

**SPAWNING AND REARING HABITAT ASSESSMENT IN LOWER
CLOWHOM RIVER**

BCRP PROJECT # 05.CL.01

Prepared for

BRIDGE COASTAL RESTORATION PROGRAM

Prepared by

SIGMA ENGINEERING LTD.

E6031 05.CL.01

Prepared with financial support of

**BC HYDRO BRIDGE COASTAL FISH AND WILDLIFE RESTORATION
PROGRAM**

Executive Summary

The Clowhom River (Watershed Code 900-178900) hydroelectric project is a 33 MW BC Hydro facility located on the Sunshine Coast. Before impoundment the Clowhom River emptied into the Upper and Lower Clowhom Lakes and a small pond before flowing over Clowhom Falls (Raphals, 2004). The project resulted in the loss of 350 m of mainstem channel and a small side channel between the dam and Salmon Inlet.

The purpose of this project was to investigate habitat conditions for fish stocks between Clowhom Dam and the Salmon Inlet and to identify potential habitat enhancement or compensation sites with hydraulic characteristics that would operate within the expected regulated regime of the Clowhom system.

No critical spawning or rearing habitat was found in the high gradient bedrock channel downstream of the dam. The site visit did not identify any potential mitigation measures: any habitat created would have to remain functional within the widely varying flows of the plant operating regime, from no instream flows other than dam seepage and tributary inflow, to spilling flows, which could potentially flush out any instream works and so would require on-going maintenance.

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INTRODUCTION

The Clowhom River (Watershed Code 900-178900) hydroelectric project is a 33 MW BC Hydro facility located on the Sunshine Coast. Before impoundment the Clowhom River emptied into the Upper and Lower Clowhom Lakes and a small pond before flowing over Clowhom Falls (Raphals, 2004). A 402 m long by 21 m high concrete gravity dam, initially constructed in 1952, impounds Lower Clowhom Lake. The plant usually runs continuously during the summer snowmelt period and fall storms; during the rest of the year it operates as a peaking plant (Consultative Committee Report, November 2003).

The project resulted in the loss of 350 m of mainstem channel and a small side channel between the dam and Salmon Inlet: the bypass reach below the dam is a bedrock and blasted rock channel that also acts as a spillway (Anon. 2000b). The side channel, flooded by the initial impoundment, may have contained spawning and rearing habitat and allowed coho and steelhead to ascend the falls (Raphals, 2004). FISS reports indicate that the Clowhom River is a major spawning location for chum salmon, however few fish were present during one undated survey by a DFO Fishery Officer (Appendix IV).

GOALS AND OBJECTIVES

One of the limiting factors identified in the Strategic Plan was reduced habitat capability below the dam due to reduced large woody debris (LWD) and gravel recruitment (Anon. 2000b). The purpose of this project was to address Fish Restoration Objective 3 of the Bridge Coastal Restoration Program Strategic Plan: investigate habitat conditions for fish stocks between Clowhom Dam and the Salmon Inlet. The Primary Objective of the project was to identify useable fish habitat below the dam and identify potential habitat enhancement or compensation sites with hydraulic characteristics that would operate within the expected regulated regime of the Clowhom system (Anon. 2000b). Enhancement initiatives would help to mitigate the loss of fish habitat from the original footprint impact of the project and could include gravel placement, habitat complexing and riparian vegetation restoration/planting.

STUDY AREA

The Clowhom project is located at the head of Salmon Inlet, approximately 32 km northeast of the town of Sechelt and 55 km northwest of Vancouver. The study area comprised the mainstem channel downstream of the dam (the

spillway, or bypass reach) and the riparian area along the left and right banks not located on private property (Figure 1).

METHODS

Sigma Engineering Ltd. assessed the amount, suitability and access to spawning and rearing habitat for fish at low flows in the lower reaches of the Clowhom River between the mouth and Clowhom Dam. For safety reasons, access was not allowed within the spillway, so fish habitat in the bypass reach was visually assessed from the left and right banks. Studies have indicated that the principal factors influencing the suitability of spawning and rearing habitat for salmonids include water velocity, depth and substrate composition (Keeley and Slaney, 1996). The riparian areas along the left and right bank were also assessed for existing side channels or potential locations of fish enhancement or compensation sites.

RESULTS

Access to and from the lower Clowhom River was from Squamish via helicopter on October 25, 2005. Air temperature was 12°C and skies were overcast. The plant operator provided a tour of the site and transportation up to the dam. According to the plant operator, cutthroat trout, kokanee salmon and stickleback are present in the lakes, and fish have been found in pools in the bypass reach when the dam is spilling.

Mainstem Habitat Assessment

Most of the bypass reach was dry at the time of the survey – the only water present in the channel was from a right bank tributary and from seepage through the spillway gates. A 1.5 to 2 m bedrock falls/cascade at the mouth would be passable to adult steelhead trout and coho salmon but would potentially be an obstacle to adult chum salmon at low flows (Photos 1&2).

In the lower ~150 m of the bypass reach, the channel is a moderate gradient (2-4%), bedrock controlled, cascade-pool channel (Photos 3&4). Rearing and spawning habitat are poor: boulders and deep pools provide only a moderate amount of instream cover for fry and juveniles (Photos 5 – 7) and spawning-sized gravel is present in small, isolated patches.

From ~150 to 250 m upstream of the mouth, gradient increases to 15-20%, ending in a 30-40% gradient, 25-30 m long bedrock cascade located ~100 m below the Interfor Bridge (Photos 8-10). Rearing habitat is poor in this section of the bypass reach due to the high gradient and lack of instream cover and pools, which could provide velocity refuges at higher flows. No

spawning gravel was seen. The cascade is potentially a velocity barrier at high flows for adult chum salmon.

Upstream of the cascade to the dam, the river is a wide (70-100 m), low-gradient (1-2%) bedrock channel. No spawning habitat exists and rearing habitat is poor: a few isolated pools and boulders provide poor to moderate amounts of cover (Photos 11-17). Again, spawning-sized gravel is present in only small, isolated patches.

No potential enhancement or compensation sites were noted during the survey: at high spillway flows any spawning gravel would be washed downstream, and ramping in the spillway could potentially strand fry and juveniles in isolated side pools along the stream edge. Since BC Hydro uses all the available inflow, within the storage, discharge and generation limits of the facilities and no instream fish flows were identified in the Water Use Plan (BC Hydro Project team and the Clowhom Water Use Plan Consultative Committee, 2003 & 2005), it is likely that large areas of the river will be dewatered during low summer flows.

Riparian Habitat Assessment

No side channels or potential enhancement or compensation sites were found within the riparian zone of the Clowhom River downstream of the dam.

