Haslam Creek
Fish and Fish habitat Assessment

Prioritizing Restoration and Protection of the Fisheries Resource

Submitted to
Nanaimo Fish and Game Protective Association

For

Urban Salmon Habitat Program
Ministry of Environment, Nanaimo B.C.

Prepared

March 2001
by
Rob Hanelt, RPBio
Aquaterra Environmetal

And
March 2010
by
Dave Clough, RPBio
D.R. Clough Consulting (2010)

Table of Contents

List Of Figures and Tables

1.0 Introduction

The Nanaimo Fish and Game Protective Association was established in 1905 and has 750 members involved with the protection of fish and wildlife. The Association has been involved with a partnership to purchase 140 acres of land along the Nanaimo River, improving fish passage on the Millstone River, tracking radio-tagged Nanaimo River steelhead trout, restoring fish habitat on Thatcher Creek, Roosevelt Elk transplant programs and winter range habitat for Columbia Black-Tailed deer.

Haslam Creek is a major tributary of the Nanaimo River and of keen interest to club members who either live, work, fish or hunt in its watershed.

In the summer of 2000 and 2001 a habitat survey was conducted by members of the Nanaimo River Fish and Game protective association and Nanaimo River Hatchery under the guidance of Rob Hanelt, RPBio. This survey was conducted in the final years of the Urban Salmon Habitat Program (USHP) undertaken by George Reid (Reg. Biologist) and Tracy Michalski (Program Biologist) with the Ministry of Environment, Lands and Parks (MELP). The Urban Salmon Habitat Program was an initiative to protect trout and salmon and their habitat in the Georgia Basin.

In March 2001, a report was published by Rob Hanelt, RPBio of Aquaterra Environmental for the Ministry of Environment and Nanaimo Fish and Game Protective Association. This report covered the habitat condition of the lower three reaches of Haslam Creek. The group conducted surveys of Reach 4 and 5, which were never published. Sadly, Rob Hanelt passed away in 2004 and the project was never completed.

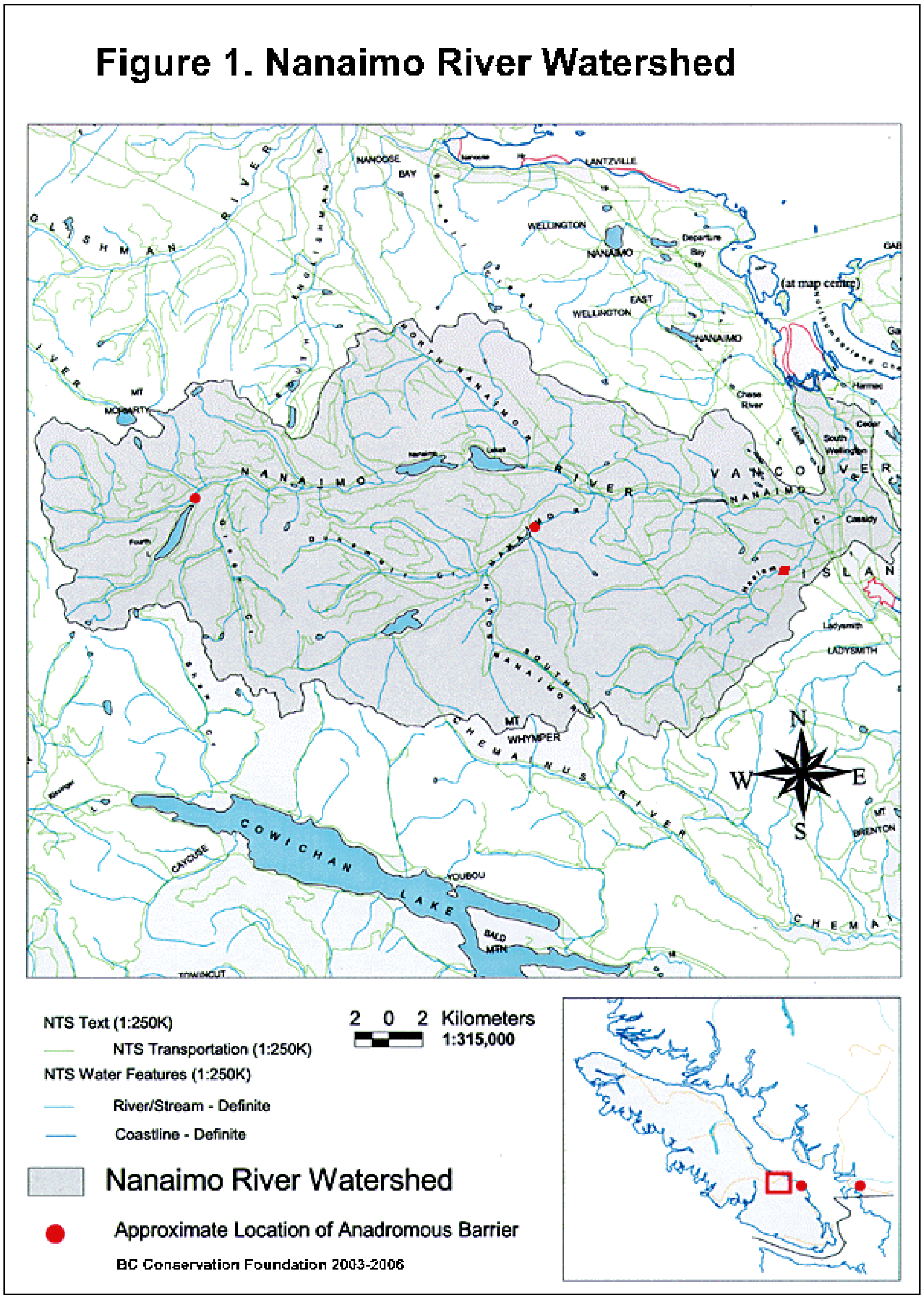
In October 2009, D.R. Clough Consulting was asked to complete the reach data for the entire Haslam Watershed including the past data as well as Reaches 4 - 8 (Haslam Lake).

The objective of the Haslam Creek Habitat Inventory and Restoration Plan is to develop a better understanding of the environmental impacts on the Haslam Creek watershed, and develop a long-term fish habitat restoration and protection plan.

2.0 Study Area

The study region is the Haslam Creek watershed, which is a sub-basin of the Nanaimo River watershed (Figure 1). It is located south of the City of Nanaimo on the east coast of Vancouver Island, situated in the South Island Forest District, and within MELP's Management Region 1 (Vancouver Island).

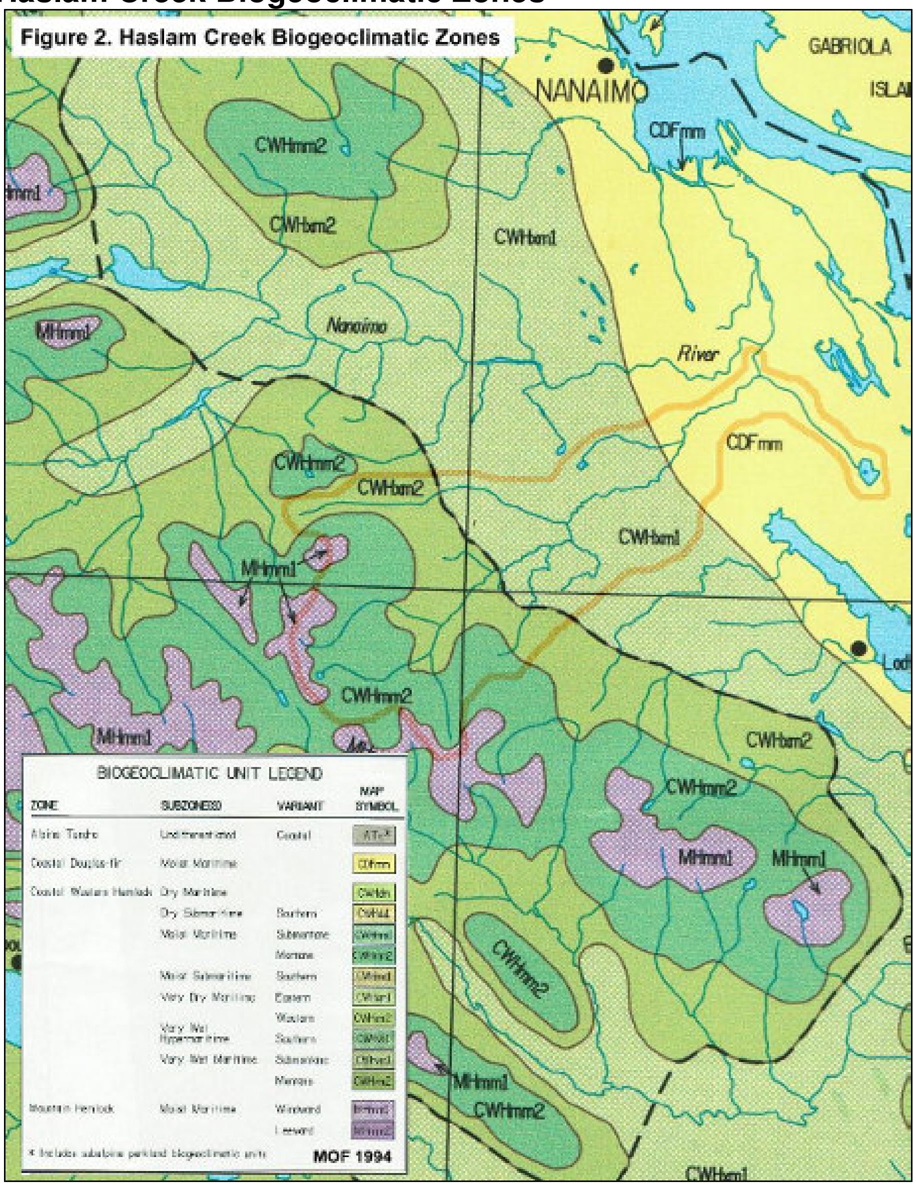
Figure 1. Nanaimo River Watershed



2.1 Ecosystem Classification

Biogeoclimatic zones (Figure 2) are differentiated by unique climate, soils and vegetation (MOF 1994). The Haslam Creek watershed is located within the Nanaimo Lowlands Eco-section. The lower elevation region from sea level to 450 meters lies within the moist maritime Coastal Douglas-Fir (CDFmm) Biogeoclimatic Subzone with a transition to Coastal Western Hemlock zones (CWHxm1, CWH xm2 and CWHmm2) up to 1050 meters. The upper tributaries of Reaches are located in the Windward moist maritime Mountain Hemlock Zone (MHmm1).

Figure 2. Haslam Creek Biogeoclimatic Zones

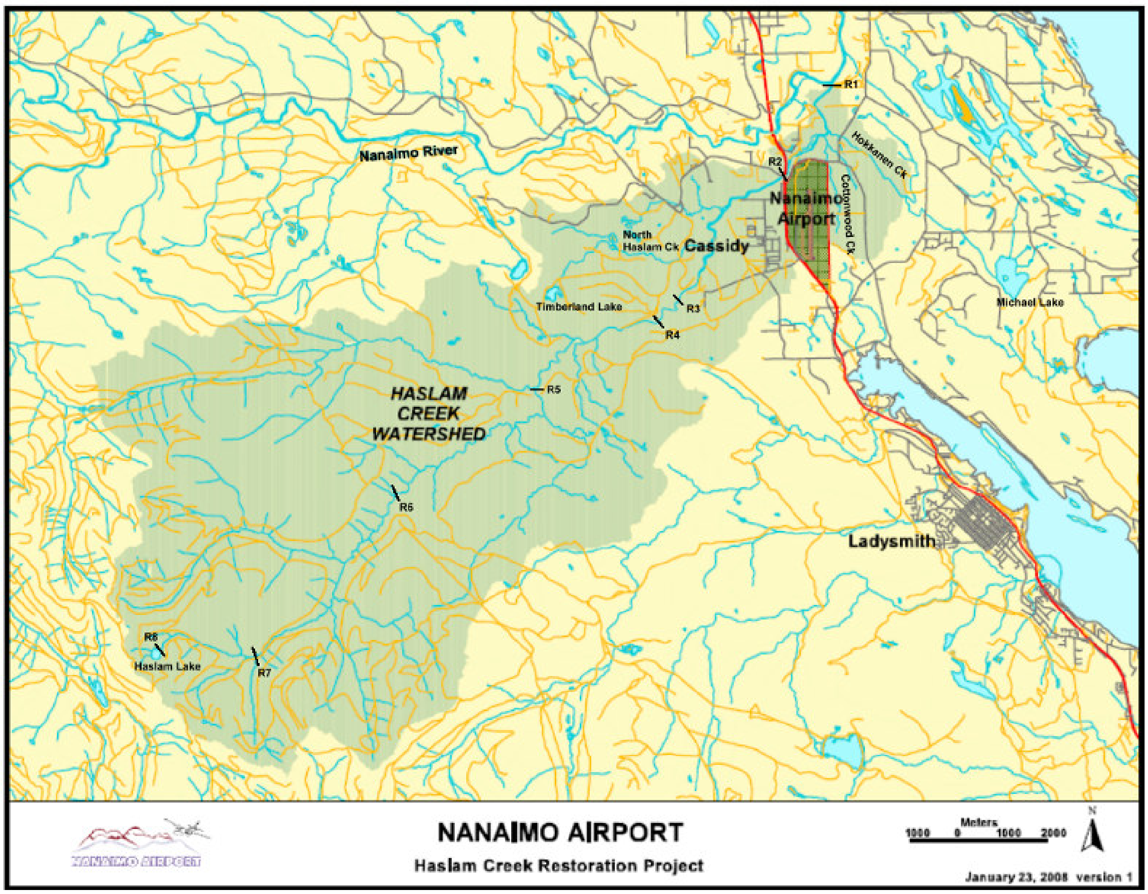


2.2 Physical Location and Size

Figure 3 below shows Haslam Creek watershed situated within the southeast quadrant of the Nanaimo River watershed. Haslam Creek is within the physiographic region known as the Coast Mountains and Islands (Valentine et. al, 1978). It flows northeasterly for 24.7 km, collecting runoff from along the slopes of McKay Peak and Mount Hayes to its confluence along the right bank of the Nanaimo River downstream of the Vancouver Island Highway (Hwy. 19).

