans Canada Pacific Region Habitat and Enhancement Branch, particularly Matt Foy, Harold Beardmore, and Jesse Neri.

Excavation contracting was provided by John Hunter Ltd. This project would not exist as it does today without the exceptional support of Rick Hunter et al, supplying additional time and effort above and beyond the requirements of this contract. The work of John Hunter Jr. as the primary excavator operator is of particular note. His sensitive attention to detail and unique site requirements are largely responsible for the channel's final form.

Letters of support:

Randall Lewis Squamish Nation; Harold Beardmore P.Eng. Fisheries and Ocean; Edith Tobe, Executive Director of the Squamish River Watershed; Steve Rochetta BC WLAP Habitat Officer for Squamish; Rob Bell-Irving, Fisheries and Oceans Community Advisor for the Squamish-Howe-Sound.

References

1. Department of Fisheries, Canada 1957. *A report on the fisheries problems related to the power development of the Cheakamus River system*. Vancouver B.C. 39p. + appendices.
2. Melville, M. and D. McCubbing. 2000. *Assessment of the 2000 Juvenile Salmon Migration from the Cheakamus River, using Rotary Screw Traps (draft)*. Prepared for BC Hydro, Burnaby. 36 p. + appendices
3. Northwest Hydraulic Consultants. 2001. *Analysis of channel morphology and sediment transport characteristics of the Cheakamus River*. Prepared for BC Hydro, Burnaby. 40p. + appendices.
4. Melville, M. and D. McCubbing. 2004. *Initial Summary of Pink Adult Escapement and Juvenile Fry Yield from Pink Salmon Enhancement Channels at the North Vancouver Outdoor School, Cheakamus River, BC in 2003-2004*

Cost Item	Description	Unit cost	PST	GST
Armtec	supply culvert under berm	3717.79	0	260.24
Burritt & Son	trucking	2745.00	0	192.15
John Hunter Ltd.	Cat 325, 966, trucking	46662.00	0	3266.34
L & A Equipment	trucking / Cat 325	5413.93	0	378.98
London Drugs	report supplies	72.48	5.44	5.07
Triton Steel	culvert valve supplies	111.15	8.34	7.78
Triton Steel	culvert valve supplies	28.05	2.10	1.96
WestBarr	trucking	2655.00	0	185.85
Total to NVOS Invoice # 38540	November 19, 2003	61405.39	15.88	4298.37
John Hunter Ltd	trucking, 966	5585.00	0	389.55
John Hunter Ltd	Cat 325, 966, trucking, compactor	13035.00	0	912.45
Garibaldi Graphics	report supplies	124.16	9.31	8.69
Instream Fisheries Consultants	monitoring	4500.00	0	0
Total to NVOS Invoice # 38541	May 7, 2004	23923.69	9.31	8.69
	November 19, 2003	61405.39	15.88	4298.37
	May 7, 2004	23923.69	9.31	8.69
Invoice Totals		85329.08	25.19	4307.06
Invoice date:	Nov. 19	May 7		Total spent in 2002
Unit total	61405.39	23923.69		85329.08
PST	15.88	9.31		25.19
GST	4298.37	8.69		4307.06
TOTAL:	65719.64	23941.69		89661.33
Grant Total: 98,200.00		8538.67 unspent		

* Financial statements contained in this report reflect total costs as per original invoices. These figures may differ from NVOS statements #38540 and 38541 because of GST disbursements and rebates.

Please refer to NVOS statements for payment information.

In-Kind Contributions	Supplied by:	Unit Value:	Total:
Project Design / Engineering	DFO	2 days @ \$500	1000.00
Project Design	DFO / NVOS	7 days @ \$300	2100.00
Contracting	DFO	2 days @ \$400	800.00
Layout	DFO / NVOS	2 days @ \$500	1000.00
Construction Supervision	DFO	20 days @ \$500	10,000.00
Construction supervision	NVOS	25 days @ \$300	7500.00
Labour: Landscaping / seeding	NVOS	10 days @ \$300	3000.00
Labour: Anchoring LWDs	NVOS	7 days @ \$300	2100.00
Labour: Site Documentation	NVOS	2 days @ \$300	600.00
Labour: Site Sketches, reports	NVOS	3 days @ \$300	900.00
Labour / materials: Intake valve	NVOS	3 day @ \$300	900.00
Rip rap rock	John Hunter Ltd		10,000.00
Labour: Accounting, copies etc.	NVOS	8 days @ \$300	2400.00
Total In-Kind Contributions		\$41,400.00	

•Appendix B: Recognition of BC Hydro Bridge Coastal Fish and Wildlife Restoration Program

- All publicity activities will be made in the name of the "BC Hydro Bridge Coastal Fish and Wildlife Restoration Program.
- Information regarding the project will be communicated to members of the Squamish / Lillooet River Watershed Society which include most of the groups in the area that are interested in fish and wildlife issues. NVOS was represented at the Water Use Plan Consultative Committee meetings.
- The North Vancouver Outdoor School produces a school newsletter, which goes out to a wide audience of staff, students, alumni and partners. This project has been included in that newsletter.
- Signage explaining the history of this project and the importance of protected channel habitats for salmonids, particularly chinook and pinks.