The confined area between the lower river and penstock along the left bank would prevent excavation and blasting of a low gradient side channel. The plant operator noted that a creek along the right bank of the bypass reach downstream of the bridge contains fish spawning and rearing habitat, however this site could not be accessed at the mouth without entering into the spillway and is on private property outside of the riparian zone. The operator did not mention if fish have ever been seen using the tributary.

A small drainage, likely ephemeral, enters the Salmon Inlet ~70 m northeast of the powerhouse. The watercourse is a high gradient channel (~15% upstream of the logging road and 60% downstream), with morphology varying from a braided channel with alluvial substrate, to sections with no visible banks and overland flow, and a step-pool configuration (Photos 18&19). Near the mouth of the creek, the water seeps over a 2 m high vertical bedrock wall before flowing southeast along the roadside ditch and passing through a culvert into the Salmon Inlet (Photo 20). No enhancement or compensation sites were identified in this creek due to its high gradient and likely ephemeral nature.

DISCUSSION

Lack of gravel recruitment, high flushing flows during spill events, grading and scarification of gravels, and extremely low flows during peaking operations have potentially impacted any spawning habitat that may have existed downstream of Clowhom Falls prior to construction of the hydro project. Rearing habitat for salmonids has likely been altered by a lack of LWD recruitment and retention, a lack of riparian vegetation, and rapid changes in flows from low flows during peaking operations to high flushing flow during spill events.

Mitigation for reduced coarse sediment supply could involve supplying coarse sediment from other sources at convenient sites along the river. Mitigation for the loss of side channel habitat might involve constructing side channels with appropriately sized intakes from the main river and appropriate bed material for rearing and spawning. However, it is likely that little spawning or rearing habitat existed in the bedrock channel below the falls prior to construction of the hydro project.

No critical habitats that sustain present stocks or potential habitat development sites were identified in the bypass reach between Clowhom Dam and Salmon Inlet. The Clowhom Water Use Plan does not contain any provisions for instream flow releases (BC Hydro Project team and the Clowhom Water Use Plan Consultative Committee 2005.), so any enhancement or compensation sites would have to rely on seepage from the dam or from tributary inflow to remain wetted. Any enhancement or compensation works would also require maintenance after high spill events (defined as flows greater than 600 m³/s), although under the proposed operating alternative, high flow events will occur less often (on average every 4.6 years rather than the current interval of 3.4 years) (BC Hydro Project team and the Clowhom Water Use Plan Consultative Committee 2003). One of the impacts of the dam noted in the Strategic Plan was reduced LWD and gravel recruitment to side channel habitats reported downstream (Anon. 2000b). The side channel that may have allowed coho and steelhead to ascend the Clowhom Falls and contained spawning and rearing habitat was flooded by the initial impoundment (Raphals, 2004): no other side channels were found during this site survey.

RECOMMENDATIONS

The site visit did not identify any potential project opportunities to develop prescriptions for fish habitat conservation and improvement. Any proposed works would have to function within the plant operating regime and require

low maintenance. The lack of instream flow release, in addition to the reduced LWD and gravel recruitment, has reduced downstream habitat capability: since no instream flow release was recommended within the WUP, any habitat created would have to rely on seepage from the dam and tributary inflow to remain wetted and functioning. High flows during spill events have the potential to flush out gravel placement, so continual monitoring and maintenance would be required.

ACKNOWLEDGEMENTS

This project was completed with the financial support of BC Hydro Bridge Coastal Fish and Wildlife Restoration Program.

REFERENCES

- Anon. 2000a. Bridge-Coastal Fish and Wildlife Restoration Program STRATEGIC PLAN Volume 1: Strategy and Overview.
- Anon. 2000b. Bridge-Coastal Fish and Wildlife Restoration Program STRATEGIC PLAN Volume 2: Watershed Plan Chapter 14 Clowhom River Watershed.
- BC Hydro Project team and the Clowhom Water Use Plan Consultative Committee. November 2003. Consultative Committee Report. Clowhom Water Use Plan.
- BC Hydro Project team and the Clowhom Water Use Plan Consultative Committee. April 2005. Clowhom Water Use Plan Revised for Acceptance by the Comptroller of Water Rights.
- Keeley, E.R. and P.A. Slaney. 1996. Quantitative measures of rearing and spawning habitat characteristics for stream-dwelling salmonids: Guidelines for habitat restoration. Watershed Restoration Project Report No. 4. Watershed Restoration Program. Ministry of Environment, Lands and Parks and Ministry of Forests.
- Raphals, P. 2004. Seeding Green Power: Community Pilot Project To Develop an International Green Standard For Small-Scale Hydropower. Final Report. Prepared for the Low Impact Hydropower Institute

Appendix I

Financial Statement

Project # _____

Financial Statement Form

	BUDGET		ACTUAL	
	BCRP	Other	BCRP	Other
INCOME				
<i>Total Income by Source</i>				
Grand Total Income (BCRP + other)				
EXPENSES				
Project Personnel				
Wages				
Consultant Fees <i>(List others as required)</i>				
Materials & Equipment				
Equipment Rental				
Materials Purchased				
Travel Expenses				
Permits <i>(List others as required)</i>				
Administration				
Office Supplies				
Photocopies & printing				
Postage <i>(List others as required)</i>				
Total Expenses				
Grand Total Expenses (BCRP + other)				
BALANCE (Grand Total Income – Grand Total Expenses)				
	<i>The budget balance should equal \$0</i>		<i>The actual balance might not equal \$0*</i>	

* Any unspent BCRP financial contribution to be returned to: BC Hydro, BCRP
 6911 Southpoint Drive (E14)
 Burnaby, B.C. V3N 4X8
 ATTENTION: JANICE DOANE

SIGMA ENGINEERING LTD.
1444 Alberni Street, 4th Floor
Vancouver, B.C., V6G 2Z4
GST# R104852421

STATEMENT

January 5, 2006

Here is our Statement from: **October 2005 - December 2005**

JOB # E6031 B

PROJECT # 05.CI.01

BC HYDRO
Bridge Coastal Restoration Program
6911 Southpoint Drive
Burnaby, BC
V3N 4X8

Re: Bridge Coastal - Clowhom River

PERSONNEL

			<u>HOURS</u>	<u>RATE</u>	<u>AMOUNT</u>
Oct-05					
	S. Eagen	Biologist	14.5	72.00	1,044.00
Dec-05					
	G. S. McDonnell	Manager	1.5	127.00	190.50
	S. Eagen	Biologist	20.5	72.00	1,476.00
			<hr/>		<hr/>
			36.5		\$2,710.50

EXPENSES

Oct-05	Telus	0.81			
Nov-05	Omega Avitation	1,200.00			
	Western Bioaquatic Consulting	606.08			
	Telus	0.19			
Dec-05	Novex Courier	10.22			
	Photocopies	13.50			
	CD data envelope	5.34			
		<hr/>			
		\$1,836.14	x	1.05	1,927.95