The Haslam Creek sub-basin encompasses approximately 133 km^2 (MELP, 1993), accounting for approximately 16.4% of the drainage in the Nanaimo River watershed. There are at least twelve first order and four second order tributaries (1:50,000 scale interpretation) to the mainstem, including the named tributaries of; North Haslam Creek, Napoleon Creek, Patterson (aka Cottonwood) Creek and Hokkanen Creek. The three identifiable lakes include Michael Lake (36.0 ha), located at the headwaters of Hokkanen Creek, Timberland Lake at the headwaters of North Haslam Creek and a small-unnamed lake (4.0 ha) at the headwaters locally referred to as Haslam Lake.

Figure 3. Haslam Creek Watershed.



Watershed Hydrology

A study of the Nanaimo River Watershed included Haslam Creek Watershed. In 1993 this planning process was documented in the MELP report entitled *Nanaimo River Water Management Plan* (NRWM Plan). The report purpose was to identify strategies for management of the surface water in the watershed (MELP, 1993), including Haslam Creek watershed, which are presented below.

2.3.1 Surface Flow

Hydrology data for the Haslam Creek watershed was provided by the Water Survey Canada operated a station (08HB003) was located at Timberlands Road at the Reach 2/3 boundary (Lat: 49.2.24 and Long. 123.54.28). Stream flow records were collected for 1914-1915, 1949-1962 and 1993-1998 (Appendix 1). There are no records beyond 1998 as the site has been discontinued. Complete yearly records are only available for seven years. The mean annual discharge (MAD) was calculated to be 4.38 m^3/sec. The annual volume is 138 million cubic meters (MELP, 1993). Summer stream flow data was summarized in Table 1. Stream flows lower than 10% and 5% of MAD are shown in bold print and bracketed bold print, respectively.

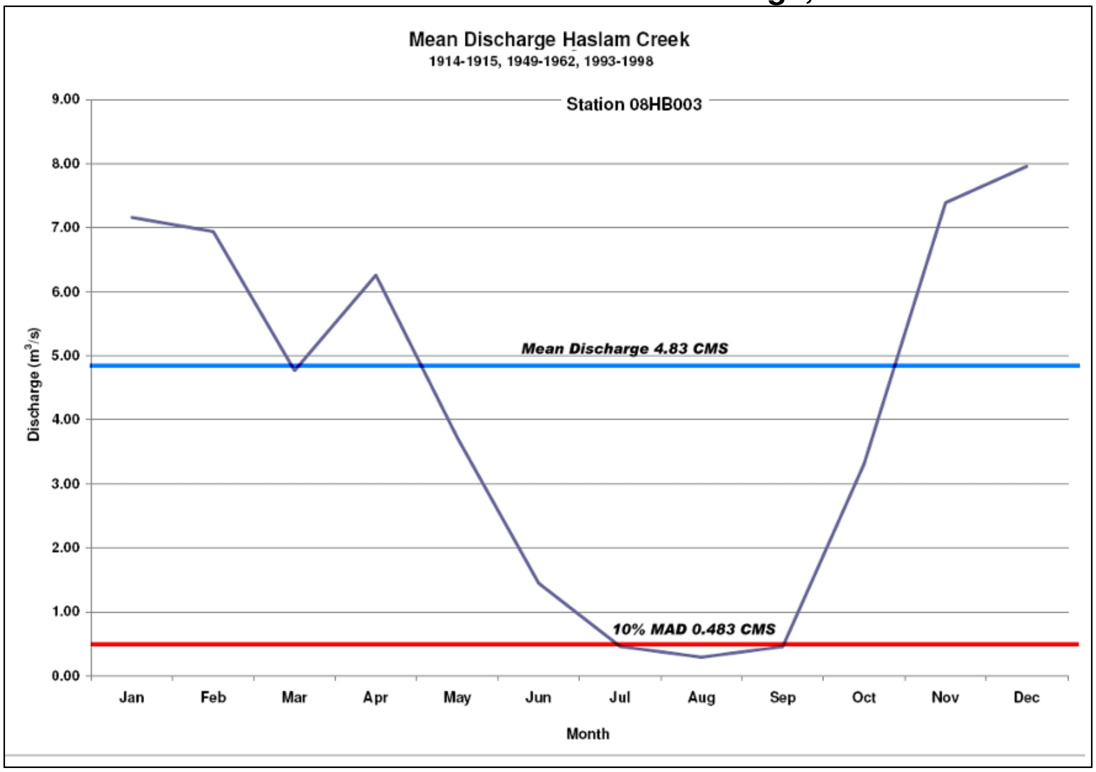
Table 1.) Haslam Creek Mean Monthly Discharge, July –Sept.:1914-1998.

Year	Haslam Creek near Cassidy 08HB003 MAD= 4.38 m^3/sec Mean Monthly Discharge		
	July	**August**	**September**
1914	**0.273**	***(0.099)***	0.450
1915	***(0.167)***	---	---
1949	**0.344**	**0.251**	**0.268**
1950	0.507	**0.311**	***(0.176)***
1951	***(0.184)***	***(0.136)***	0.439
1952	**0.424**	**0.331**	**0.333**
1953	0.722	**0.374**	0.743
1954	1.150	**0.415**	0.972
1955	0.836	0.734	0.562
1956	0.769	**0.249**	0.482
1957	0.476	0.962	0.779
1958	**0.220**	***(0.173)***	0.506
1959	0.484	***(0.193)***	0.927
1960	0.505	0.492	**0.349**
1961	***(0.188)***	***(0.130)***	**0.319**
1962	**0.349**	---	---
1993	**0.377**	***(0.175)***	***(0.114)***
1994	***(0.203)***	***(0.101)***	***(0.117)***
1995	***(0.125)***	***(0.174)***	***(0.097)***
1996	***(0.173)***	***(0.073)***	***(0.134)***
1997	1.410	**0.365**	1.360
1998	**0.311**	***(0.095)***	***(0.054)***
MEAN	0.464	0.292	0.459
% of MAD	11%	7%	10%

* Bold - mean monthly flow less than 10% of MAD **(Bold)* flow less than 5%

Tennant (1976) established a method of determining the flow needs of fish and other aquatic biota and also for maintaining recreational and aesthetic qualities. Tennant suggests that minimum flows at any time of the year flow must be >10% of mean annual discharge. Below the 10% threshold, fish habitat and recreational value will be severely degraded. Above 10%, habitat and recreational quality increases in a range from fair conditions (10% in winter and 30% in summer) to outstanding (40% in winter and 60% in summer). An optimum range is considered 60-100% of mean annual flow at any time of the year. Figure 4 shows the results of the data.

Figure 4. Haslam Creek Summer Mean Annual Discharge, 1914-1998.



In 1990, R.P. Griffith and Associates (Griffith, 1990) employed the Tennant method to calculate instream flow requirements to provide suitable fish habitat for the Nanaimo River. Table 2 shows that 40 of the 62 months (65%) of July, August and September are less than 10% of MAD, and 22 of the 62 months (35%) are less than 5% of MAD.

Another method of analysis was done by recording the mean 7-day low flow values for 16 years of data. The value for the 16 years of flow records was 0.208 m^3/sec which is less than 5% MAD. The mean 7 day low flow will drop to 0.134 m^3/sec or lower once every five years on the average (MELP, 1993/2000).

Table 2.) Haslam Creek Summer Flow Less Than 10% & 5% of MAD.

	Haslam Creek near Cassidy 08HB003 MAD = 4.38 m^3		
Months	Total Months Recorded	No. Months <**10% MAD**	No. Months <**5% MAD**
July	22	13 (59%)	6 (27%)
August	20	17 (85%)	10 (50%)
September	20	10 (50%)	6 (30%)
Total:	**62**	**40 (65%)**	**22 (35%)**

2.3.2 Groundwater

The Cassidy Aquifer underlies the lower reaches of Haslam Creek. The creek and the groundwater system are linked through bi-directional recharge mechanisms. Unconsolidated and permeable deposits of sand and gravel result in both surface and groundwater sources being sporadic and unreliable (MELP, 1993).

2.3.3 Water Extraction

The Greater Nanaimo Waterworks District (GNWD) stores water on the South Nanaimo River and Jump Creek but not currently in the Haslam sub basin. On Haslam Creek, there are 45 water licenses recorded for Irrigation, domestic and industrial uses primarily by well extraction (MELP 1993).

The largest water user in the sub basin is the Harmac pulp mill, which has a well alongside the creek in Reach 1 opposite the airport (Well A). The extraction capacity of Well 'A' is approximately 8,000gpm, and typically pumps at 3,000 to 4,000gpm. Total well capacity is approximately 26,000gpm, and typically extracts 10,000 to 13,000gpm. Well water is preferred for its better quality, especially for the boiler feed. Total water consumption has been reduced over the last 20 years from 107cfs (1981) to 34cfs (2000) (pers. comm. Mill Staff). While water extraction reductions for the pulp mill has been significant; however, it is important to take into account the impact of groundwater extraction in the vicinity of Haslam Creek during low flow conditions from July to September (MELP, 1993).

Irrigation, domestic and industrial uses account for a small proportion of the licensed extractive demands, however they are on small tributary streams where local competition with instream fish flow requirements do occur. For example in 1993; 73% of the irrigation demand was in the Haslam Creek drainage area (MELP, 1993). Since then, further demands on the aquifer have been made with agriculture and new golf course development.

2.4 Vegetation

Based on the Biogeoclimatic Ecosystem Classification system, the Haslam Creek watershed is divided into three major zones: Coastal Douglas-fir (CDF), Coastal Western Hemlock (CWH) and Mountain Hemlock (MH) (Figure 2). The lower two reaches are located entirely within the CDF zone, and are dominated by Douglas-fir (*Pseudotsuga menziesii*), Western Red Cedar (*Thuja plicata*), and Red Alder (*Alnus rubra*) within disturbed areas. An understory of salal (*Gaultheria shallon*) and Oregon Grape (*Mahonia nervosa*) dominate the shrub layer. The remaining upper reaches are located primarily in the CWH zone and are dominated by Douglas-fir, Western Red Cedar and Western Hemlock (*Tsuga heterophylla*), The major understory species are primarily salal and red huckleberry (*Vaccinium parvifolium*). Upper tributaries of Reaches 6, 7, and 8 are located in the Mountain Hemlock zone and is dominated by Mountain Hemlock (*Tsuga mertensiana*), Western Hemlock and Amabilis Fir (*Abies amabilis*). The understory species are primarily Oval-leaved Blueberry (*Vaccinium ovalifolium*), Alaskan Blueberry (*Vaccinium alaskaense*) and Black Huckleberry (*Vaccinium membranaceum*).

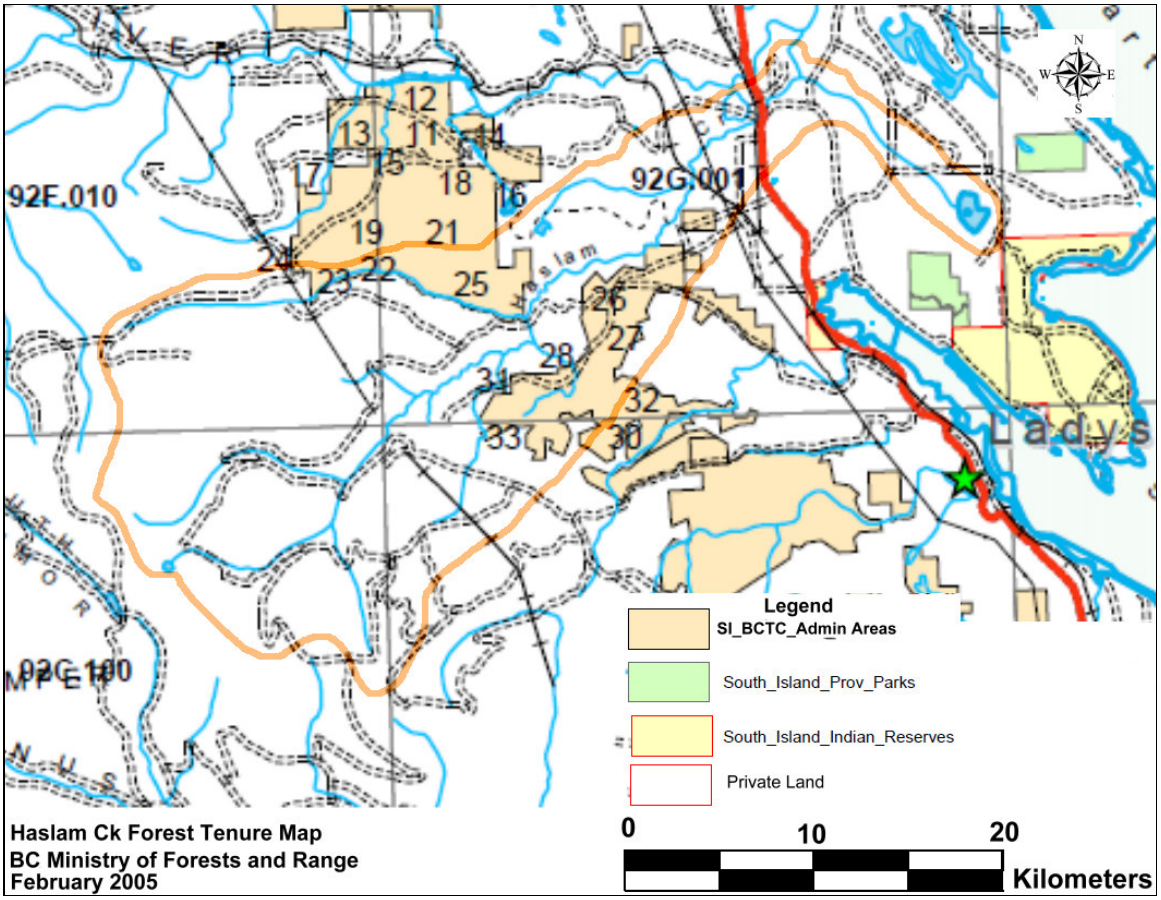
2.5 Land Use and Impacts

The lower half of the Haslam Creek watershed is mainly located within the Regional District of Nanaimo (RDN), with portions of Hokkanen Creek and Michael Lake located in the Cowichan Valley Regional District. Decisions on all land use matters rest with the Board of the Regional District and is governed by the requirements of the Regional District of Nanaimo Bylaw No. 500, Schedule 6A and 7A – "Land Use Zones and Subdivision Districts" (RDN, 1987). The upper watershed (Reach 5-8) is located within the Cowichan Valley Regional District.