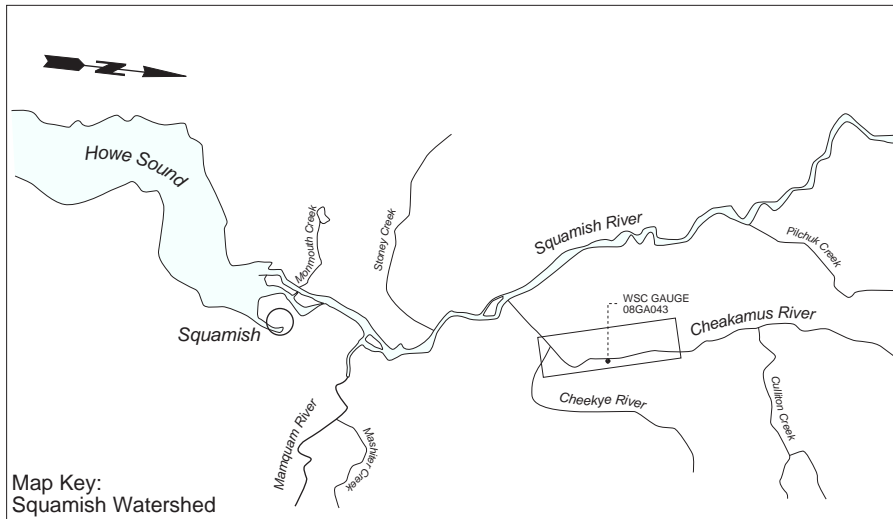
Appendix C: Project Documentation

(see attached files)

- Project locator
- Site plan (NVOS)
- Site plan (channel specific)
- Channel as-built drawings (5 sheets)
- Images (before, during and after construction)

Appendix D: Additional Information

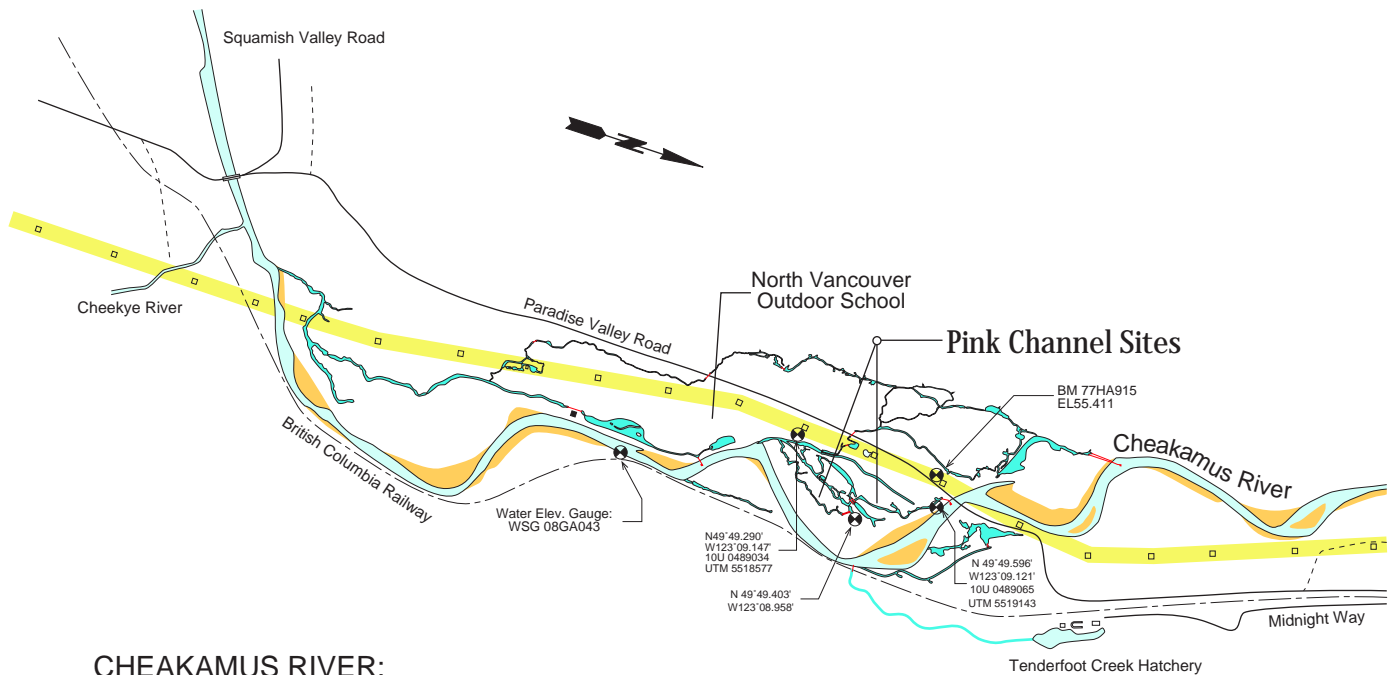
- October 2003 Flood Impacts
- Monitoring Report