TOTAL PERSONNEL AND OTHER EXPENSES

 \$4,638.45

GOODS & SERVICES TAX @ 7%

 318.94

TOTAL BILLING

 \$4,957.39

LESS PREPAYMENT RECEIVED ON APRIL 26, 2005 (4,958.00)

Underbudget

 (\$0.61)

SIGMA ENGINEERING LTD
1444 Alberni Street, Suite 400
Vancouver, BC V6G 2Z4
Telephone: (604) 688-8271

INVOICE NO: CR6131 B

GST# R104852421

Here is our invoice for: **October 2005**

Job: E6031 B
Project # 05.CI.01

BC Hydro
6911 Southpoint Drive
Burnaby, BC
V3N 4X8

Re: Bridge Coastal - Clowhom River

<u>PERSONNEL</u>		<u>HOURS</u>	<u>RATE</u>	<u>AMOUNT</u>
S. Eagen	Biologist	14.5	72.00	1,044.00
TOTAL PERSONNEL				\$1,044.00
 <u>EXPENSES</u>				
Telus		0.81		
		<u>0.81</u>	x 1.05	\$0.85
TOTAL PERSONNEL AND OTHER EXPENSES				\$1,044.85
GOODS AND SERVICES TAX @ 7%				\$73.14
TOTAL BILLING				\$1,117.99
ADVANCED PAYMENT BALANCE				(\$4,958.00)
CREDIT BALANCE				(\$3,840.01)
(PLEASE DO NOT PAY)				

TERMS: NET 30 DAYS
INTEREST ON OVERDUE ACCOUNTS MAY BE CHARGED AT 1.5% PER MONTH
EQUIVALENT TO 19.56% PER ANNUM



ACCOUNT BILLING CONTROL REPORT
 Long Distance Summary by Account

Account	Total Calls	Total Minutes	Full Charges	Discounted Charges	Taxes	Total
20100	6	3:24	2.84	✓0.29✓	0.04✓	0.33
206053- BECHTEL	21	599:36	366.80	✓71.60✓	10.02✓	81.62
20653- BECHTEL	34	90:18	41.42	✓9.03✓	1.26✓	10.29
21004	5	10:54	6.24	✓0.88✓	0.12✓	1.00
21005	9	10:30	7.68	✓0.96✓	0.13✓	1.09
21011	7	13:54	7.00	✓1.11✓	0.15✓	1.26
26043- BECHTEL	1	3:36	2.96	✓0.58✓	0.08✓	0.66
26053- BECHTEL	548	3345:00	1850.45	✓371.52✓	52.01✓	423.53
31568- BECHTEL	1	97:54	21.56	✓9.79✓	1.37✓	11.16
4006- KPL	7	56:06	19.84	✓4.56✓	0.63	5.19
40100	3	37:48	17.60	✓3.03✓	0.42✓	3.45
40111	1	23:18	7.20	✓1.86✓	0.26	2.12
40598 ⁴¹⁰⁰⁰	1	2:06	0.81	✓0.17✓	0.02✓	0.19
406075	9	134:54	255.76	✓79.62✓	11.14	90.76
41000	22	103:06	49.02	✓8.95✓	1.25	10.20
41005	3	4:06	1.55	✓0.32✓	0.04	0.36
43059	2	7:42	2.64	✓0.61✓	0.08	0.69
44006	1	0:30	0.56	✓0.05✓	0.00	0.05
44007 ⁴¹⁰⁰⁰	1	1:06	0.60	✓0.09✓	0.01	0.10
45928	38	131:54	69.14	✓10.96✓	1.53	12.49
45983-41000	1	0:30	0.48	✓0.04✓	0.00	0.04
45984	2	2:06	1.23	✓0.16✓	0.02	0.18
46023	1	2:54	0.99	✓0.23✓	0.03	0.26
46031	4	9:24	3.72	✓0.76✓	0.10	0.86
46075	130	429:30	172.55	✓36.12✓	5.05	41.17
46134	3	74:18	26.25	✓5.94✓	0.83	6.77
46142	11	56:24	21.02	✓4.52✓	0.63	5.15
46152	1	10:06	3.85	✓0.81✓	0.11	0.92
46156	1	13:06	6.72	✓1.05✓	0.14	1.19
50100 ⁵¹⁰⁰⁰	1	0:36	0.27	✓0.05✓	0.00	0.05
502007	10	19:24	13.40	✓1.94✓	0.27	2.21
503059	4	14:30	6.66	✓1.26✓	0.17	1.43
503100	5	5:12	2.94	✓0.42✓	0.05	0.47
50401-51000	1	0:42	0.29	✓0.06✓	0.00	0.06
51000	1	0:30	0.31	✓0.04✓	0.00	0.04
52002	1	9:18	5.40	✓0.93✓	0.13	1.06
52007	1	2:30	1.68	✓0.25✓	0.03	0.28
53048 ⁵³¹⁰¹	2	1:06	0.54	✓0.09✓	0.01	0.10
53058	1	3:12	1.32	✓0.26✓	0.03	0.29
53059	2	2:24	0.99	✓0.19✓	0.02	0.21
53060	5	18:00	6.18	✓1.44✓	0.20	1.64
53100	1	1:00	0.29	✓0.08✓	0.01	0.09
53101	7	22:42	7.88	✓1.81✓	0.25	2.06
54006	1	1:54	0.68	✓0.15✓	0.02	0.17
56053- BECHTEL	1	0:54	0.54	✓0.09✓	0.01✓	0.10

SIGMA ENGINEERING LTD
1444 Alberni Street, Suite 400
Vancouver, BC V6G 2Z4
Telephone: (604) 688-8271

INVOICE NO: CR6131 B

GST# R104852421

Here is our invoice for: **November 2005**

Job: E6031 B
Project # 05.CI.01

BC Hydro
6911 Southpoint Drive
Burnaby, BC
V3N 4X8

Re: Bridge Coastal - Clowhom River

<u>PERSONNEL</u>	<u>HOURS</u>	<u>RATE</u>	<u>AMOUNT</u>
		TOTAL PERSONNEL	<u>\$0.00</u>
 <u>EXPENSES</u>			
Omega Avitation	1,200.00		
Western Bioaquatic Consulting	606.08		
Telus	0.19		
	<u>1806.27</u>	x 1.05	\$1,896.58
TOTAL PERSONNEL AND OTHER EXPENSES			\$1,896.58
GOODS AND SERVICES TAX @ 7%			\$127.02
TOTAL BILLING			<u><u>\$2,023.60</u></u>
ADVANCED PAYMENT BALANCE			(\$3,840.01)
CREDIT BALANCE (PLEASE DO NOT PAY)			(\$1,816.41)