Land use within the Haslam Creek watershed is dominated by forestry activities in the upper watershed (Reach 3-8), with a mix of agricultural, recreational, residential and industrial activity in the lower reaches of the watershed.

Along Haslam Creek, the RDN (Appendix 2) has designated land use from the B.C. Hydro right-of-way easement towards the headwaters as *Resource Management* (RM4V, RM5V, RM5B, RM9B). To the east, from the B.C. Hydro easement to the confluence with the Nanaimo River, land use has been designated as *Rural* (RU4B, RU4D, RU7D).

Figure 5. Crown and private land in Haslam Watershed.



2.5.1 Forestry

Landowners

The majority of the forest harvesting within the Haslam Creek watershed occurs on privately owned forested land holdings (Figure 5). TimberWest Forest Corp., formerly Fletcher Challenge Ltd. is the largest private timberland owner, including former holdings of Canadian Pacific Forest Products Ltd., operating from the Nanaimo Lakes Operations. Island Timberlands Ltd owns land formerly owned by Weyerhaeuser Company Ltd. and MacMillan Bloedel Ltd. is the second major timberland owner, operating out of the South Island Timberland Division. The provincial Ministry of Forests is responsible for managing the Crown Land within the watershed, through the South Island Forest District.

History

Harvesting of forests, to varying degrees, has been occurring throughout the Nanaimo River watershed for over a hundred years and presently falls under the jurisdiction of the Ministry of Forests (MoF). Harvesting of the Timberwest land holdings began in 1936 when the first truck logging on coastal B.C. went into operation in the Nanaimo Lakes area. A large wooden bridge crossing of Haslam Canyon allowed access into the Timberland Lake area for railway logging of timber. The majority of the timber harvesting continued from the 1930's until the 1970's, when large tracks of land had been cleared from Ladysmith to the Nanaimo River (pers. comm.). Large-scale clearcuts and poor road construction result in degradation of environmental parameters such as water quality, physical structure of the creek, flow regime and the biotic interactions.

Current Logging Activities

Forest lands constitute almost the entire headwaters. The harvest practices and total cut in the watershed are important considerations to its' health. Each tenure and property owner has their own harvest targets which should be considered on the whole to best protect the watershed from cumulative effects.

Private Forest Land

The area has significant private forest operations. The logging operations are by Timber west and Island Timberlands. There have been significant private forest land harvest operations on Haslam watershed in the last 10 –15 years. New logging roads and cut blocks have appeared along the river between reaches 3-6.

Crown Land

In the South Island Forest District – Small Business Enterprise have tenure in this area. Woodlots have also been recently established for Chemainus First Nation in this watershed.

Forest Land Management

On Crown land, timber and non-timber resources are examined and developed into an integrated resource plan. This five-year plan specifies the allowable annual cut (AAC) and management objectives. The plan is updated every year and reviewed by MoF, MELP and the federal department of Fisheries and Oceans Canada (F&OC). The public participates in the review process, providing comment on draft plans.

Landowners of privately managed forestland in the watershed are members of the Private Forest Landowners Association (PFLA). New standards in harvesting techniques minimize the size of clearcuts. Variable retention harvesting is being phased in as part of the recently established (April 1, 2000) *Private Forest Land Practices Regulations.* Provincial forests on Crown Land must take into account the Sensitive Ecosystem Inventory (SEI) and comply with the *Forest Practices Code of British Columbia Act* (1995).

2.5.2 Agriculture

Original old growth forests in the Lowland area were logged and converted to agricultural and residential use. Rural land use includes activities such as hobby farming, agriculture and silviculture.

Agricultural Land Reserves (ALR) are subject to the Agricultural Land Reserve Act to preserve agricultural land and to encourage the establishment and maintenance of farms. Non-agricultural uses are regulated, and overseen by the Land Reserve Commission. Approximately 10% of the Cranberry / Bright Land Districts are classified as ALR (MELP, 1993).

Direct impact to Haslam Creek may come in the form of reduced summer flows possibly related to crop irrigation, changes to drainage patterns, loss of water storage (i.e. fill-in wetlands and remove beaver dams), chemical runoff and a loss of riparian vegetation.

2.5.3 Industrial and Commercial

Gravel processing activities and commercial developments are another form of land use within the watershed. A gravel pit is located just to the south of the upstream end of Reach 2. Just to the south of this gravel pit along the right bank of the river is a recreational development which has encroached on the riparian buffer zone and resulted in localized bank erosion (see Section 5.2: Prescriptions).

Nanaimo Airport Authority has recently expanded its runway (2009) which has required the purchase of a farm on river left bank in Reach 1. Prior to the runway expansion, the airport has conducted a riparian management program with an RPF to fell or prune trees in the flight lines. They also had to establish landing light grids. The airport has been involved in habitat referrals with DFO to compensate fish habitat in 2007 & 2008, but has continued to work with local stewardship groups on further projects in 2009 and planned in 2010. Airport Creek is a seasonally accessible channel that drains the parking lots and runway areas.

2.5.4 Residential

There has been very little residential expansion in the last 10 years in the Haslam Watershed. There were acreages developed off Rugby Road near the Fish Hatchery in the late 1990’s in Reach 1. In Reach 2, most of the largest residential area is the older Timberlands subdivision which drains away to the south into Walker Creek. Spruston Road on the north side has no appreciable new housing that enters this drainage, most of the houses are on the Nanaimo River side. In summary, the area suffers very little impact from residential development

2.5.5 Roads and Crossings

Road development is significant in that the Island Highway crosses at the Reach 1 and 2 break at Cassidy. There is a high volume of traffic with potential volatile chemicals in transport trailers and fuel tanks of cars. There are annual accidents at the Cassidy Junction that no doubt result in at least some pollution entering the channel or ditches into Haslam Creek. There are also at least two logging road crossings in Reach 3 and Reach 7 respectively. The Railway corridor in Reach 2. There is also the Trans Canada Trail crossing and the Vancouver Island Gas Line crossing in Reach 3

2.6 Fisheries Resources

Historically Haslam Creek watershed fisheries were diverse, comprised of populations of anadromous and resident fish. Anadromous species known to be present (FOC, 2000) include Coho (*Oncorhynchus kisutch), C*hum (*O. keta*), Chinook (*O. tshwaytscha*), Pink (*O. gorbuscha*), Steelhead Trout (*O. mykiss*), and Sea Run Cutthroat Trout (*O. clarki clarki*). Resident fish species include Rainbow Trout and Coastal Cutthroat Trout, and possibly Dolly Varden (*Salvelinus malma*). Non-salmonid species include Threespine Stickleback (*Gasterosteus aculeatus*) and Prickly Sculpin (*Cottus asper*).

2.6.1 Fish Distribution

The individual fish species distributions are presented in Appendix 3. Historically Coho salmon have been observed as far upstream as the logjam waterfall in Reach 3, which is approximately 8km upstream from the mouth. SHIM and Mapster indicate the anadromous Coho/Chinook barrier to be further upstream approximately 1.2Km upstream of the lower Reach 4 break, and the Steelhead barrier to be approximately 50m downstream of the lower Reach 5 break.

SHIM identifies observed Chum presence from the confluence with Nanaimo River to the North Haslam confluence in Reach 2 (5+446m). Chum salmon have been observed farther downstream, 3,000 meters upstream of the Island Highway (SHIM), with the majority of fish spawning downstream of the highway. SHIM identifies observed known presence of Chinook and Coho salmon upstream to Reach 4, at 9+600m. Chinook salmon could access as far upstream as the barrier in the Haslam canyon, but have been observed spawning just upstream of the highway. A fish distribution map by LGL Limited and provided on the BCCF website indicates the possible anadromous steelhead/coho fish barrier to be approximately 1480m downstream of the upper Reach 5 break (LGL, 2002). Historically there was a good run of anadromous cutthroat trout, with no records of present status. Resident cutthroat and rainbow trout are found throughout the system wherever there is access, including the unnamed headwater tributaries. SHIM also identifies known Steelhead presence upstream to 12+000m, at the confluence with a left bank tributary near the upper Reach 4 break (SHIM). Steelhead access is noted as continuing up this tributary for approximately 4.0Km.

2.6.2 Obstructions

Napoleon Creek, a tributary in Reach 1, has a fish ladder built at the flow control structure, and is functioning very well in passing anadromous and resident fish further upstream. Another form of barrier to fish passage is the dry channel sections that exist in Reach 1 of Haslam Creek and many of the tributaries during low flow summer conditions. The lack of connectivity between pools in Reach 1 was recorded in Form 1 of the USHP fish habitat assessment. In August 2000, approximately 24% (715m of 3,010m) of the stream channel length was dewatered. It was also dewatered in 2007 and 2009 but not in 2008 when Well A was not operating during the Harmac shut down (DRC). Tributaries such as Patterson (Cottonwood) Creek, Hokkanen Creek and numerous mainstem and off-channel habitat sites in Reach 1 and 2 also dry up or become isolated from Haslam Creek during the summer months.

There is reference to a logjam within the lower canyon of Reach 3 as being a barrier to upstream migration of Coho salmon (FOC, 2000). Steelhead trout have been recorded upstream of the barrier, and further sampling for juvenile fish would identify limits of distribution. In the upper watershed above Reach 3, F&OC has indicated on Fisheries Information Summary System (FISS) maps that there may be other waterfall barriers to fish passage in the mainstem and tributaries.

The anadromous barrier was identified in 2001 during the USHP survey. The barrier is located at 17+396m, and is represented by a 6m vertical bedrock falls. Although the falls ends anadromous fish access, SHIM identifies known fish presence to end downstream of this barrier. The North Haslam creek has a 6 meters waterfall located approximately 850 meters upstream of the confluence with Haslam Creek (FOC, 2000). According to a Nanaimo Field Naturalist article (Sept/Oct, 2000) this barrier is actually 30 meters high. Regardless, the waterfall barrier is impassible to all fish, with resident fish populations occurring upstream.

2.6.3 Salmonid Escapement Data

Historical escapement date is found in Table 3 (FOC, 2000), with more recent adult salmon spawning data from FOC in Table 4 (pers. comm.). Table 5 provides the results of MELP's (Fisheries Section) 1999 and 2000 snorkel surveys to enumerate steelhead trout. Full reports for the snorkeling data and escapement summary from FISS are found in Appendix 4.

Table 3.) FOC Salmon Escapement Data (1981 – 2000)

Species	10 Year Interval	10 Year Mean / Max Escapement	Maximum Escapement Year	Maximum Escapement
Chinook	1981-1990	50 / 145	1982	145
Chum	1981-1990	4,056 / 18,800	1982	18,800
Coho	1981-1990	440 / 600	1983	600
Chinook	1991-2000	19 / 100	1995	100
Chum	1991-2000	2,680 / 8,000	1992	8,000
Coho	1991-2000	62 / 295	1992	295

Table 4.) FOC Salmon Escapement Data (2000 – 2004)

Species	Year	4 Year Mean / Max Escapement	Maximum Escapement Year	Maximum Escapement
Chinook	2001-2004	99 / 198	2003	198
Chum	2001-2004	5008 / 15,464	2003	15,464
Coho	2001-2004	750 / 1,394	2003	1,394

Table 5. MELP Adult Steelhead Trout Snorkel Survey (1999 and 2000)

Date	Location	Steelhead Trout Observed	Other Salmonids Observed
March 25, 1999	500m u/s of highway bridge to mouth of creek	3 winter steelhead no juvenile observed	No mention
April 22, 1999	500m u/s of Rondalyn's to highway bridge	3 winter steelhead 10 – 15 smolts	No mention
May 8, 2000	Highway bridge to Nanaimo River confluence pool	No Steelhead observed	One resident trout and Chinook Jack Very low abundance of trout coho juveniles

2.6.4 CEDP Hatchery Broodstock and Stocking Records

The CEDP Nanaimo River Fish Hatchery started collecting coho salmon broodstock and releasing coho fry into Haslam Creek in 1980. The last fry release of was in March of 2001. The historic stocking numbers are summarized in Appendix 5.