Cheakamus Sidechannel Enhancement Gorbuscha Channels

(02.Ch.6) Phase 1 / (03.Ch.02) Phase 2

- Cheakamus River Habitats
- Off - channel Habitats
- River Bars (from flood plain mapping)
- BC Hydro transmission corridor
- BC Hydro transmission tower



CHEAKAMUS RIVER:
Cheekye River confluence - Midnight Way / BCR Crossing

Legend:

- Enhanced Aquatic Habitat
- Cheakamus River
- River bar
- Checkamus Side Channel Construction 2002
- Re-established habitat
- Interpretive Trail Sign
- Groundwater monitoring site
- Nature Conservancy Canada monitor site
- October 2003 flood flows
- Flood damaged berms

Project Summary:

03.Ch.02 excavations

Total project:

3225 m² new salmonid habitat

* additional "side" benefit:

800 m² flood damaged habitat re-established

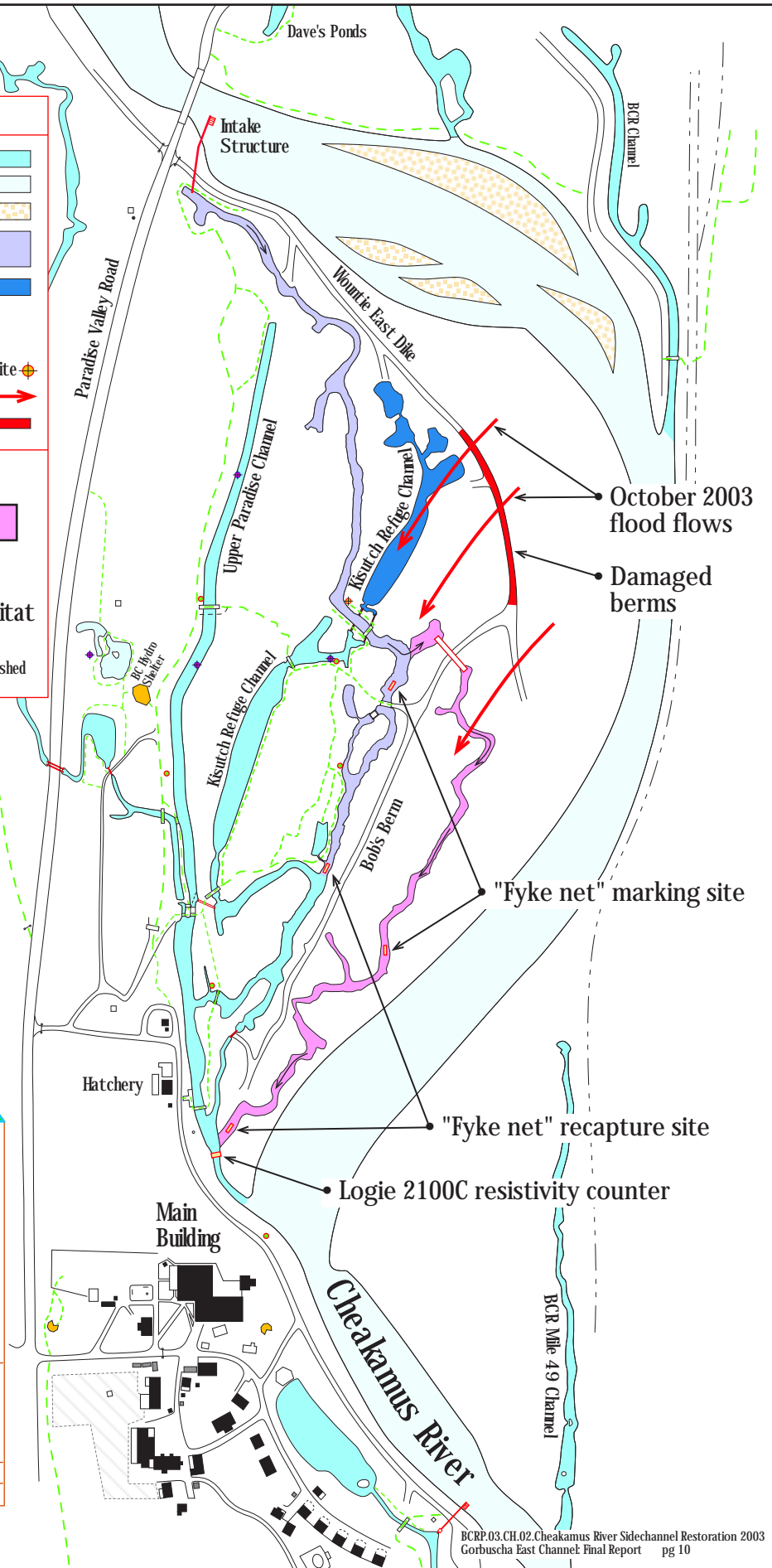


**North Vancouver
Outdoor School**
School District #44



**Cheakamus Sidechannel
Construction Project 2003
Site Plan
Project: 03.Ch.02**

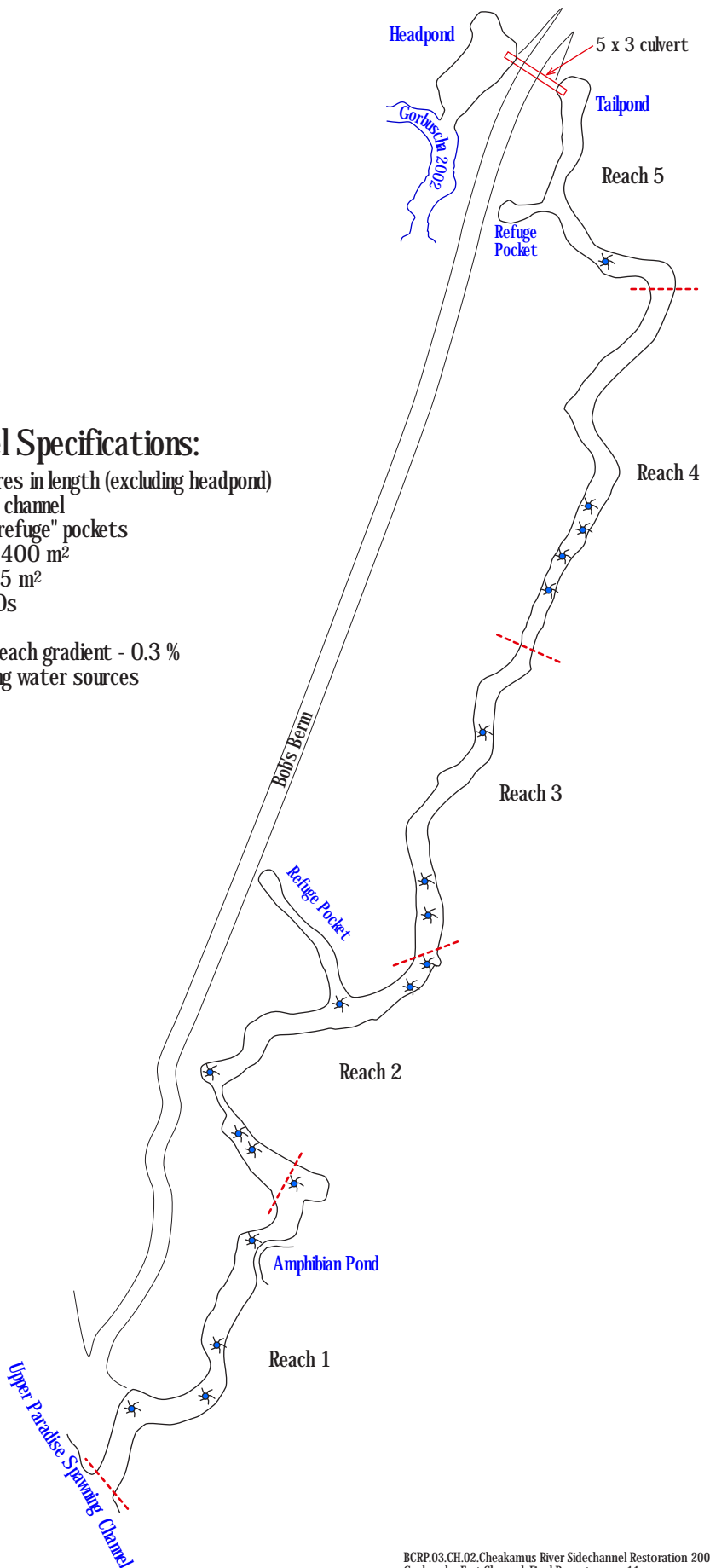
scale: drawing is representative only
chlvorson June 2, 2004