TERMS: NET 30 DAYS
INTEREST ON OVERDUE ACCOUNTS MAY BE CHARGED AT 1.5% PER MONTH
EQUIVALENT TO 19.56% PER ANNUM



ok to pay
E6031 05. CL. 01

FLIGHT REPORT

4360 Agar Drive, Richmond, BC, V7B 1A3
Tel: 604 273 5311 Fax: 604 273 8991
Squamish: 604 898 1067
GST REG No. 89422 0383 RT

No 2099

RECEIVED NOV 14 2005

CUSTOMER NAME <u>Sigma Engineering</u>		DATE <u>Oct. 25/05</u>
ADDRESS <u>1444 Alberni St. 4th Floor</u>		
<u>Vancouver B.C. V6G 2Z4</u>		TELEPHONE <u>604-688-8271</u>
A/C TYPE <u>BH206B</u>	<u>C-GHMH</u>	BASE OF OPERATIONS <u>Squamish</u>

ITINERARY	START	STOP	TOTAL
<u>CYSE → 2 pay to (clowhom)</u>	<u>0900</u>	<u>0938</u>	<u>0.6</u>
<u>→ CYSE</u>			
<u>E6031</u>			
<u>CYSE → P0.2 pay Clowhom</u>	<u>1312</u>		
<u>→ CYSE</u>			
G/L Acct: <u>5290 = 1200.00</u> Description:		<u>1349</u>	<u>0.6</u>
		<u>TOTAL</u>	<u>1.2</u>
GST # 1605: <u>84.00</u> Entered: <u>\$1,284.00</u>			
Rec'd By	Checked	Authorized by / Date	
<u>[Signature]</u>	<u>[Signature]</u>	<u>Nov 25/05</u>	

RATE	<u>1.2</u>	HOURS @ \$	<u>875</u>			
FUEL CHARGE	<u>1.2</u>	HOURS @ \$	<u>125</u>		<u>1050.00</u>	
LANDING FEES					<u>150.00</u>	
OTHER CHARGES						
PURCHASE ORDER NUMBER				SUB TOTAL	<u>1200.00</u>	
TERMS: DUE ON RECEIPT. A service charge of 2% per month / 24% per annum will be charged on all overdue accounts. This flight report is expressly subject to terms and conditions printed on reverse and which are hereby accepted. Any applicable Provincial or Federal tax is due and payable by the customer.					GST	<u>84.00</u>
					AMOUNT DUE	<u>1284.00</u>

CUSTOMER Stephanie Eagen
Print Name

X
Signature

PILOT N. Dubek
Print Name

X
Signature

WHITE: INVOICE

CANARY: CUSTOMER

PINK: ACCOUNTING

GREEN: OPERATIONS

GOLD: BOOK



- INVOICE -

Western BioAquatic Consulting
1153 Esperanza Drive,
Coquitlam, BC V3B 6A6
(604) 941-5003

DATE: 28-Oct-05

INVOICE No.: 190-05
OUR FILE: 2005-019
YOUR FILE: E6031-05.CL.01

TO: SIGMA ENGINEERING LTD
400 - 1444 ALBERNI STREET,
VANCOUVER, BC
V6G 2Z4

RE: FISHERIES HABITAT POTENTIAL SURVEY: CLOWHOM RIVER TAILRACE

*okay to pay
S. Zagon.*

PROFESSIONAL CHARGES

ITEM	EMPLOYEE	RATE (\$/HR)	TIME (HRS)	TOTAL
1	JOHN RITHALER, R.P.BIO <i>FIELD</i>	\$ 65.50	8.00	\$ 524.00 ✓
TOTAL PROFESSIONAL:				\$ 524.00 ✓
<u>DISBURSEMENTS</u>				
1	MILEAGE	\$ 0.38	216 KM	\$ 82.08 ✓
TOTAL DISBURSEMENTS				\$ 82.08 ✓
SUBTOTAL				\$ 606.08 ✓
GST:				\$ 36.68 ✓
TOTAL				\$ 642.76 ✓

ENTERED NOV 18 2005

E6031

Job # 5250 = 606.08

G/L Acct: _____

Description: _____

GST # 1006: = 36.68

Entered: = \$ 642.76

Rec'd By	Coding	Authorized by / Date
<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>

SYNEX GROUP
NOV 28 2005
PAID

GST#: 86622 5071RT

Invoice due and payable 30 days from receipt



ACCOUNT BILLING CONTROL REPORT
 Long Distance Summary by Account

Account	Total Calls	Total Minutes	Full Charges	Discounted Charges	Taxes	Total
20100	1	0:36	0.48	0.05✓	0.00	0.05
20605 (BECHTEL)	36	869:36	647.26	153.69✓	21.51	175.20
21005✓	6	5:54	4.32	0.47✓	0.06	0.53
21011✓	14	107:30	46.35	8.82✓	1.23	10.05
26033 (BECHTEL)	1	0:30	0.56	0.05✓	0.00	0.05
26052 (BECHTEL)	1	67:18	37.40	6.73✓	0.94	7.67
26053	176	2827:12	1560.74	280.85✓	39.31	320.16
26054 } BECHTEL	1	0:30	0.56	0.05✓	0.00	0.05
26059 } BECHTEL	1	0:30	0.56	0.05✓	0.00	0.05
26073 } BECHTEL	1	0:54	0.54	0.09✓	0.01	0.10
30400 } BECHTEL	1	6:54	3.22	0.55✓	0.07	0.62
40100✓	1	2:48	1.05	0.22✓	0.03	0.25
40601-41000	1	2:54	0.93	0.23✓	0.03	0.26
← 40607-46075 (PT. ALBERNI)	4	75:24	138.96	43.46✓	6.08	49.54
40615-41000	1	1:12	0.70	0.10✓	0.01	0.11
41000✓	14	44:30	17.66	3.58✓	0.50	4.08
45515✓	2	1:48	1.02	0.14✓	0.01	0.15
45928✓-H1005	1	1:24	0.92	0.11✓	0.01	0.12
46031✓	1	2:18	0.81	0.18✓	0.02	0.20
46075✓	140	348:24	146.93	29.71✓	4.15	33.86
46095✓	1	5:36	2.76	0.45✓	0.06	0.51
46107✓	1	12:24	3.90	0.99✓	0.13	1.12
46134✓	3	21:12	8.05	1.70✓	0.23	1.93
46142✓	13	154:24	61.28	12.37✓	1.73	14.10
46152✓	4	13:24	5.20	1.08✓	0.15	1.23
46156✓	8	76:06	37.27	6.09✓	0.85	6.94
46160✓	1	3:24	1.20	0.27✓	0.03	0.30
46161✓	16	42:36	22.86	3.41✓	0.47	3.88
46752-41000-WLANS LK.	1	2:12	1.05	0.18✓	0.02	0.20
50260- (BECHTEL)	1	203:54	112.20	20.39✓	2.85	23.24
50305-51000	3	2:42	1.18	0.22✓	0.03	0.25
50310-53101	2	2:36	1.33	0.21✓	0.02	0.23
50400-51000	1	0:30	0.30	0.04✓	0.00	0.04
50401-51000	2	5:30	1.80	0.44✓	0.06	0.50
50605 (BECHTEL)	1	0:30	0.54	0.05✓	0.00	0.05
4506075- PT. ALBERNI-SEL	1	4:54	1.55	0.39✓	0.05	0.44
50615-51000	1	0:48	0.35	0.06✓	0.00	0.06
53057✓	1	4:30	1.50	0.36✓	0.05	0.41
53058✓ (3101)	4	17:42	5.51	1.42✓	0.19	1.61
53059✓	10	22:36	9.51	1.81✓	0.25	2.06
53060✓	13	71:06	25.11	5.69✓	0.79	6.48
53069✓	1	0:36	0.29	0.05✓	0.00	0.05
53100✓	3	22:06	5.97	1.77✓	0.24	2.01
53101✓	11	18:54	8.18	1.58✓	0.22	1.80
684006- KPL	5	38:24	16.80	3.38✓	0.47	3.85