2.6.5 Provincial Stocking Information

The Vancouver Island Trout Hatchery (MELP/Freshwater Fisheries Society) in Duncan is responsible for rearing and releasing trout in lakes and rivers across Vancouver Island. Table 6 summarizes trout releases within the Haslam Creek watershed. Stocking sites include Haslam and Timberland Lake.

Table 6.) Haslam Watershed Trout Stocking Information.

Date	Species	Number Released	Stock	Life Cycle Stage	Hatchery
Timberland Lake					
3/23/00	Cutthroat	1200	Taylor	Yearling	Vanc. Isl. Hatchery
4/14/99	Cutthroat	1200	Taylor	Yearling	Vanc. Isl. Hatchery
3/12/98	Cutthroat	1200	Taylor	Yearling	Vanc. Isl. Hatchery
4/16/97	Cutthroat	600	Taylor	Yearling	Vanc. Isl. Hatchery
4/16/97	Cutthroat	600	Quinsam	Yearling	Vanc. Isl. Hatchery
4/11/96	Cutthroat	600	U. Taylor	Yearling	Vanc. Isl. Hatchery
4/11/96	Cutthroat	600	Quinsam	Yearling	Vanc. Isl. Hatchery
Haslam Lake					
2005	Cutthroat	500	Taylor	Yearling	Vanc. Isl. Hatchery

3.0 Methods

3.1 Assessment Procedures and Personnel

The Urban Salmon Habitat Program (USHP) Assessment Procedures for Vancouver Island (MELP, 2000b) was used on Haslam Creek.

In the summer of 2000, the fish habitat survey was done from the confluence with the Nanaimo River to approximately 8.0km upstream. Field assessment and documentation of Reaches 1-3 was done in 2000 by Patti McKay (Co-manager Nanaimo Hatchery), Henry Bob (Co-manager Nanaimo Hatchery), Larry Proteau (Nanaimo Fish and Game Protective Assn.) Tracy Michalski,(Ministry of Environment) Doris Edwards (Nanaimo Hatchery staff), John Segal (Nanaimo Hatchery), and Rob Hanelt, RPBio. Information reviewed included air photographs and maps, and data made available from resource agencies (MELP, MOF, FOC).

In 2001, Reach 4 and 5 were inspected by Patti McKay, Wayne Hamilton (Nanaimo Fish and Game protective Assn.), as well as seasonal staff at Nanaimo Hatchery including Snuneymuxw Band members.

In 2009 data on Reach 5 and 6 was collected by reviewing air photos and point inspections by D.R. Clough, RPBio and Boone Barber, B.I.T. Reach 7 was assessed in 2009 by D.R. Clough and Brad Remillard. B.I.T.

Various property owners were considerate in allowing access through out the survey period and expressed interest in the river health.

3.1.1 Instream Habitat Assessment

Overview Assessment
To become familiar with the watershed it was necessary to complete an overview assessment. Information was gathered from various sources (see References), and included in Section 2.0 – Delineation of Study Area.

Field Assessment
Field data collection and interpretation methods followed those described in Section 2.2 of the USHP assessment procedures (MELP, 2000b). Steps included:

- delineate three reaches as per Resources Inventory Committee (RIC) standards (MELP, 1995);
- assemble existing overview information (air photos, maps, fish distribution);
- collect water quality parameters (i.e. dissolved oxygen, pH, velocity, etc.);
- measure habitat parameters (i.e. habitat unit, cover, gradient, erosion sites);
- photographic documentation; and,
- data rating, interpretation and determining priorities for instream restoration.

Photo-documentation of survey reaches has been included in a separate album. The pictures are of disturbed areas, potential restoration sites and examples of good fish habitat. All pictures have been labeled with a description of the photograph and its' location along the creek.

3.1.2 Riparian Assessment

Overview Assessment
Available information was gathered including maps, air photographs and land use. Collecting information on land use involved a review of RDN zoning, RDN Environmentally Sensitive Areas Atlas, and contact with environmental agencies (MELP, MOF and F&OC) and major landowners of timberland (Weyerhaeuser and TimberWest). Background information is included in Section 2.0 – Delineation of Study Area.

Field Assessment
Field data collection and interpretation methods followed those described in Section 3.2 of the USHP assessment procedures (MELP, 2000b). Steps included:

- delineate three reaches as per Resources Inventory Committee (RIC) standards;
- assemble existing overview information (air photos, maps, fish distribution);
- measure riparian parameters (i.e. land-use, vegetation, stability, etc.);
- photographic documentation; and,
- data rating, interpretation and determining priorities for riparian restoration.

3.2 Stream Mapping

As part of the fish habitat overview assessment, it is important to gather as much reference material for the report as possible. Various forms of stream mapping have been included, in order to cover the various aspects of the report. Reach breaks, barriers, fish distribution, historical data references and other key features were mapped (Appendix 3 and Appendix 6).

3.2.1 Orthophotos

Orthophotos from SHIM and Google Earth were utilized to compare stream morphology, timber harvesting, riparian vegetation, and urban development at different locations and different times. Further review of earlier aerial photographs would be desirable for further assessment of the upper watershed. These photographs were not available at MoELP - Nanaimo, but are listed for future reference. Appendix 6 identifies Reaches 1 to 8 and the overview of the watershed.

3.2.2 Environmentally Sensitive Areas Atlas

Orthophoto maps (CMNBC, 2007) were extrapolated from Sensitive Habitat Inventory and Mapping (SHIM), which identify fish habitat, fish distribution, and sensitive ecosystems. SHIM is important to the Haslam Creek watershed when identifying environmental risk with land development. The relevant maps are included in Appendix 3.

4.0 Results

4.1 Fish Habitat Assessment

Riparian and instream fish habitat characteristics are described for each of the eight reaches. The USHP habitat field survey data (Appendix 7) resulted in a summary page that consolidates the primary habitat characteristics. Photo pages of physically surveyed reaches are located in Appendix 7. The USHP Riparian and Instream Habitat Rating Summary is presented in Tables 7 to 13 below.

4.1.1 Reach 1

Reach 1 of Haslam Creek is approximately 3,010m long from the confluence with the Nanaimo River upstream to the Island Highway (Hwy 19). The elevations within this reach range from 12m to 28m. Bankfull width of this aggraded stream reach is approximately 30m and the gradient was 1.3%. The substrate was predominately cobbles (43%) and gravels (38%), with significant areas of aggradation, most notably from 1+400m to 2+100m.

Three tributaries enter this reach; Napoleon Creek at 0+309m on the left bank, Hokkanen Creek (Cottonwood Creek) on the right bank at 1+239m and Patterson Creek (Airport Ck) at 1+436m on the Right Bank. Off-channel habitat was identified at 1+267m (LB), 1+490m (RB) and the mouths of Hokkanen Creek and Patterson Creek.

R1-Fish Habitat Characteristics

Perennial fish habitat exists from the Nanaimo River to the confluence of Napoleon Creek approximately 309m upstream, mainly due to good overhead cover and stream flow. Although instream cover (Bo:2%, LWD: 1%, Cutbk:3%, Veg:8%) and pool depth is reduced, consistent flows and cooler temperatures from Napoleon Creek greatly enhance this lower section of Reach 1 for summer rearing of salmonids. The amount of functional large woody debris (LWD) in Reach 1 is poor (0.7 pieces/bankfull channel width). Where pool habitat exists, stable LWD has scoured out deeper fish habitat (i.e. 0+571m).

Upstream of Napoleon Creek the effects of gravel aggradations and the lack of surface water are more evident. There are long lengths of de-watered fish habitat and isolated pools, only averaging 0.24m in depth. Excess bedload and loss of wetted habitat during low flow conditions are most evident just upstream of the confluence with Hokkanen Creek at 1+400m, past the Nanaimo Airport to 2+200m. Within this section the channel has significantly widened which has resulted in deposition of bedload, reduced quality of fish habitat, not to mention very little water during the summer months.

Further upstream towards the highway crossing, signs of excess gravel deposition in large bars are evident, however, narrowing of the channel and a higher water table has resulted in better juvenile fish rearing conditions. Spawning gravels suitable for anadromous fish are abundant.

R1-Fish Habitat Disturbance

Reach 1 suffers from negative impacts as a result of land use decisions and the nature of the local aquifer. Gravel aggradation in this reach has reduced the quality of fish habitat by infilling pools and promoting channel widening (18.5m to 54.0m). Increased bedload has resulted in extensive areas of unvegetated gravel bars. In an effort to alleviate the build up of bedload within the channel, gravel extraction (32,500m^3) in 1996 was completed across from the Nanaimo Airport at 1+900m. Unfortunate results included down cutting, lateral erosion of the banks and a loss of riparian vegetation.

Bank erosion is throughout with many significant sites (0+450m, 1+700m, 1+900m, 2+200m) resulting in a loss of riparian vegetation is evident. Sections of streambank have been armoured with riprap rock (2+000m, 2+325m, 2+497m, 2+777m, 2+900m) in an attempt to control erosion.

Lack of water during summer low flow conditions (see Section 2.3.1) has the biggest impact on fish habitat, and is the result of the characteristics of the Cassidy Aquifer (see Section 2.3.2), gravel accumulation, channel widening, and groundwater and surface water use. All of these factors impact the naturally low water levels evident in many streams on the east coast of Vancouver Island.

Table 7.) Haslam Creek Reach 1 Habitat Data Summary and Ratings.

Habitat Parameter	R1	Ratings	Result
Pool Area (%)	66.5	1	Good
Large Woody Debris/Bankfull Channel Width	0.7	5	**Poor**
Average Cover in Pools (%)	15.0	3	Fair
Average Boulder Cover (%)	2.0	5	**Poor**
Crown Cover (%)	40.6	3	Fair
Substrate (% Fines)	14.1	3	Fair
Erosion Sites (%)	5.0	1	Good
Obstructions	0.0	0	-
Altered Stream Sites (%)	7.0	3	Fair
Wetted Area (%)	21.5	5	**Poor**
Dissolved Oxygen (ppm)	9.8	1	Good
PH	7.8	1	Good
Result		**3**	**Fair**

4.1.2 Reach 2

Reach 2 of Haslam Creek is approximately 4,117m long from the Hwy 19 bridge (3+010m) and ends at the logging road bridge (7+127m). The reach break is located between the Rondalyn Resort (6+239m) and the lower canyon. This elevations within this reach range from 28m to 62m. Bankfull width of this moderately aggraded and sinuous stream reach was approximately 44m and the gradient was 1.82%. The substrate was predominately cobbles (50%) and gravels (32%).

North Haslam Creek (LB: 5+446m) enters the mainstem at just upstream of the old railway bridge site and a gas pipeline crossing (5+410m). Off-channel habitat was identified at 4+665m (RB), 5+410m (RB), 5+583m (LB), 5+838m (RB) and 6+534m (RB). Forms 2 and 6 (Appendix 7) provides stream channel and fish habitat characteristics for Reach 2 and off-channel habitat of Haslam Creek. SHIM detects end of chum salmon access to be at the North Haslam confluence in Reach 2 (5+446m).

R2-Fish Habitat Characteristics

Fish habitat of Reach 2 had more diverse habitat features than Reach 1, due in large part to better water flow conditions. LWD associated with pool habitat resulted in scour depth and cover. More LWD in this reach (2.3 pieces/bankfull channel width) created better primary pools for adult holding habitat. During a survey on November 24, 2001 coho salmon (25) and redds (5) were observed from the powerlines (4+510m) to the gas line crossing (5+410m). Upstream of 5+410m, the majority of the LWD available instream was contained in a few large logjams (4+807m, 5+741m, 5+786m, 5+954m, 6+370m). Spawning gravel quality and quantity was good for salmonids, with low levels of compaction.

There were a number of off-channel habitat sites (4+665m, 5+365m, 5+537m, 5+838m, 6+534m) with good canopy cover. During the summer water depths tended to be shallow or the channels were dry due to low flows and deposition of fines. During high water flow conditions of the winter months, these off-channel sites would be important refuge for juvenile salmonids.

R2-Fish Habitat Disturbance

Gravel aggradations and channel widening has caused the creek to meander within the boundaries of the floodplain as seen from the air photos (Appendix 6). High bars of gravel deposition were evident throughout most of the reach. Ten erosion sites with a total length of 413m were identified in 2000. Banks with lengths of riprap armouring from past erosion protection of private land were found at 3+160m, 3+222m, 3+755m, and 3+810m. In most cases riparian vegetation removal has resulted in bank erosion.

A BC Hydro power line crossing (4+510m), gas line crossing (5+410m), old railway bridge crossing (5+410m), riprap, and erosion due to vegetation removal (3+610m, 3+710m, 3+790m, 4+110m, 4+260m) were all signs of disturbance within this reach. Effects of timber harvesting were also evident, and further described in Section 4.2. Better water quality and flow in this reach provided good summer rearing although areas of gravel aggradations were quite evident.

Table 8.) Haslam Creek Reach 2 Habitat Data Summary and Ratings.

Habitat Parameter	**R2**	**Ratings**	**Result**
Pool Area (%)	68.7	1	Good
Large Woody Debris/Bankfull Channel Width	2.3	1	Good
Average Cover in Pools (%)	23.0	1	Good
Average Boulder Cover (%)	5.0	5	**Poor**
Crown Cover (%)	37.3	5	**Poor**
Substrate (% Fines)	7.6	1	Good
Erosion Sites (%)	10.0	5	**Poor**
Obstructions	0.0	0	-
Altered Stream Sites (%)	3.0	1	Good
Wetted Area (%)	18.8	5	**Poor**
Dissolved Oxygen (ppm)	10.9	1	Good
PH	8.0	1	Good
Result		**3**	**Fair**

4.1.2.1 Reach 2 – Side Channels

Since the original assessment in 2000, one significant off channel was identified at 2,573m. In 2007 & 2008, field surveys and heliflites identified three more sidechannels over 100m long in the reach.