Channel Specifications:

478 metres in length (excluding headpond)
 2525 m² channel
 225 m² "refuge" pockets
 Headpond 400 m²
 Tailpond 75 m²
 170+ LWDs

Average reach gradient - 0.3 %
 ✧ Upwelling water sources



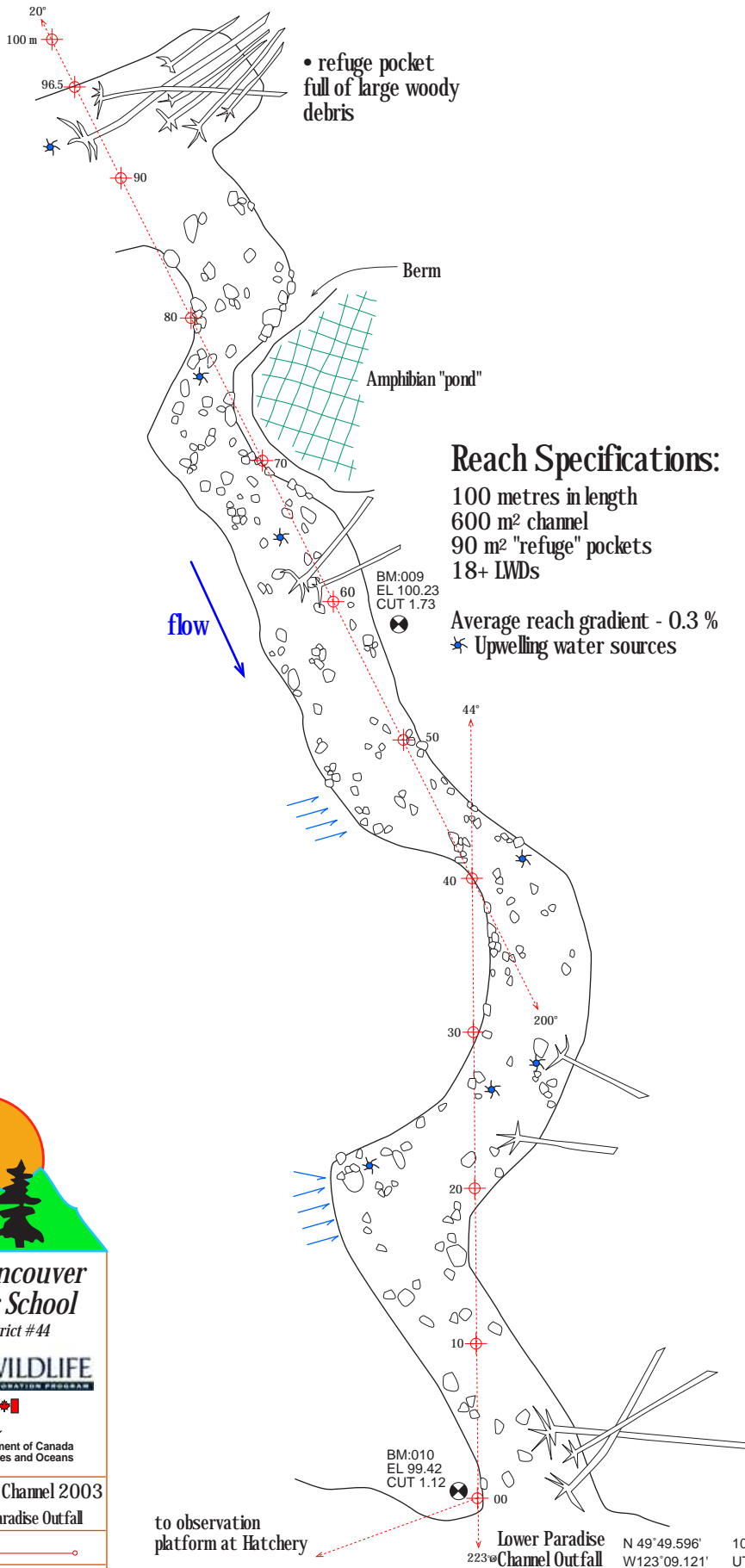
**North Vancouver
Outdoor School**
School District #44