SIGMA ENGINEERING LTD
1444 Alberni Street, Suite 400
Vancouver, BC V6G 2Z4
Telephone: (604) 688-8271

INVOICE NO: CR6131 B

GST# R104852421

Here is our invoice for: **December 2005**

Job: E6031 B
Project # 05.CI.01

BC Hydro
6911 Southpoint Drive
Burnaby, BC
V3N 4X8

Re: Bridge Coastal - Clowhom River

<u>PERSONNEL</u>		<u>HOURS</u>	<u>RATE</u>	<u>AMOUNT</u>
G. S. McDonnell	Manager	1.5	127.00	190.50
S. Eagen	Biologist	20.5	72.00	1,476.00
			TOTAL PERSONNEL	\$1,666.50
 <u>EXPENSES</u>				
Novex Courier		10.22		
Photocopies		13.50		
CD data envelop		5.34		
		<u>29.06</u>	x 1.05	\$30.51
TOTAL PERSONNEL AND OTHER EXPENSES				\$1,697.01
GOODS AND SERVICES TAX @ 7%				\$118.79
TOTAL BILLING				\$1,815.80
ADVANCED PAYMENT BALANCE				(\$1,816.41)
CREDIT BALANCE				(\$0.61)
(PLEASE DO NOT PAY)				

TERMS: NET 30 DAYS
INTEREST ON OVERDUE ACCOUNTS MAY BE CHARGED AT 1.5% PER MONTH
EQUIVALENT TO 19.56% PER ANNUM



NEW ORDER

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1-877-566-6839

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PICK UP

SYNEX INTERNATIONAL INC
 1444 ALBERNI ST, Unit 400
 Vancouver, BC V6G2Z4
 CAN
No Contact Specified
 P:
 F:
 E:

DELIVER TO

BC HYDRO
 6911 SOUTHPOINT DR, Unit B03
 Burnaby, BC V3N4X8
 CAN
No Contact Specified
 P:
 F:
 E:

Order Information							
Pick Up Date:	1/5/2006	Ready Time:	11:00	Service:	4-REG	Vehicle:	CAR
Delivery Date:	1/5/2006	Deliver By:	15:00				
Weight:	5 Lbs	Reference:	E6031 B				
Ordered By:	BILLY	Department:					

Packages
ENV 1

Comments:

Charges	
Subtotal:	\$10.22
GST (7%):	\$0.72
Total:	\$10.94

To **CLEAR** this order, click on *New Order* at the top of this page
 To **EDIT** this order, click on *Previous* at the bottom of this page
 To enter a return trip click on **RETURN TRIP**, and on the second half,
 click on *Complete* at the bottom of this page

** Please note that SuperHot service is delivered as fast as possible. Delivery times will vary between 1 and 1.5 hours depending on distance, traffic and weather conditions. **

[Previous](#) [Complete](#) [Return Trip](#)

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**Photocopies
December 2005**

<u>Dept/acct.</u>	<u># of copies</u>	<u># of pages</u>	<u>Amount</u>
401000	1		
401000	2		
401000	17		
401000	25		
401000	309		
401000 Total	354		
401005	1		
401005	23		
401005	173		
401005	230		
401005 Total	427		
40602099	26		
40602099	164		
40602099 Total	190		
406031B	90		
406031B Total	90		
Sigma Engineering Ltd.		1061	159.15

Vendor Number

0000502073

Sigma Engineering Ltd.

Check Date: 22.Apr.2005

Check No. 311283

INVOICE NUMBER	AMOUNT	DISCOUNT	NET AMOUNT
P001729 PROJECT # 05.CL.01	4,958.00 (PE6031) <i>B - Clowhorn River</i>	0.00	4,958.00 ✓
P001731 PROJECT # 05.BR.01	4,977.00 (PE6031) <i>A - Downton Reservoir Bridge Coastal</i>	0.00	4,977.00 ✓

RECEIVED APR 26 2005

INVOICE NUMBER	AMOUNT	DISCOUNT	NET AMOUNT
P001729 PROJECT # 05.CL.01	4,958.00 (PE6031)	0.00	4,958.00
P001731 PROJECT # 05.BR.01	4,977.00 (PE6031) <i>Bridge Coastal</i>	0.00	4,977.00

RECEIVED APR 26 2005

Apr 28 05

Prepaid INVOICE

PE6031

June/July/Aug.

G/L # was 3150

*Keep an eye for
the invoice of
PE6031*

\$9,935.00

\$0.00

\$9,935.00

TOTALS

Appendix II

Performance Measures/
Actual Outcomes

Performance Measures

Using the performance measures applicable to your project, please indicate the amount of habitat actually restored/enhanced for each of the specified areas (e.g. riparian, tributary, mainstream).