4.1.3 Reach 3

Reach 3 is in a canyon, beginning at the logging road bridge (7+127m) and terminating 872m upstream at 7+999m. The elevations within this reach range from 62m to 83m. The lower section of this reach was contained by the high walls of the canyon. There are no tributaries or off-channel habitat within the reach. Form 3 (Appendix 7) provides stream channel and fish habitat characteristics for Reach 3 of Haslam Creek. The Trans Canada Trail (TCT) suspension bridge was constructed in May 2003 and is located at approximately 7+968m.

R3-Fish Habitat Characteristics

The lower section of the reach is typical of a canyon, with steep sides, exposed bedrock features and substrate dominated by bedrock and boulders. The riparian depth is shallower (30m) than the upper half of the reach, with moderate crown cover (40-60%). Deep scour pools in the exposed bedrock and boulder cover provide good habitat for adult and juvenile salmonids. LWD is being held up by the logjam at 7+359m, which may act as a barrier to upstream fish migration at times. (see Section 2.6.2). The upper half of the surveyed area is not as confined by steep banks and the riparian vegetation is deeper (100m) and provides good canopy cover (80-90%). The substrate is dominated by boulder and cobbles. Further upstream a deep pool and confined canyon walls mark the end of the assessment in 2000.

R3-Fish Habitat Disturbance

Past logging of the riparian area is the most obvious disturbance to the channel. Large stands of red alder and some young conifers are signs of a recently disturbed area, with limited input of LWD. There are no signs of erosion or altered stream sites, besides the bridge crossing which marks the downstream limit of the reach.

Table 9.) Reach 3 Habitat Data Summary and Ratings.

Habitat Parameter	R3	Ratings	Result
Pool Area (%)	61.6	1	Good
Large Woody Debris/Bankfull Channel Width	1.3	3	Fair
Average Cover in Pools (%)	20.0	1	Good
Average Boulder Cover (%)	19.0	3	Fair
Crown Cover (%)	70.0	3	Fair
Substrate (% Fines)	6.4	1	Good
Erosion Sites (%)	0.0	1	Good
Obstructions	0.0	0	-
Altered Stream Sites (%)	3.0	1	Good
Wetted Area (%)	39.9	5	Poor
Dissolved Oxygen (ppm)	10.9	1	Good
PH	8.0	1	Good
Result		**1**	**Good**

4.1.4 Reach 4

Reach 4 was surveyed in 2001 and is approximately 4,080m long. This reach begins at 7+999m and ends at 12+079m. The elevations within this reach range from 83m to 149m. The reach started where the previous survey ended, at the top end of Reach 3. Fish were observed at the beginning of the reach (8+139m) in a large pool (30m X 12m). The average bankfull width of this channel was 21.5m on a gradient of 3.4%. Within this reach there was a number of tributaries and possible off channel habitat. At the beginning of the reach 8+011m there was a swamp over 50m wide on the river right, presenting potential off channel habitat. A small tributary enters the mainstem on the river right at 9+864m and Wolfe Creek enters at 11+442m on the river left. SHIM detects the end of chinook and coho salmon access to be at 9+600m, and steelhead access to end at 12+000m at the confluence with a left bank tributary. Steelhead access continues in this tributary for approximately 4.0Km. Form 4 (Appendix 7) provides stream channel and fish habitat characteristics for Reach 3 of Haslam Creek.

R4-Fish Habitat Characteristics

This reach had varying riparian depths, ranging from creek side logging to 30m depth. A mixed vegetation of conifers and deciduous species (Maple and Alder) dominated the riparian, with an average crown cover of 66%. Recently logged banks (10+499m) had shrubs remaining. The substrate had few fines (4%) and was composed mainly of bedrock and cobble, with dominant sections of bedrock (80-90%) at 9+982m and 11+971m. Moderate pool depth (0.42m) and instream cover (11%) provide little refuge for juvenile salmonids. Low LWD/bankfull width (0.03) limits the number and depth of scour pools and cover opportunities for adult salmonids. Two log jams were located on the river left and right bank at 8+317m and 8+826m respectively. Neither of these log jams prevented upstream fish access.

R4-Fish Habitat Disturbance

The majority of altered sites along this reach were found along the river right. Logging was found throughout the reach with slash up to the stream bank (8+269m, 8+499m, 10+499m and 11+517m) and falling boundary tape along the river right (9+202m). Blowdown was observed along the banks and in the creek at nearby logging blocks. This reach had good bank stability throughout, with one large (66m long) erosion site at the beginning of the reach 8+043m.

Table 10.) Reach 4 Habitat Data Summary and Ratings.

Habitat Parameter	R4	Ratings	Result
Pool Area (%)	29.7	5	**Poor**
Large Woody Debris/Bankfull Channel Width	0.0	5	**Poor**
Average Cover in Pools (%)	11.0	3	Fair
Average Boulder Cover (%)	6.0	5	**Poor**
Crown Cover (%)	66.0	3	Fair
Substrate (% Fines)	3.7	1	Good
Erosion Sites (%)	2.0	1	Good
Obstructions	0.0	0	-
Altered Stream Sites (%)	17.0	5	**Poor**
Wetted Area (%)	36.4	5	**Poor**
Dissolved Oxygen (ppm)	9.3	1	Good
PH	8.4	5	**Poor**
Result		**3**	**Fair**

4.1.5 Reach 5

Reach 5 was the last reach assessed in 2001. It begins at 12+079m and ends 17+396m, at a 6m vertical falls. These falls are the anadromous fish barrier to upstream habitat. This reach is 5317m long, with 4690m of surveyed data. The elevations within this reach range from 148m to 270. At the beginning of the reach (12+096m) a tributary enters on the river right. Further upstream, a waterfall (12+894m) and a creek (15+368m) drain into this reach on the river right and left bank respectively. A 2008 heliflite presented a vertical waterfall on the right bank, at 15+132m. Multiple small tributaries are also located at 16+499m, 16+862m and 17+214m. There were over 50 trout observed in the deep pools within this reach. Form 5 (Appendix 7) provides stream channel and fish habitat characteristics for Reach 3 of Haslam Creek.

R5-Fish Habitat Characteristics

The reach is mainly of low gradient riffles of boulder and cobble and deep bedrock pools (0.5m – 2.0m). The substrate was composed primarily of bedrock (39%), boulder (23%) and cobble (23%). The reach had segments of steep bedrock sidewalls (90%), with shallow vegetation depth (23m) and little crown cover (28%). The average bankfull width was 18.29m on a gradient of 2.08%. The channel provided moderate instream cover, however it was solely boulder cover (15%). Low LWD/bankfull width (0.09) minimized adult and juvenile salmonids cover. The reach ends at the anadromous fish barrier (17+396m), a 6m vertical bedrock falls.

R5-Fish Habitat Disturbance

This reach had multiple erosion sites (12+091m – 38m; 12+257m – 132m; 12+917m – 9m; 13+970m – 20m; 14+087m – 43m; 14+703m – 20m, 16+410m – 10m). Logging has also had a major impact on this reach, as cut blocks are evident right to the stream bank (12+091m, 13+062m and 13+607m) reducing overhead canopy. Nearby logging activity has left portions of the stream exposed, with grasses and shrubs as its sole vegetation (12+091m, 12+564m, 12+889m, 13+062m and 13+559m). Large logging blocks are also found on either side of the creek, with 30m strips of riparian buffer between it and the creek. A large slide approximately 18m long, is located at 16+976m to 16+994m. This slide is composed mainly of large boulders that block the creek channel entirely. A large gravel wedge (>2m deep) is located upstream of the large slide (16+994m to ~17+014).

Table 11.) Reach 5 Habitat Data Summary and Ratings.

Habitat Parameter	R5	Ratings	Result
Pool Area (%)	37.6	5	**Poor**
Large Woody Debris/Bankfull Channel Width	0.1	5	**Poor**
Average Cover in Pools (%)	15.0	3	Fair
Average Boulder Cover (%)	15.0	3	Fair
Crown Cover (%)	28.0	5	**Poor**
Substrate (% Fines)	2.3	1	Good
Erosion Sites (%)	6.0	3	Fair
Obstructions	1.0	1	-
Altered Stream Sites (%)	13.0	5	**Poor**
Wetted Area (%)	26.7	5	**Poor**
Dissolved Oxygen (ppm)	9.1	1	Good
PH	8.5	5	**Poor**
Result		**3**	**Fair**

4.1.6 Reach 6

This reach was not physically surveyed, as it was unsafe to traverse due to its confined canyon sidewalls, deep pools and falls. This reach was assessed by using information acquired from the USHP data of Reach 5 and Reach 7 (which was traversed in 2009), as well as retrieving data from Google Earth and SHIM. Tributaries are found entering this reach on both the left and right banks (SHIM image). This reach begins at the anadromous fish barrier (17+396m) and ends approximately 4+360m upstream at a 5m bedrock falls (21+755m). The elevations within this reach range from 270m to 545m.

R6-Fish Habitat Characteristics

This reach is predominantly bedrock with boulder and cobble substrates. The downstream segment (17+400m to 20+300m) of this reach has a wider channel width (~18m) on a lower gradient (4-5%) than the upstream segment (6-10m wide on a 10-15% gradient) approximately 4.3Km upstream. The reach is expected to have deep bedrock pools (~1.0-1.5m) with boulder likely being the sole instream juvenile fish cover. Looking downstream from the Reach 7/Reach 6 break, the creek flows into a steep canyon with multiple bedrock falls on a 48% gradient. It is expected that this reach has a poor rating in the following USHP habitat parameters; LWD/bankfull width, instream boulder cover, percent altered reach, percent crown cover and percent wetted area ratings as its adjacent reaches had similar ratings.

R6-Fish Habitat Disturbance

A high concentration of cutblocks are located at the beginning of the reach along the right bank ridge. Logging roads are found along the riparian ridges. A hydro power line crossing is located at approximately 17+625m.

4.1.7 Reach 7

This reach underwent a USHP assessment in the fall of 2009. The reach began at the upstream Reach 6 reach break (21+755m), where the channel enters a steep canyon, and terminates approximately 2.9Km upstream at the entrance of Haslam Lake (24+665m). The first 374m of this reach (21+755m to 22+119m) underwent a USHP survey, the remainder of the reach (22+119m to 24+665m) was assessed through the use of SHIM, Google Earth and field reports. There are no tributaries entering this surveyed portion of the reach, however a left bank braid (21+886m to 21+911m) provides off channel habitat within this reach. SHIM provides evidence of small tributaries throughout the upper section of this reach. Form 7 (Appendix 7) provides stream channel and fish habitat characteristics for Reach 3 of Haslam Creek.

R7-Fish Habitat Characteristics

The average bankfull width of this channel was 8.81m on an average gradient of 6.45%. The substrate was composed mainly of bedrock (30%), boulder (31%) and cobble (22%). The beginning of this reach consisted of an 18% boulder cascades (21+797m) and a 5m bedrock falls on a steep 48% gradient. The first 134m of this reach (21+755m to 21+899m) ran on steep grades (21% average), with deep pools (0.8m – 1.5m) on bedrock substrates. The last 240m of the surveyed reach (21+889 to 22+119m) had shallow pools (0.35m average) on a low gradient substrate (5% average) composed mainly of boulder, cobble and gravel.

This reach had moderate vegetation depths ranging from 15m to 50m with a consistent crown cover (80-85%) throughout the reach. The channel had moderate instream cover (13%), consisting of boulder (8%) and cutbanks (5%) and minimal LWD/bankfull width (0.1). Eight Rainbow trout were observed (75-200mm) in a deep (0.8m) boulder pool, with one piece of LWD at 21+900m. At 22+004m Rainbow trout observed in a deep (0.4m) pool, with no cover.

R7-Fish Habitat Disturbance

Altered sites, logging activity and erosion sites are found along this reach. The USHP survey of this reach ended at a bridge crossing (22+119m). A 13m wide left bank slide on a 75% slope was located at the downstream end of the reach (21+769m to 21+782m). A 25m left bank braid is located just downstream of the logging block, providing potential off channel habitat. A logging road gate is found (22+029m to 22+054m). Logging activity (22+043 to 22+096m) was evident approximately 30m from the stream banks.

Table 12.) Reach 7 Habitat Data Summary and Ratings.

Habitat Parameter	R7	Ratings	Result
Pool Area (%)	40.8	3	Fair
Large Woody Debris/Bankfull Channel Width	0.1	5	**Poor**
Average Cover in Pools (%)	13.0	3	Fair
Average Boulder Cover (%)	8.0	5	**Poor**
Crown Cover (%)	84.4	1	Good
Substrate (% Fines)	9.1	1	Good
Erosion Sites (%)	3.5	1	Good
Obstructions	1	1	-
Altered Stream Sites (%)	26.4	5	**Poor**
Wetted Area (%)	35.8	5	**Poor**
Dissolved Oxygen (ppm)	n/a	-	-
PH	n/a	-	**-**
Result		**3**	**Fair**

4.1.8 Reach 8 – Haslam Lake Headwaters

The 4.0ha Haslam Lake marks the final reach of this creek, Reach 8. This lake sits an elevation of 889m. This reach was not physically surveyed due to weather and timing restrictions.

4.2 Riparian Habitat Assessment

Tables 13 to 18 below show the Riparian Characteristics scores and ratings. The higher overall score indicates negative impacts to the riparian zone.