BC HYDRO
FISH & WILDLIFE
BRIDGE COASTAL RESTORATION PROGRAM

Canada
Government of Canada
Fisheries and Oceans

**Cheakamus Side Channel 2003
Project Overview:**
scale: drawing is representative only

chahvorson 08.02.2003



Reach Specifications:

- 100 metres in length
- 600 m² channel
- 90 m² "refuge" pockets
- 18+ LWDs

Average reach gradient - 0.3 %
 * Upwelling water sources

North Vancouver Outdoor School
 School District #44

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 BRIDGE COASTAL RESTORATION PROGRAM

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 Fisheries and Oceans

Cheakamus Side Channel 2003
Reach #1: to Paradise Outfall

scale: one unit = 10 m

chavorson 06.23.2003

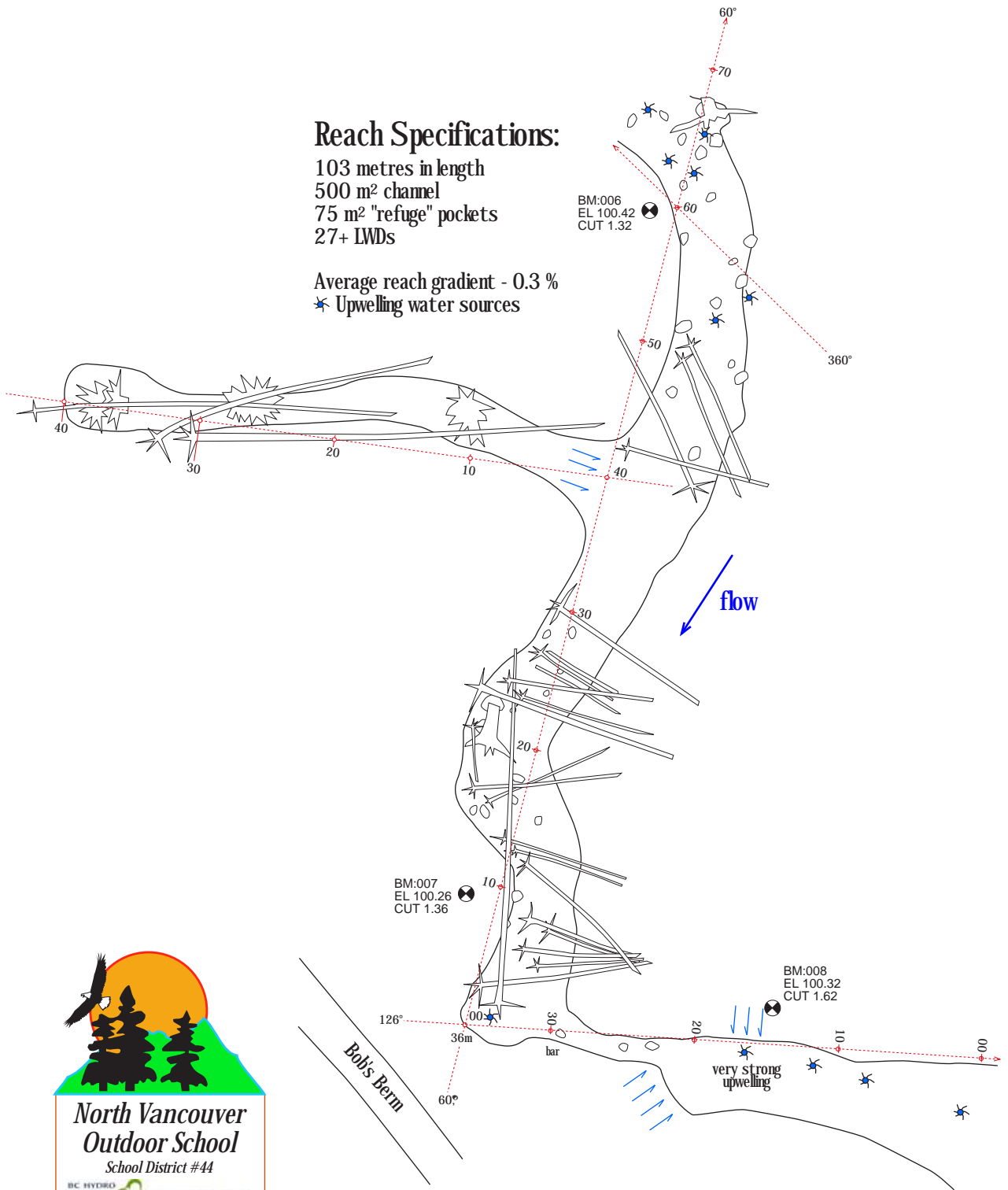
to observation platform at Hatchery

Lower Paradise Channel Outfall
 223°
 N 49°49.596' 10U 0489065
 W123°09.121' UTM 5519143