Performance Measures – Target Outcomes										
Project Type	Primary Habitat Benefit Targeted of Project (m ²)	Primary Target Species	Habitat (m ²)							
			Estuarine	In-Stream Habitat – Mainstream	In-stream Habitat – Tributary	Riparian	Reservoir Shoreline Complexes	Riverine	Lowland Deciduous	Lowland Coniferous
Impact Mitigation										
Fish passage technologies	Area of habitat made available to target species									
Drawdown zone revegetation/stabilization	Area turned into productive habitat									
Wildlife migration improvement	Area of habitat made available to target species									
Prevention of drowning of nests, nestlings	Area of wetland habitat created outside expected flood level (1:10 year)									
Habitat Conservation										
Habitat conserved – general	Functional habitat conserved/replaced through acquisition and mgmt									
	Functional habitat conserved by other measures (e.g. riprapping)									
Designated rare/special habitat	Rare/special habitat protected									
Maintain or Restore Habitat forming process										
Artificial gravel recruitment	Area of stream habitat improved by gravel plmt.									
Artificial wood debris recruitment	Area of stream habitat improved by LWD plcmt									
Small-scale complexing in existing habitats	Area increase in functional habitat through complexing									
Prescribed burns or other upland habitat enhancement for wildlife	Functional area of habitat improved									
Habitat Development										
New Habitat created	Functional area created									

Appendix III

FISS Report

FISS Report

Gazetted Name : CLOWHOM RIVER
Watershed Code : 900-178900
Waterbody Identifier : 00000JERV
Region : 2
Alias :
Type : **S**
Report created on : [Wed Oct 05 13:17:29 PDT 2005](#)

Water Quality Stations

No records found

Water Survey Stations

Station ID	Geo Ref 1	Geo Ref 2
08GB013	P 092G14 296	

Management Objectives

Habitat Type	Objective 1	Objective 2
Anadromous River		

Enhancement

Activity	Start Year	Finish Year	Species Name	Comments	Reference Number	Geo Ref 1	Geo Ref 2
110 Water Quality and Quantity	2000			(WATER SURVEY OF CANADA STATION.)	WSCANDB	P 092G14 296	

Harvests and Uses

No records found

Resource Use

No records found

Resource Values

No records found

Resource Sensitivities

No records found

Land Use

Description	Comments	Reference Number	Geo Ref 1	Geo Ref 2
Forestry	ACTIVE LOGGING IN WATERSHED	16-2	W 265533	

Fisheries Potentials and Constraints

No records found

Obstructions

Description	Height	Length	Comments	Species Name	Reference Number	Geo Ref 1	Geo Ref 2
Dam	0	0	BC HYDRO DAM BUILT IN 1954		13-35	P 092G12 79	

Escapements

No records found

Fish Distributions

Species Name	Stock / Stock Type	Stock Char	Management Class	Activity	Comments	Refs And Dates	Geo Ref 1	Geo Ref 2
Chum Salmon	/ NOT SPECIF	Anadromous	Not Specified	SPM Major spawning location	FEW PRESENT, SPAWNING IN LOWER 0.2 KM	(16-2, no date) 	U 092G12 78	
Cutthroat Trout	/ NOT SPECIF	Not Specif	Not Specified	OBL Fish observed at this point or zone		(SISSM01, 01-JAN-1995) 	W 265533	
Dolly Varden	/ NOT SPECIF	Not Specif	Not Specified	OBL Fish observed at this point or zone		(SISSM01, 01-JAN-1995) 	W 265533	
Steelhead	/ NOT SPECIF	Not Specif	Not Specified	OBL Fish observed at this point or zone		(SISSM01, 01-JAN-1995) 	W 265533	

Species and Life Phase History

No records found

Fiss References

Search AquaCat for keywords: [CLOWHOM RIVER](#)

Reference Number : DFP001
 Title : **Addition of zones & points re: FISS maps for fish distribution for G.I.S. display purposes**
 Description : Addition of zones & points re: FISS maps for fish distribution for G.I.S. display purposes
 Location : MELP, Fisheries Branch, Victoria
 Reference code : Unpublished Government Report
 Year : 1995
 Author : PHILIP, D.F.

Reference Number : 16-2
 Title : **FISHERY OFFICER, MADEIRA PARK, B.C.. PERSONAL COMMUNICATIONS.**
 Description : AF; enhancement; fish sampling; gradient; land use; migration; morphology; obstructions; physical habitat; spawning; substrate; water quality; water use
 Location : DFO - SUBDISTRICT 16: Pender Harbour

Reference code : Personal Information/Communication

Year :

Author : TANCOCK, R.

Reference Number : WSCANDB

Title : **LIST OF ALL WATER SURVEY CANADA STATIONS IN B.C. AND YUKON, OCTOBER 1, 2000.**

Description : LIST OF ALL WATER SURVEY CANADA STATIONS IN B.C. AND YUKON RECIEVED OCTOBER 1, 2000.

Location : BC FISHERIES, VICTORIA, B.C.

Reference code : Government Database

Year : 2000

Author : WATER SURVEY CANADA

Reference Number : 13-35

Title : **M.O.E.P. FISHERIES BRANCH, SURREY. STREAM AND LAKE FILES, INCLUDING STREAM SURVEY FORMS AND VARIOUS FISH DISTRIBUTION MAPS.**

Description : AF; migration; morphology; physical habitat; spawning

Location : MOE - REGION 2 - SURREY

Reference code : Government Report

Year :

Author : ANONYMOUS

Reference Number : SISSM01

Title : **SISS map information (source not indicated)**

Description : map information

Location : MELP - Fisheries Headquarters, Victoria

Reference code : Map

Year : 1995

Author : DEPARTMENT OF FISHERIES AND OCEANS (DFO)