4.2.1 *Reach 1*

Due to urban and rural development, the riparian buffer zone has been reduced (20m), compromising the integrity of the greenway corridor along the creek for fish and wildlife. Exposed and eroding banks near the Nanaimo Airport (1+700m) are the most heavily impacted. This reach had an average depth of 21m which is poor. This low score is due to nearby industrial and urban development, agriculture fields, proximity to airport, waterline crossing and bridge crossings.

Land Use: This reach was historically logged, with urban development and agricultural fields surrounding the riparian. This lower reach is within the RDN. This reach has the highest land use score of all the reaches, as it is bordered by agriculture, roads and urban development.

Bank Slope: Reach 1 has moderate bank slopes (30-45%) at the Nanaimo River confluence, however the riparian slopes quickly flatten to a low 1-2% for the remainder of the reach which is good. The banks were clay with no bedrock.

Bank Stability: This reach has fair bank stability due to the stable banks having multiple erosion sites (0+571m, 1+700m, 1+900m, 2+200m), braids (1+500m, 1+775m) and alterations (0+571m).

Table 13.) Reach 1 Riparian Habitat Ratings

Characteristics	Score	Rating	Result
Land Use	156	3	Fair
Bank Slope	36	1	Good
Bank Stability	158	3	Fair
Total	**350**		Fair

4.2.2 *Reach 2*

As with Reach 1, timber harvesting has had an impact on the vegetation along the creek. The riparian vegetation is a mix of red alder, big-leaf maple, Douglas-fir, Western Red Cedar and some Western hemlock. A reduction in the amount of strong coniferous root masses along the stream bank results in increased bank erosion and a wider channel. Reach 2 had an average vegetation depth of 57m which is fair. The reach had riparian depths ranging from 2m to 100m. Multiple riparian alterations (current logging, bridge crossings, hydro and gas line crossings, Rondalyn Resort) throughout the reach reduced the vegetation depth.

Land Use: This reach was historically logged, with current logging practices of second growth forests still underway by private logging companies. This reach is within the RDN, with urban development encroaching on the riparian area. This reach had the second highest land use score as portions of this reach are neighboring farms, roads and commercial buildings.

Bank Slope: This reach had the highest bank slope score of all the reaches. The higher score is a result of the first 1.0Km of the reach having steep banks slopes (50-100%) and the remaining reach segment had low bank slopes (1-10%). The banks were composed of clay substrates with no bedrock.

Bank Stability: This reach had the highest bank stability score of all the reaches due to the multiple erosion sites (13-100m wide) and altered sites throughout the reach.

Table 14.) Reach 2 Riparian Habitat Ratings

Characteristics	Score	Rating	Result
Land Use	120	2	Fair
Bank Slope	94	1	Good
Bank Stability	208	3	Fair
Total	**422**		Fair

4.2.3 *Reach 3*

Along the canyon and further upstream timber harvesting has effected the tree species composition in the riparian zone, but not to the same degree as in Reaches 2 and 3. Small blocks of old-growth timber inaccessible to past timber harvesting can still be seen along the canyon. In 2001, helicopter logging is expected to remove 4-5 ha of wood within the canyon.

Reach 3 had an average depth of 73m, which is good. The reach had riparian depths ranging from 30m to over 300m.

Land Use: The reach begins at a bridge crossing, just upstream of the Rondalyn Resort. This reach is within the RDN and has private logging parcels nearby. This reach lacks the intense urbanization seen in the first two reaches. A 32ha gravel pit is found on the right bank, with a riparian strip ranging from 30m to ~380m deep between the pit and the creek. The TCT is an active walking trail used by the public. The Haslam Creek suspension bridge was open to the public in May 2003 and is located just downstream of the Reach 4/Reach 3 boundary at 7+968m.

Bank Slope: This reach had very low bank gradients (1-5%) which appear to be stable.

Bank Stability: High bank stability was found throughout this entire reach. The first 400m of stream bank were stabilized by bedrock canyon sidewalls.

Table 15.) Reach 3 Riparian Habitat Ratings

Characteristics	Score	Rating	Result
Land Use	24	1	Good
Bank Slope	13	1	Good
Bank Stability	18	1	Good
Total	**55**		Good

4.2.4 *Reach 4*

Reach 4 has large cutblocks of second growth forest along both riparian banks. This reach has both deciduous and conifer dominated segments along the streambank. Low lying shrubs are also evident in exposed areas that have an open canopy and few mature trees. Reach 4 had an average vegetation depth of 23m, which is fair. This low score is due to the logging blocks encroaching on the riparian zone.

Land Use: This reach begins in the RDN and crosses into the CVRD at 10+699m into the reach. Logging of cutblocks are found along both river banks by private logging companies. The TCT borders the left bank riparian for approximately 1Km before it then diverges north towards Timberland Lake (Appendix 8).

Bank Slope: This reach had low bank slopes (1-30%) for the first 3.0Km which is good. The remaining reach length had steeper bank slopes (30-75%) resulting in a poorer rating.

Bank Stability: This reach had high bank stability throughout, with small segments of poor stability due to nearby logging activity and erosion sites.

Table 16.) Reach 4 Riparian Habitat Ratings

Characteristics	Score	Rating	Result
Land Use	58	3	Fair
Bank Slope	36	2	Fair
Bank Stability	24	2	Fair
Total	**118**		Fair

4.2.5 *Reach 5*

The riparian vegetation within this reach is composed of a mixed second growth forest composed of Maple, Western Red Cedar and Douglas Fir. Exposed stream side areas have low lying shrubs. Reach 5 had an average vegetation depth of 23m, which is poor. This reach had riparian depths ranging from 0m to 50m and wide open canopy averaging 10%.

Land Use: Reach 5 is found solely in the CVRD. The reach is highly impacted by logging practices, as both river banks have multiple large parcels of cutblocks. There is no urbanization within this upper reach.

Bank Slope: This reach had steep riparian slopes (80-90%) throughout its length, with a shallow segment (10%) along the river right (13+000m-14+044m).

Bank Stability: This reach had good bank stability due to the bedrock canyon walls, however it is vulnerable to disturbance as multiple erosion sites (12+079m, 12+245m, 13+958m, 14+027m, 14+691m, 16+410m) are found throughout its length. A large debris slide plugs the entire channel at 16+976m to 16+994m.

Table 17.) Reach 5 Riparian Habitat Ratings

Characteristics	Score	Rating	Result
Land Use	34	2	Fair
Bank Slope	56	4	Fair
Bank Stability	36	3	Fair
Total	**126**		Fair

4.2.6 *Reach 6*

Reach 6 was not physically surveyed, however analysis of the reach was conducted through the use of Google Earth. The reach is within a second growth forest dominated by Western Red Cedar and Douglas Fir. The vegetation depth ranged from 20m to over 100m (Google Earth).

Land Use: Reach 6 is within the CVRD. Large parcels of cutblocks are found at the beginning of the reach on either side of the creek gully. A BC Hydro powerline crossing is also located approximately 17+625m upstream of the beginning of the reach.

Bank Slope: This reach likely has moderate bank slopes (40-90%), through data comparison of reaches 5 and 7. The upstream portion of reach 5 had slopes of 80%, and the downstream portion of reach 7 had bank slopes of 40%. A Google Earth image of the reach depicts a canyon segment with high slopes (70-90%) at the beginning of this reach.

Bank Stability: This reach is expected to have medium to high bank stability with a bedrock channel and sidewalls stabilizing the banks. The upstream portion of Reach 5 and downstream portion of Reach 7 were also quite stable with a similar substrate and channel structure.

4.2.7 *Reach 7*

This reach was physically surveyed from 21+755 to 22+119m. The remaining 2.5Km was assessed with assistance of Google Earth, SHIM and field reports. The riparian vegetation within this reach is that of a second growth forest composed of Western Red Cedar, Douglas Fir, Hemlock, Maple and Red Alder. The lower 400m of this reach had an average depth of 32m, which is fair. This reach had riparian depths ranging from 15m to 50m and provides a crown cover of 85% on the stream channel. A large cutblock along the left bank is present at approximately 22+800, reducing the riparian vegetation depth to 50m at some locations. The remainder of the reach has vegetation depths of over 100m long.

Land Use: Reach 7 is within the CVRD. There are no urban or agricultural activities within this upper reach. The majority of the reach is natural with large parcels of wood harvested along the left bank.

Bank Slope: The first 150m of this reach is confined by bedrock sidewalls on slopes averaging 20-40%. The remaining upstream segment has shallower bank slopes (5-20%).

Bank Stability: The entire reach had moderate bank stability throughout with no erosion sites. Logging activity (86m long) downstream of the bridge crossing (22+119m) creates a site of vulnerability within this reach.

Table 18.) Reach 7 Riparian Habitat Ratings – Dave/Brad Survey

Characteristics	Score	Rating	Result
Land Use	36	2	Fair
Bank Slope	24	1	Good
Bank Stability	57	2	Fair
Total	**117**		Fair

4.2.8 *Reach 8 – Haslam Lake*

Reach 8 was not physically surveyed, however analysis of this reach was conducted through Google Earth and SHIM. Haslam Lake is surrounded by a second growth forest, in similar composition as the lower creek reaches (Western Red Cedar, Douglas Fir, Hemlock). Logging activity is present within this reach. It is unclear how much of the headwaters have recent cutblocks as the most recent available images are from 2007, from SHIM.

Land Use: Reaches 8 is within the CVRD and is the upper reach of this creek. Logging within this reach is evident through the large cutblocks and the extensive logging road networks in this upper portion of this watershed.

5.0 Discussion

5.1 Overview of Current Survey Data

The USHP surveys conducted on Haslam Creek were completed in 2000 (Reaches 1 to 3), 2001 (Reaches 4 and 5) and 2009 (Reach 7). The data obtained in 2000 and 2001 are still pertinent information, however its analysis must be adjusted for the changes the stream has undergone in a 10 year period. High flows over the years have created additional, as well as concentrated the issues, such as: channel braiding, unstable stream banks, erosion sites, sediment loading and riparian loss in the lower reaches. The overview heliflite in 2008, as well as satellite images from SHIM and Google Earth have provided current information of the status of the lower reaches, as they were surveyed nearly a decade ago. Data for Reach 6 and the upper 2.4Km of Reach 7 were obtained from data extrapolation from Reaches 5 and 7, heliflites, SHIM and Google Earth.

The USHP survey exceeded minimum sampling requirements (10%) for representative USHP stream surveys (Johnston and Slaney, 1996). We surveyed almost every habitat unit completely (pools and riffles) resulting in approximately 17.1Km of the 24.7Km length being entirely sampled. The high rate of sampling allows high precision in the habitat survey and gives specific conditions of pools and riffles for restoration planning. In the end, this saves time and money by gathering enough data to not only know the condition but also have enough information to do something about it. The major tributaries of Haslam Creek (Napoleon, Hokkanen, Cottonwood, Airport, North Haslam) would also benefit from a USHP survey.

All three USHP surveys were conducted in a similar manner, following the USHP Assessment Procedures for Vancouver Island (MELP, 2000b). Data acquired for Reaches 1 through 5 were conducted by the same crew, providing consistent methods and data entry for those reaches. Data collection of Reaches 6, 7 and 8 were conducted by a separate field crew, creating minor discrepancies in methods and data.

Data entries in Reaches 1 through 5 USHP spreadsheets are inconsistent and/or missing data. The reaches are measured and broken up into habitat units (pools/riffles), however there are sections of substantial length absent between these units. Although the missing lengths would provide more data points and create a more accurate summary of the reaches, they are not required as key features were noted. Furthermore, the depth of every pool and gradients were not regularly measured. There seemed to be an inconsistency in determining which pools were measured and which were not. There is a significant amount of data provided within the reaches and all major habitat units (wetted pools and wetted riffles), alterations, obstructions, erosion sites and stream characteristics are noted.

Reach 6 and the upper 2.4Km of Reach 7 were not physically surveyed due to weather and timing restrictions, as well as inhospitable terrain. A USHP survey was not conducted on either of those sections, causing data comparison between all the reaches to be inconsistent. A USHP survey was conducted on the first 374m of Reach 7, however the data was collected and entered differently then Reaches 1 through 5. The Reach 7 survey involved measuring every habitat unit, as well as measuring the entire length with no missing sections within the assessed reach portion. All riffles (dry and wet) and pools were noted, as well as every pool depth was measured.

Water quality (DO, pH, TDS, Temp) was measured at the beginning of Reaches 1 through 5, however only water temperature was measured in Reach 7. In depth water quality sampling is recommended for this creek annually at each reach. Field samples, as well as grab samples sent to laboratories would be valuable in determining such parameters as coliform, metals, nutrient and PAH contents. A stream discharge station (08HB003) was run from 1914-1915, 1949-1962 and 1993-1998 in Haslam Creek near Cassidy. Monitoring should be re-established at the station to determine current flow regimes.

Reaches 1, 2, 4, 5 and 7 of Haslam Creek are in poor habitat condition based on the diagnostics provided by the USHP Assessment and Mapping Procedures (Table.19).

Table 19.) USHP Habitat Results; R1 - R7, Parameters with Poor Rating.

Habitat Parameter	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6*	Reach 7
Pool Area (%)				✓	✓		
Large Woody Debris/ Bankfull Channel Width	✓			✓	✓	✓	✓
Avg. Cover in Pools (%)							
Avg. Boulder Cover (%)	✓	✓		✓		✓	✓
Crown Cover (%)		✓			✓	✓	
Substrate (% Fines)							
Erosion Sites (%)		✓					
Obstructions							
Altered Stream Sites (%)				✓	✓	✓	✓
Wetted Area (%)	✓	✓	✓	✓	✓	✓	✓
Dissolved Oxygen (ppm)							
PH				✓	✓		

*Reach 6 data extrapolated from Reach 5 and 7 USHP data.