Reach Specifications:

103 metres in length
 500 m² channel
 75 m² "refuge" pockets
 27+ LWDS

Average reach gradient - 0.3 %
 * Upwelling water sources



**North Vancouver
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 School District #44

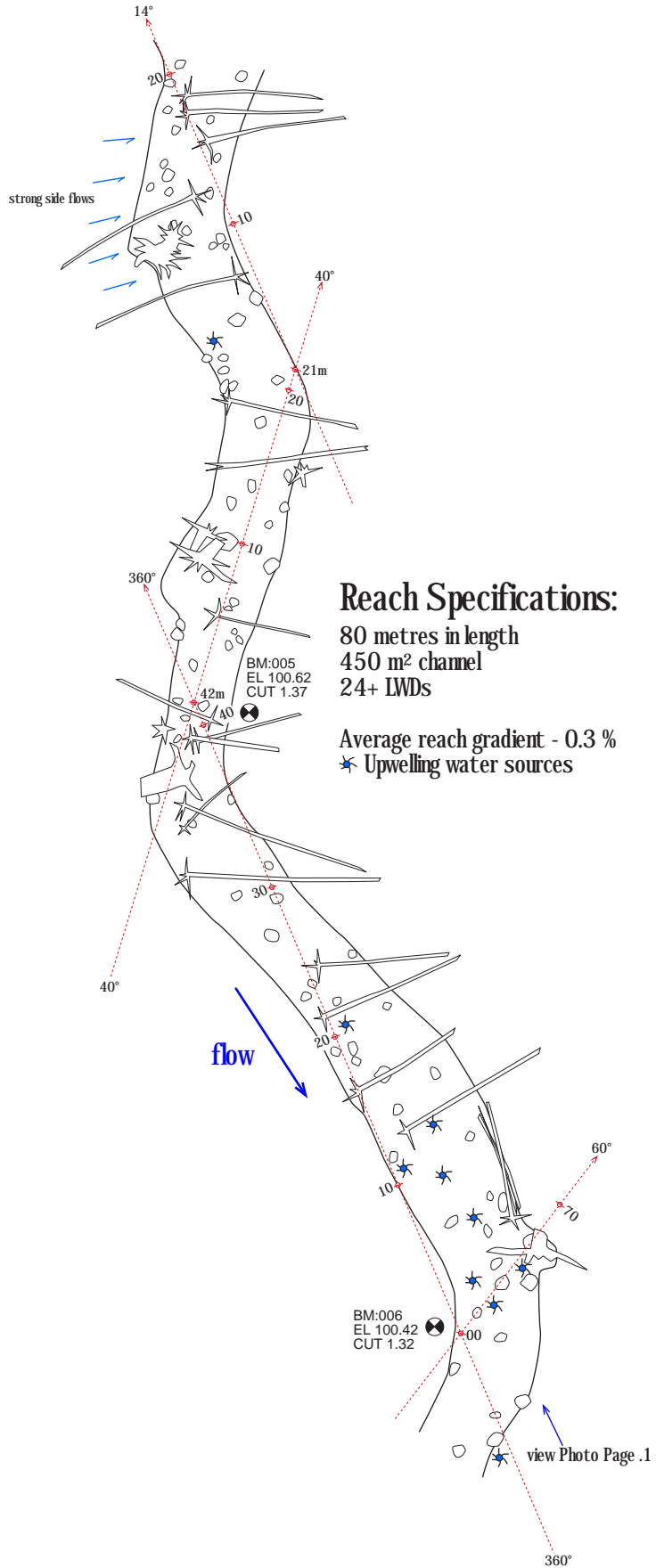


Canada
 Government of Canada
 Fisheries and Oceans

Cheakamus Side Channel 2003
 Reach #2:

scale: one unit = 10 m

chakorson 06.30.2003



Reach Specifications:

- 80 metres in length
- 450 m² channel
- 24+ LWDS

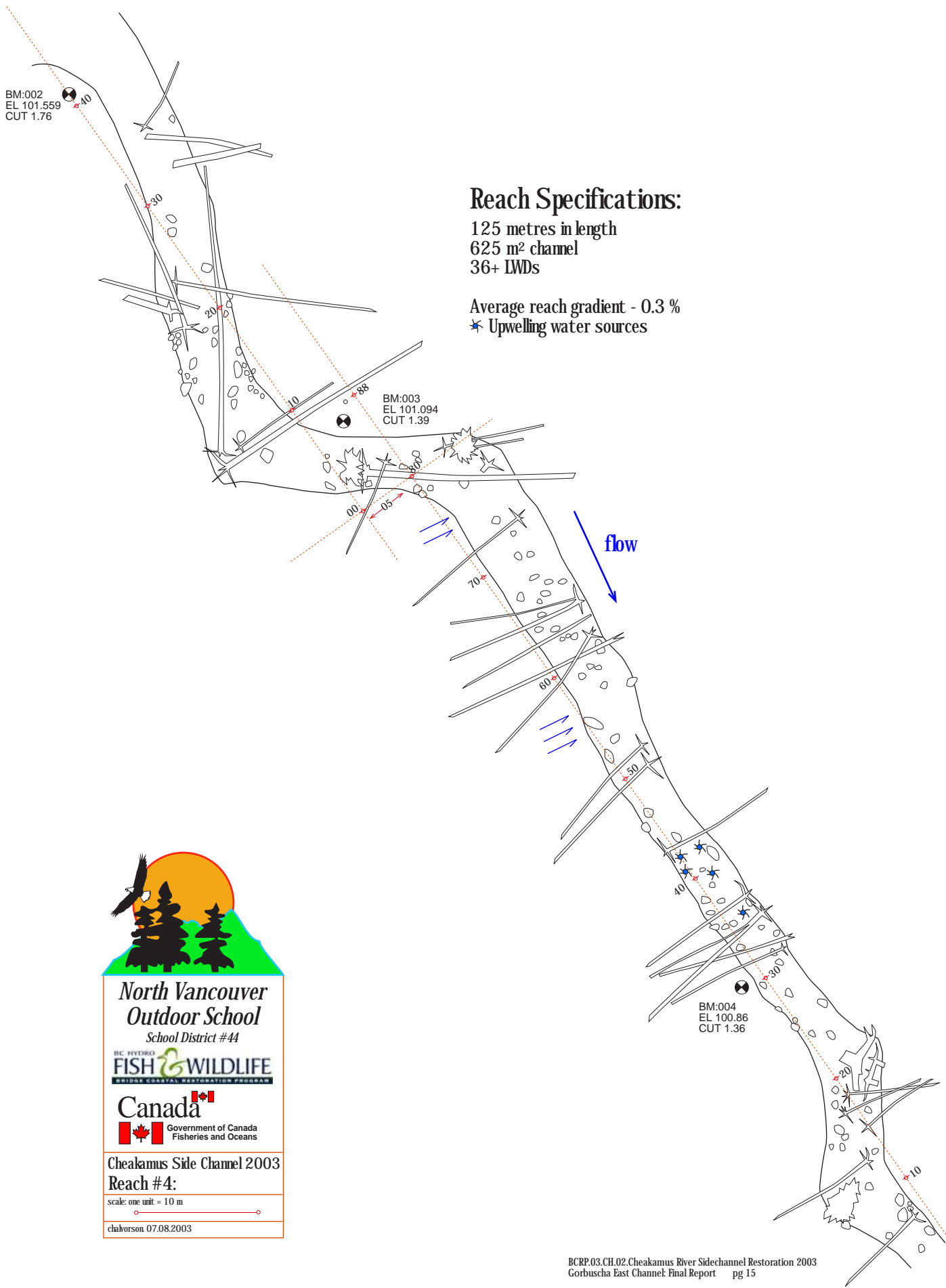
Average reach gradient - 0.3 %
 * Upwelling water sources

**North Vancouver
Outdoor School**
School District #44

BC HYDRO
FISH & WILDLIFE
BRIDGE-CASUAL RESTORATION PROGRAM

Canada
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**Cheakamus Side Channel 2003
Reach #3:**
scale: one unit = 10 m
chahorson 07.02.2003



Reach Specifications:

125 metres in length
 625 m² channel
 36+ LWDs

Average reach gradient - 0.3 %
 * Upwelling water sources

**North Vancouver
 Outdoor School**
 School District #44

BC HYDRO
FISH & WILDLIFE
 BRIDGE CHANNEL RESTORATION PROGRAM

Canada
 Government of Canada
 Fisheries and Oceans

**Cheakamus Side Channel 2003
 Reach #4:**
 scale: one unit = 10 m
 chahorson 07.08.2003