Reference Number : SISSM01

Title : **SISS map information (source not indicated)**

Description : map information

Location : MELP - Fisheries Headquarters, Victoria

Reference code : Map

Year : 1995

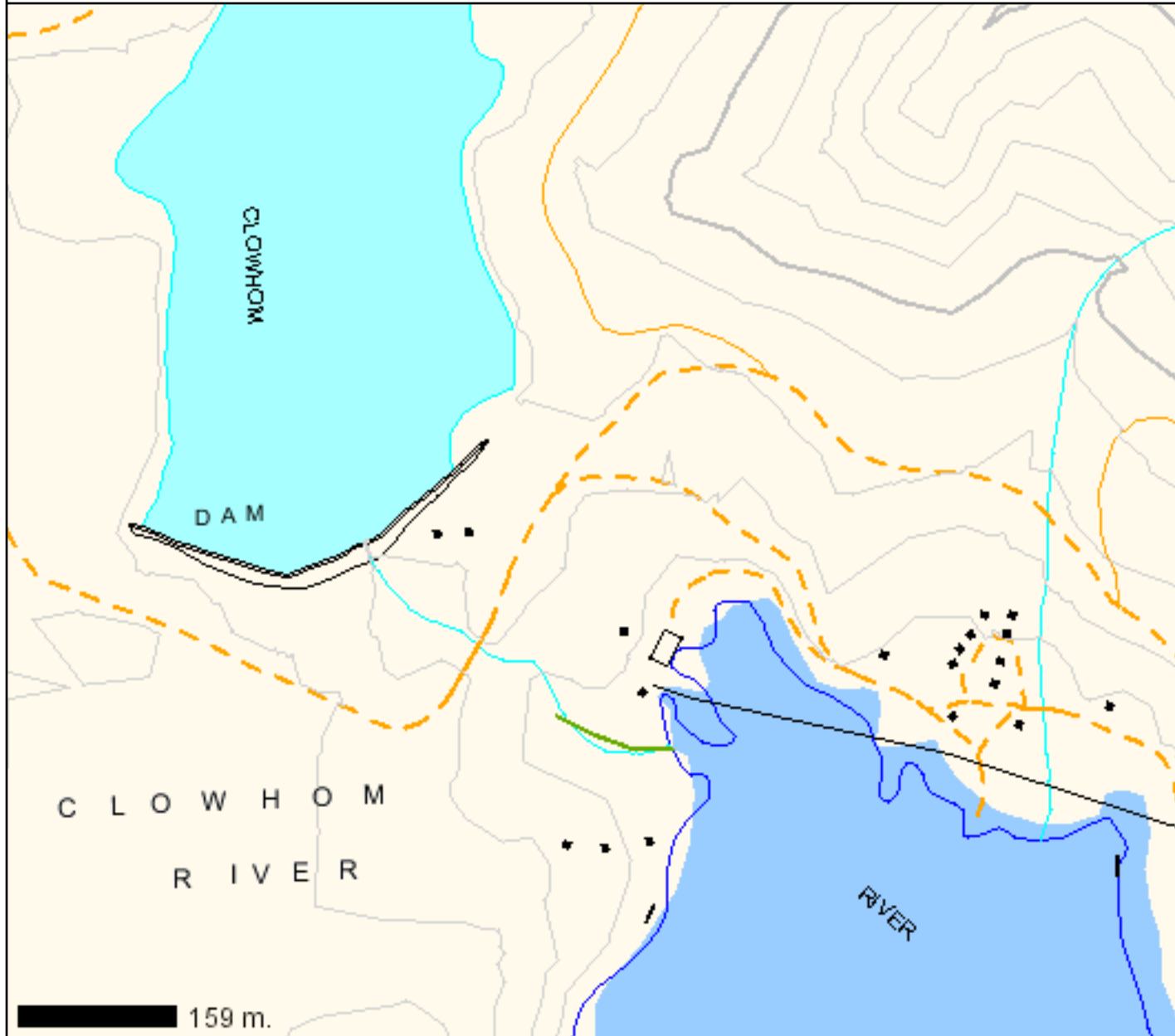
Author : MELP

6 references were found.

[Top of Page](#)

Clowhom River Chum Spawning Zone

Legend



- Borders
 - Borders
- Water Bodies - Polygons (1:20K)
 - Water Bodies - Polygons (1:20K)
 - Mine - Tailing Pond
 - Lake - Definite
 - Reservoir - Definite
- Water Courses - Polygons (1:20K)
 - Water Courses - Polygons (1:20K)
 - Canal
 - River/Stream - Definite
- Wetlands - Polygons (1:20K)
 - Wetlands - Polygons (1:20K)
 - Flooded Land - Inundated
 - Marsh
 - Swamp
- Yukon Lakes (1:50k)
 - Yukon Lakes (1:50k)
- Yukon Streams (1:50k)
 - Yukon Streams (1:50k)
- Settlements
 - Settlements

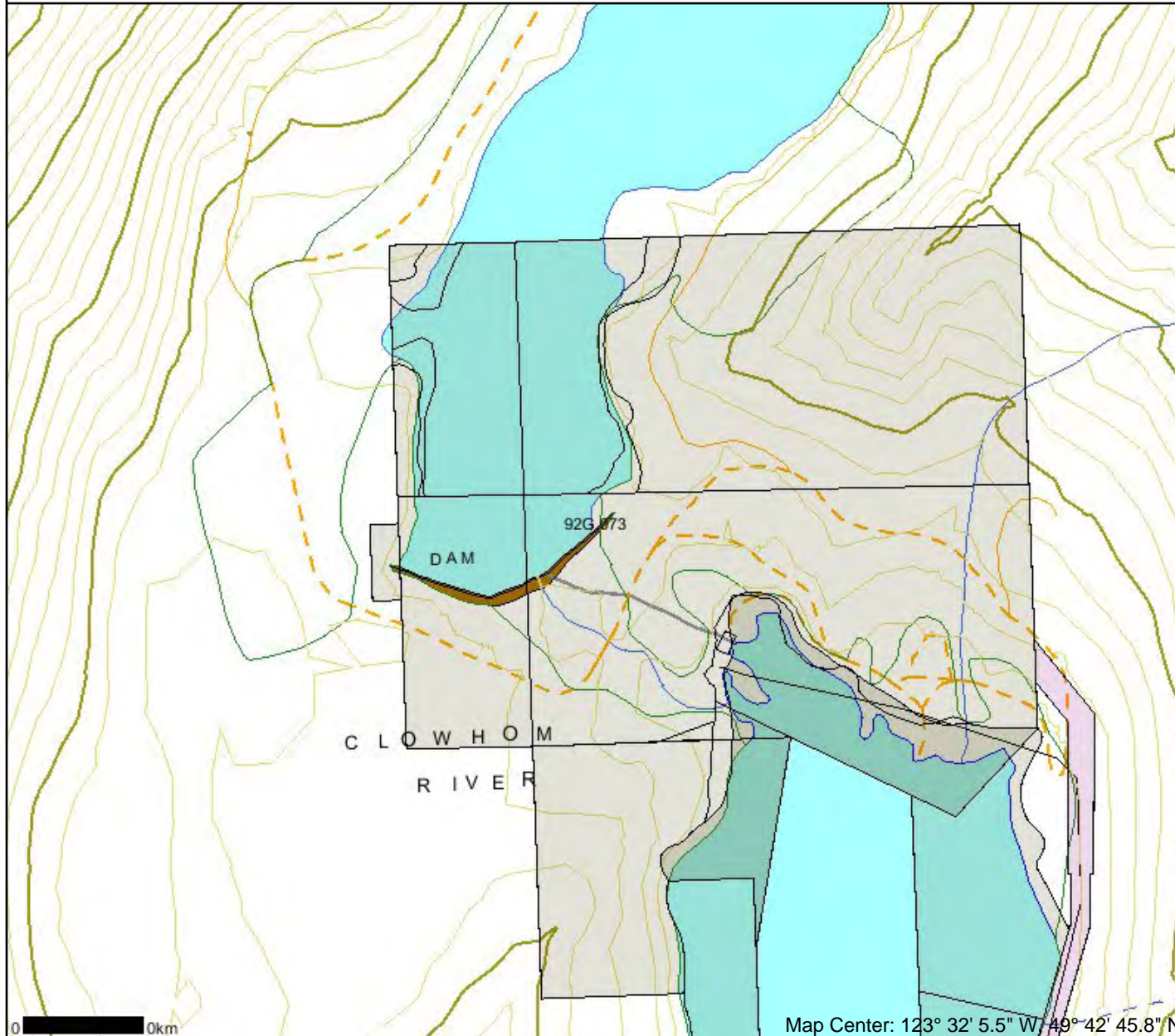
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DO NOT USE FOR NAVIGATION