5.2 Study Comparison

In 1999, Reid et al, wrote a report on fish habitat status on 14 east coast Vancouver Island streams. The streams were all inventoried under the USHP methodology by stewardship organizations. Table 20 compares five habitat variables (Pool Area, LWD, Cover, Fines, Wetted Area) of Haslam Creek to 14 Vancouver Island streams, four of which had poor results.

Table 20.) Status of Fish Habitat of Haslam Creek & 14 Vancouver Island Streams

Watershed	Percent Pool Area (<55%)	Large Woody Debris (<2)	Percent Instream Cover (<20%)	Percent Fines (10-20%)	Percent Wetted Area (<90%)
Haslam Ck	**X**	**X**	**X**		**X**
Ayum Creek	X				X
Beach Creek		X		X	X
Bear Creek		X	X	No Data	X
Fairways Creek		X	X	No Data	X
Kingfisher Creek	X	X	X	X	X
Little Oyster R.		X	X	No Data	X
Little River		X		X	X
Nile Creek		X	X	No Data	X
Piercy Creek	X	X	X	X	X
Scales Creek	X	X		X	X
Simms Creek	X	X	No data	No Data	X
Thatcher Creek		X	X	X	No Data
Woodhus Creek	X	X	X	No Data	X
Woods Creek		X		X	X

*An X entry represents a rating poorer than the proposed cutoff for acceptable habitat quality.

In 2002, LGL Limited and BCCF conducted an in-depth fish habitat restoration prescription for the MWLAP (Gaboury and McCulloch, 2002). The prescription included five eastern Vancouver Island creeks, one of which was Haslam Creek. Instream restoration designs of the first 7,049m of Haslam Creek were described in order to target both juvenile and adult salmonids at a site specific basis (Appendix 9). The USHP data provided in the previous publication of this report (Hanelt, 2001) was the basis of the restoration prescription design. LWD structures, boulder and spawning gravel placement were recommended in order to improve rearing and spawning habitat, increase fish access and improve fry densities. The report covers site specific material requirements, as well as a cost estimate (equipment, materials and labour) for the proposed project (Appendix 9).

In 2007, Michalski and Sala conducted an examination of the amounts of critical habitat components in almost 90 east coast Vancouver Island streams, one of which being Haslam Creek. Creeks were separated by districts and then the biostandards were compared for good and poor habitat. The data was based on USHP surveys provided by stewardship group volunteers. The study divided Haslam Creek into two reaches: Haslam Lower (0+000m to 8+815m) and Haslam Upper. The data was entered into the USHP excel spreadsheet where the habitat data was compared to the biostandards and then rated (Appendix 10). Based on the USHP biostandards, Lower and Upper Haslam rated poorly in both the instream and riparian classification. This study recognized pool area, LWD input, percent fines, percent wetted area and riparian habitat to be the major concerns of this creek, which coincides with the USHP data provided in this report. The 2007 study did not indicate erosion or altered site locations, as well as water quality.

5.3 Restoration Planning

Watershed Assessment

This report covers a habitat assessment of Haslam Creek. The habitat prescriptions below address the impacts on the watershed from logging practices, and urban and rural development. A Watershed Assessment involving the geomorphology, silviculture, hydrology and cultural uses involving the Snuneymeuwx First Nation should considered a high priority. This assessment would identify areas of development that are currently exceeding sustainable levels such as:

- logging road impacts – deactivation plans
- riparian recovery – planting & maintenance strategies

5.4 Restoration Activities

Restoration activities along Reach 1 began in 2007 and have been carried through to 2009 by Nanaimo River Stewardship Society, Nanaimo Airport Commission, D.R. Clough Consulting and many partners (Clough, 2007-2009). Future work is planned for the summer of 2010. Reach 1 was determined as the highest priority reach. The prioritization of restoration in Reach 1 was determined by the effects of flooding, erosion, riparian loss and channel sediment loading. Log spurs, gravel bar scalping, stump revetments and rock groins were accomplished from 2007 to 2009 (See table 21). Continued site visits and maintenance are required to determine structure additions or modifications.

Table 21. Haslam Creek Reach 1 Restoration History 2007-2009.

Site	Site Length (m)	Stream Bank	Activity	Bank Length (m)	Log # & Length (m)	Stump #	Ballast Rock #	Project Year
1	2+382-2+390	RB	Spur	8	1-15 2-8	6	6	Completed 2007
2	2+350-2+390	LB	Bar Scalp	40	-	-	-	Completed 2007
3	2+350-2+390	RB	Stump	40	10-8	40	40	Completed 2007
4	1+960 - 2+033	RB	Stump	80	15-5	75	75	Began 2008
5	1+890 - 1+960	LB	Bar Scalp	70x5	-	-	-	Began 2008
1	2+362-2+382	RB	Stump/ Rock groin	20	-	5	15	Completed 2009
4	1+960 - 2+033	RB	Stump	15	-	5	10	Completed 2009
6	2+368-2+372	RB	Stump	4	-	2	6	Completed 2009
7	2+114-2+159	LB	Stump	45	-	30	55	Completed 2009
8	2+109 - 2+159	RB	Stump	50	-	40	60	Completed 2009
	Total:				**28**	**197**	**267**	

The restoration activities described below are proposed based on the habitat conditions detailed within this report. The prescriptions listed generally require additional site visits to photograph the site and determine changes in habitat conditions and access. Work plans, permits and land owner notification are also required. Design considerations are also reviewed such as equipment, materials (LWD, rip rap, gravel, and plants), tools and crew size.

5.4.1 Monitoring

1. Water: A staff gauge or a remote data logger is recommended to receive water flow and temperature data, as they are both simple and inexpensive methods. On-site field equipment, as well as grab samples should be conducted to determine the quality of water for fish and aquatic life.

2. Habitat Surveys
There is missing data on the complete status of fish habitat. Reach 6, the upper 2.4Km of Reach 7, as well as Reach 8 (Haslam Lake) require a habitat assessment in order to confirm the summer wetted area of all reaches. Major tributaries would benefit from a USHP survey, as many are salmon accessible that offer spawning and rearing opportunities.

3. Riparian Assessment: The reaches throughout Haslam Creek require a survey of the health, type and density of the riparian vegetation. This survey would require grouping tree types into polygons on an ortho map of the riparian zone adjacent Haslam Creek. Each polygon would represent a different stand condition and corresponding treatment, if any. Riparian assessment and restoration procedures are based on improving the forest health and biodiversity towards a target of old growth characteristics, described in the publication "Riparian Restoration in British Columbia: What's Happening Now, What's Needed for the Future by Vince Poulin, Cathy Harris and Bart Simmons (March 2000) for the Watershed Restoration Program".

Ultimately the creek health will depend on the health of the riparian zone – a mix of shrubbery, conifers and deciduous trees. Some hot spots may have to be addressed before the assessment such as areas of blow down or under-stocked erosion sites. Bioengineering techniques such as willow staking and wattles will also be prescribed that straddle a grey area between riparian work and erosion control.

5.4.2 Habitat Restoration

Instream restoration techniques improved markedly with the implementation of the Watershed Restoration Program in the mid 1990s'. Although disbanded, its manuals and references are good examples of the basic templates used today. Fish Habitat Rehabilitation Procedures; Watershed Restoration Technical Circular No. 9" edited by Pat Slaney and Daiva Zaldokas (1997) describes the following techniques. In-stream restoration should follow the methods outlined in the Standard Operation Procedures for in-stream work (Appendix 11).

1. Bank Repair: Bank repair is needed in Reaches 1, 2 and 5. Erosion is a process that can occur naturally (such as: flooding, channel braiding, bank failure) or from anthropogenic activities (such as: logging, road building, urban development). Techniques incorporating wood debris and rock (instead of solid man-made structures) as much as possible, as well as streamside planting are used to mitigate the damages of failing banks.

Babakaiff et al. (1997) describe bank stabilization methods, specifically used to rehabilitate stream banks that have been historically impacted by logging. These techniques include LWD revetments, rock (revetments, groins, deflectors), and bioengineering methods. Bioengineering methods (live stakes, brush mats, live gravel bar staking, wattle fences, live palisades) are used to repair unstable banks by providing a sustainable vegetative cover on treated sites. Soil Bioengineering Techniques For Riparian Restoration by David Polster (2002) provides an in depth manual of the materials and methods required to address unstable banks using live plant material.

Significant erosion sites should be addressed by covering the eroded banks with LWD revetments (See below: 5.3.2 #4). Riparian planting of conifers and shrubs has mulitiple benefits, such as reducing sediment input as the established roots will stabilize banks, as well as provide instream fish cover and contribute nutrients, organics and food material for fish and invertebrates.

2. Stump Revetments: The banks along Reaches 1 and 2 are composed of soft clays that are easily erodible when subjected to winter flows. The 2008 heliflite showed evidence of flooding, causing streamside vegetation to tear from the bank, creating loose, exposed banks to be subjected to high flows.

The placement of conifer stumps (1.5-3.0m diameter) with large rock (0.75-1.5m) anchoring the structures are used to protect the eroding banks. The stumps will be placed with root wads directed instream, providing cover for fish, creating scour pools and redirecting flow. The structures will be drilled through and looped with 5/8" galvanized cable and secured with splices and clamps.

3. LWD Placement: LWD is generally described as wood material (>10 cm dia. and >2 m long) that mainly enters stream channels from stream bank undercutting, windthrow, and slope failures (Johnston & Slaney, 1997). Most of the large old growth was logged and the smaller second growth is small and easily displaced by floods. The introduction of instream LWD improves habitat complexity, increasing the production of coho smolts, instream rearing of anadromous and resident salmonids (Koning and Keeley, 1997). The addition of anchored LWD provides much-needed habitat for adults and juveniles, as it contributes to escape cover from predators and high velocities. It is also an integral device for protecting banks from erosion, creating scour pools, as well as assist in channel stabilization and energy dissipation (Cedarholm et al., 1997).

The most typical LWD structure is a triangular spur consisting of 4-6 pieces of Cedar and Fir logs at least 0.3m diameter. The voids in the spur are filled with stumps and smaller logs. The entire structure is anchored by large ballast rock (approximately 6) and/or trees and stumps. LWD structures ballasted with rip rap, will be anchored by looping 5/8" galvanized cable through drilled holes in the rock and using an anchoring compound (such as Rockite), splices and clamps to secure the structure. The long term desired treatment is at least 1 LWD structure per pool. Placement of these structures will create scour provided the flood waters cannot exit around them. The locations of log spurs are recommended in areas where the channel can be confined.

LWD placement should occur in all reaches, with an emphasis on Reaches 1 and 2. LWD should be placed according to the guidelines in the LWD Placement SOP (Appendix 11) developed by program biologists in conjunction with Fisheries and Oceans Canada staff.There are limited stable LWD within these reaches. This would confine the channel, and assist in directing flow away from weak banks. Reach 2 would especially benefit from this technique due to the braiding and blow outs occurring between the hydro line crossing (4+510m) and the downstream end of the Rondalyn Resort (6+239m). Large pieces of wood are found throughout Reach 2, as floods and high water have displaced streamside trees and created LWD jams. This wood can be utilized instream by creating structures or cabling in place. This would protect the bank and prevent downstream movement and future jams. Ballast rock would have to be trucked in, and the wood and rock would be placed by machine.

4. Off Channel Habitat: Haslam Creek suffers from low flows and total dewatering, especially in Reaches 1 and 2, during the summer. This lower reach has shallow isolated pools in the summer that strand fry in warm, low oxygenated water. This will affect year-round fish and other aquatic species significantly. High winter flows erode the unstable clay banks, causing sediments to fill in the channel and bury their eggs. Off channel habitat can mitigate these impacts. The habitat can be short alcoves which are supplied by ground water or longer systems supplied by an inflow supply from upstream. They are designed in flood stable locations where the summer water table will not dry up, providing year round food supplies for fish. Off-channel habitat is constructed using an excavator with material side cast to the river side to protect it from floods. Off channel habitat does not replace mainstem habitat, which offers better spawning potential due to higher flows but can be an excellent rearing for seasonal to perennial periods until it heals.

5. Riparian Restoration: Instream habitat restoration procedures described above provide a short to medium time frame benefits that would be reaped with a healthy riparian zone. There has been no riparian assessment completed to date. The habitat survey indicates stands composed primarily of deciduous trees along the stream bank, with a riparian strip of second growth Douglas Fir, Western Red Cedar and Hemlock. Reach 2 demonstrates high flows blowing through the young forest, causing stream banks and trees to fall into the mainstem. The felled timber create unstable debris jams.

5.5 Determining Priorities

In general, the assessment results highlight some of the impacts of almost a century of land-use in the Haslam Creek watershed. Low summer water flows and changes to the riparian vegetation have reduced the quantity and quality of fish habitat. A combination of past logging practices, coal mining operations, water extraction, gravel aggradation, bank erosion and rural and urban land-use have all put pressure on the fisheries resource.

Based on the Summary and Ratings Table (Form 8 - Appendix 7) a comprehensive priority list of proposed future habitat restoration projects has been generated. Priorities were determined by utilizing the habitat parameter rating system and professional judgment.