Appendix IV

Figure 1 Study Area

Figure 1 - Study Area

Legend



- Integrated Survey Areas
- Well Sites
- Integrated Cadastral Fabric
- Survey Parcel Right of Ways
- Survey Parcels
- BCGS Grid
- Contours (TRIM)
- Contour - Index
- Contour - Index.Indefinite
- Contour - Index.Depression
- Contour - Index.Depression Indefinite
- Contour - Intermediate
- Contour - Intermediate.Indefinite
- Contour - Intermediate.Depression
- Contour - Intermediate.Depression Indefinite
- Area of Exclusion
- Area of Indefinite Contours
- Annotation (1:20K)
- Landcover - Points (TRIM)
- Landcover - Lines (TRIM)
- Wooded Area
- Nursery
- Orchard
- Landform - Points (TRIM)
- Slide
- Landform - Lines (TRIM)
- Cliff
- Crater - Volcanic
- Esker
- Lava Flow
- Moraine
- Scree/Talus
- Slide
- Landmark - Lines (TRIM)
- Yard - Auto Wrecker
- Yard - Lumber
- Fish Hatchery
- Electrical Substation Complex
- Mine (Open-pit)
- Mine (Underground)
- Pile - Raw Material
- Pit
- Pit - Abandoned
- Campground/Campsite
- Drive-in Theatre
- Exhibition Ground
- Golf Course
- Park
- Playing Field (Sports)
- Race Track
- Race Track - Athletic

Scale: 1:10,000

DO NOT USE FOR NAVIGATION

Appendix V

Photos

**Clowhom River below Clowhom Dam -
Mainstem Habitat Assessment
Photodocumentation**

Photos 15 & 16

Photo 17

Photos 13 & 14

Photo 12

Photo 11

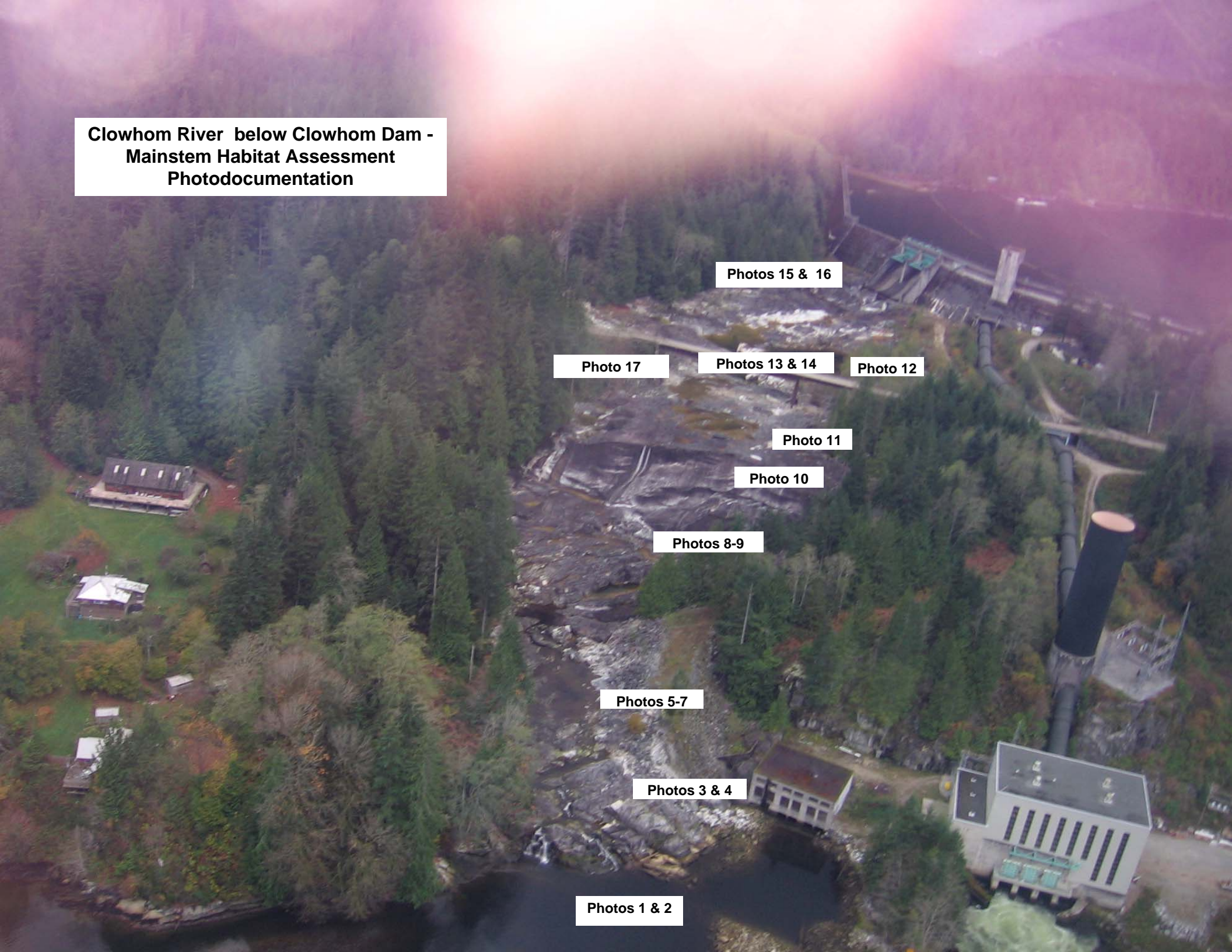
Photo 10

Photos 8-9

Photos 5-7

Photos 3 & 4

Photos 1 & 2





Photos 1 & 2: View across Salmon Inlet of Clowhom River spillway and powerhouse.



Photo 3: Cross channel view of Clowhom River from the left bank near the mouth.



Photo 4: Downstream view of Salmon Inlet from the Clowhom River, left bank.



Photos 5-7: Cross channel panorama from left bank showing bedrock dominated substrate and step-pool configuration.



Photos 8& 9: Upstream view of bedrock cascade below Interfor Bridge.



Photo 10: Downstream view of channel below bedrock cascade.



Photo 11: Cross channel view from left bank below Interfor bridge.



Photo 12: Upstream view from left bank above Interfor bridge.



Photos 13 & 14: Upstream view of bypass reach from bridge.



Photo 15: Upstream view of spillway from right bank.



Photo 16: Cross channel view below spillway from right bank.



Photo 17: Downstream view below bridge from right bank.



Photo 18 – Ephemeral stream located north of the Clowhom generating plant.



Photo 19 – Ephemeral stream in section with no visible banks.



Photo 20– Ephemeral stream near Salmon Inlet (above road near powerhouse).