From the ***fish habitat assessment***, the highest priorities of concern were:
- Altered reach (20 points)
- large woody debris/bankfull channel width (24 points)
- average % boulder area (26 points) and
- % wetted area (30 points)

Although these reaches did not have the highest scores, the reaches of most concern, are:
- Reach 1 (28 points) and
- Reach 2 (22 points)

From the ***riparian habitat assessment***, the highest priorities of concern were:
- % crown cover (20 points); and
- average vegetation depth (22 points)

It should be noted that typical instream restoration recommendations such as building LWD structures and rock groins in the mainstem of Haslam Creek are more difficult due to the unstable nature of the channel. Boulder clusters were built during the 1990's in the lower Haslam Creek with limited success due to bedload movement. A meandering channel, high bedload movement and low water levels in the summer make this type of restoration work more of a risk of failure.

The concept of restoration within Haslam Creek is to improve the stream ecosystem from its present state by recognizing the limiting factors.

1. Watershed Restoration: control of erosion from upslope sources
2. Stream channel and instream habitat must be stabilized
3. Fish production through restoring habitat carrying capacity

To function properly a stream must be able to:

- dissipate stream energy from floods thereby reducing erosion;
- filter sediment, capture bedload and aid floodplain development;
- improve flood-water retention and ground-water storage;
- develop root masses that stabilize streambanks against cutting action;
- develop diverse habitat and water depth, duration and temperature necessary for fish production and other uses.

Table 22.overleaf lists restoration activities recommended for the stream that would improve one or more of the habitat parameters that scored poorly on this USHP inventory. The prioritization of activity is based on best benefit to fish populations on a given budget and reasonable feasibility. These prioritizations are the authors' opinion based on experience, with stream restoration projects in the area.

Table 22.) Priority Restoration Activities Reaches 1-8.

Reach	Length (m)	Restoration Activity	Priority
1	3,010	LWD Placement Boulder Placement Bank Repair Riparian Assessment Sediment Removal	Critical Critical Medium High Medium
2	4,117	LWD Placement Boulder Placement Bank Repair Riparian Assessment Sediment Removal	Medium-High Medium-High Critical High Medium
3	872	LWD Placement Boulder Placement Riparian Assessment	Medium-High Medium Low-Medium
4	4,080	LWD Placement Boulder Placement Riparian Assessment	Critical High-Critical Medium
5	5,317	LWD Placement Bank Repair – Road Deactivation Riparian Assessment	Critical Medium-High Medium
6	4,359	LWD Placement Bank Repair – Road Deactivation Riparian Assessment	High Medium-High Medium
7	2,910	Slide Stabilization LWD Placement Boulder Placement Riparian Assessment	High Critical High-Critical Medium
8	4.0ha	Fish Density Survey Habitat Assessment Riparian Assessment	Medium-High High Medium
Total Length	**24,665 m +4ha**		

5.6 Reach Prescriptions

5.6.1 Reach 1 Prescriptions

Reach 1 is the highest priority reach within this creek due to the high levels of erosion and gravel aggradations, as well as the lack of riparian and invasion of rural and urban development. A lack of riparian vegetation stabilizing the stream bank has contributed to the eroding banks and subsequent excessive sediment loading. This reach has small, isolated pools and large dry riffles during the summer, partly attributed to the large unvegetated gravel bars (>2m deep) found throughout. The stream bed is flat, with little thalweg. Water licenses on this creek are attributing to the low summer flows found throughout this reach, causing fry to be stranded in warm, low-oxygenated pools.

Reach 1 has nearly 1.0Km of erosion, with a high concentration along the river left bank at the Napoleon Ck confluence (0+300m) and the river right bank starting at the Cottonwood Ck confluence (1+411m) upstream to T-bridge (2+382m). The data within this reach (as well as reaches 2-5) are ten years old, causing a high degree of site condition alterations in the past decade. Erosion sites have increased in size and severity causing riparian and property loss to nearby residences.

This reach would benefit from bank stabilization in the form of stump revetments and A-frame log spurs along the steep, eroding banks. This would prevent future contributions of sediments into the channel. Gravel removal using an excavator could remove large sediment accumulations, increasing channel capacity and reducing erosion. Placing willow stakes in unvegetated areas could stabilize the remaining gravel bars. Spawning habitat can be enhanced by stabilizing mobile gravel through rock crest installations on the downstream side of gravel beds.

1. Riparian Vegetation Planting - Agricultural and urban land-use put a tremendous pressure on the river and the riparian vegetation. The stream's carrying capacity to produce salmonids is controlled by the structure and function of the riparian zone (Koski, 1992). The interaction between the forest and the stream shape the physical and biological features. Buffer zones on streams provide the least costly, most effective, and best long-term method for maintaining salmonid habitat.

Based on the commitment of landowners a planting program involving community volunteers or club members could be established to restore eroding sites and to protect areas with reduced vegetation depth. Potential planting locations at erosion sites are highlighted in Form 1 of Appendix 7.

Native coniferous and deciduous trees will provide canopy cover and bank stability. Over the long-term, conifers such as Douglas-fir and Western Red Cedar provide the instream LWD necessary to maintain pool structure and instream cover for fish.

2. Riparian Vegetation Protection and Awareness – Maintaining present riparian buffers along the mainstem, tributaries, off-channel habitat and wetlands of Haslam Creek is critical. A simple signage and brochure program, similar to the yellow fish stream crossing signs will bring awareness to the importance of the vegetation. Fencing may be required on Hokkanen and Patterson Creek. Identification of sensitive areas is needed on the RDN Environmentally Sensitive Areas Atlas.

3. Gravel Bar Stabilization – Unvegetated gravel bars in Reach 1 (and Reach 2) would benefit from planting of willows in bundles or individual stakes. This project would assist in speeding up the natural reformation of vegetated islands in areas with wide alluvial plains and large scale gravel aggradation. There are many good examples on Haslam Creek where bar stabilization is occurring naturally, promoting the narrowing of the channel and increased scour depth. With suitable locations throughout Reaches 1 and 2, good access may be the determining factor. Initial trials should be viewed as experimental. If successful, the project could be expanded to other gravel bars. Gravel bar locations are identified in Form 1of Appendix 7.

4. Bank Repair – This reach would benefit from the placement of stump revetments along the eroded and failing banks (0+300m, 0+450m, 1+700m, 1+900m, 2+200m). Bioengineering techniques, as well as planting of native vegetation would assist in bank stabilization and protect the eroding banks.
Reach 1 has eroding sites identified in Form 1 (Appendix 7). Also see photos.

5. LWD Placement – Stump revetments and log spurs protect banks; provide instream juvenile and adult salmonid cover. Scour created by LWD will increase pool depth and percent wetted area within this reach. Stumps can be trucked in and placed by an excavator during the low flow summer months. Trees and debris found instream from bank failures, can be reoriented and utilized for bank protection and instream cover. Potential stump revetment sites are identified at the erosion sites highlighted in Form 1 of Appendix 7.

Equipment required includes; ground anchors (Duckbills), 5/8 galvanized steel cable, cable clamps, sledge hammer, wood drill, torque wrench/drill, chain saw. Cost per LWD cabled structure would be approximately $200.00 each, (depending on the size of the structure). Site specific prescriptions are required for Section 9 approval.

8. Gravel Bar Scalping – The excavation of the large gravel beds have occurred in 2007 and 2008 in Reach 1 (1+890m-1+960m and 2+350m - 2+390m). Gravel bars at the confluence (0+000m) with Nanaimo River and Napoleon Creek (0+300m) prevent upstream fish access during low flow conditions. Machine access during low flow summer conditions is achievable, which would allow trucking of material in and out of the site. In order to control the gravel movement within the channel, the gravel source needs to be addressed first. The eroding banks need to be stabilized, preventing large surges of gravel to migrate into this lower reach. Large sediment wedges are identified in Form 1 (Appendix 7).

8. Off-channel Habitat – Potential restoration sites were identified in the field and summarized in Form 1 (Appendix 7). On-site review during high flow conditions would further determine the value of these sites. Monitoring during low flow conditions by digging test pits will help to determine the depth of the water table and the water quality, prior to any major excavation. Assistance from F&OC – Nanaimo would be recommended. Need to also contact landowners for site access for equipment.

Reach 1	Mouth of Hokkanen Creek (1+239 m)	1+267 (LB) 250m x 2m
	Mouth of Patterson Creek (1+436 m)	1+490 (RB) 100m Good access

9. Water Storage Potential – Within this report a study was not conducted on the feasibility of water storage. A potential site to study in Reach 1 would be Michael Lake.

10. Salmonid Fry Salvage – Organize crews, map sites, purchase required equipment to capture, hold and transport salmonid fry when salvaging from trapped areas of Haslam Creek, tributaries and off-channel habitat.

11. Napoleon Creek – Within Reach 1 of Haslam Creek, the best fish habitat on a year round basis is found within Napoleon Creek and the lower 300 meters of Haslam Creek. Controlled water flows and channel stability in Napoleon Creek are important to good fish habitat. Need to coordinate this with Nanaimo River Hatchery staff to determine what projects would be acceptable to their program. Fish habitat assessment of this tributary or a site visit by a fisheries biologist with your group would be required before prescriptions for instream work could be made.

5.6.2 Reach 2 Prescriptions

Reach 2 is the second highest priority within this creek. Similar to Reach 1, eroding banks and channel degradation has contributed to the large gravel bars and lack of instream cover. Nearby urban and agricultural land has impeded the density and type of riparian vegetation, limiting its depth and the percent overhead crown cover on the stream channel. This reach is easily accessible along the hydro and gas line crossings, enabling the public to access the creek and remove LWD for fire wood.

There are two segments within this reach that have a significant lengths of erosion; river left bank from 3+468m to 4+386m and the river right bank at 6+239m to 6+890m adjacent the Rondalyn Resort. This reach would benefit from bank stabilization with LWD. A-frame log spurs would also assist in narrowing the channel and creating pool scour. The substrate within this reach lacks complexity.

1. Riparian Vegetation Planting – As with Reach 1, improvements to the amount and quality of riparian vegetation will directly benefit the stream morphology and the fisheries resource.

Based on the commitment of landowners, a planting program involving community volunteers or club members could be established to restore eroding banks and to protect areas with reduced vegetation depth. Potential planting locations are identified as eroding sites on Form 2 (Appendix 7).

Native coniferous and deciduous trees will provide the shade and bank structure required. The conifers (Douglas-fir, Western Red Cedar) will provide the instream LWD necessary to maintain pool structure and cover for fish

2. Riparian Vegetation Protection and Awareness – As per Reach 1, maintaining riparian buffers along the mainstem, tributaries and off-channel habitat of Haslam Creek is critical. Two priority sites include protection of vegetation at 6+239m (RB) (Rondalyn Resort) and an area along the left bank at 5+741m where valuable off-channel habitat exist downstream of a large logjam. Falling boundary flagging has been seen within near proximity to fish habitat. Making contact with Island Timber to discuss logging plans and riparian protection is important. Further sensitive areas may be identified and field checked on the RDN Environmentally Sensitive Areas Atlas and air photos.

3. Gravel Bar Stabilization – Bioengineering techniques such as willow or cottonwood stakes, as well as planting native vegetation would stabilize the gravel bars, and narrow the channel. See Section 5.6.1 for similar prescriptions. Suitable locations can be determined from viewing air photographs and an on-site survey. Good proximity to willow sources (BC Hydro right-of-way) and easy installation techniques could be very beneficial. Potential planting locations at unvegetated gravel bars are highlighted in Form 2 of Appendix 7.

4. Bank Repair – Stump revetments and rock groynes would protect the weak banks, as well as dissipate the force acting on them. Strategically placed groynes would act as deflectors, directing water away from the eroding portion, and towards the natural thalweg. Planting of native vegetation (i.e. willow and red-osier dogwood) and/or fencing. Reach 2 has eroding sites identified in Form 2 (Appendix 7 - see photo documentation).

5. LWD Placement - LWD associated with pool habitat provides the best rearing and holding habitat for salmonids, but is a limiting factor in Reach 2. The usual method of maintaining or establishing LWD is to anchor it with steel cable to secure it in place. This application must be carefully prescribed due to potential negative impacts from failure of suitable anchoring. LWD must be securely anchored to rock ballast, buried logs, bedrock pins or other very secure items. Numerous sites are identified in Form 2 (Appendix 7) in Reach 2 (4+032m, 4+807m, 5+085m, and 5+472m), just u/s of the BC Hydro Access) and along the off-channel habitat at 5+583m.

6. Gravel Bar Scalping – High gravel bars (3+310m, 3+365m, 4+440m, 5+085m and 5+210m) within this reach are causing water to be directed towards the banks, creating large sections of erosion. Bar scalping should occur on unvegetated gravel buildups in order to relax the pressure on the river banks by increasing water capacity. Sediment locations and characteristics are identified in Form 2 of Appendix 7.

7. Off-channel Habitat – The river is actively braiding and swapping channels within its floodplain due to extreme flows, sediment loads and the weak banks of a young forest. The year 2000 assessment for the sidechannel at 2.5 km is now completely different with the river mainstem flowing through the site. Three additional braids have formed since 2000 in other meanders of the river. Off channel habitat development in this reach offers many potential areas but they are all vulnerable to flooding and sediment deposition. A sidechannel project in this reach would require a safe location from flooding and erosion as well as have a clean, low maintenance water supply. No sites within this reach appear to have those characteristics. Tributaries such as the North Haslam and short unnamed tributaries on developed farmland at the hydro line crossing are more protected and may offer some development options. Potential off channel sites were identified in the field and summarized in Form 2 and 4 (Appendix 7). Suitable sites include:

Reach 2	4+665 m (RB)	50 m x 3 m Presently dry.
	5+410 m (RB)	Near old RR crossing, wet in summer.
	5+583 m (LB)	186m x 3m good summer flow.
	5+838 m (RB)	105 m length, subsurface for 15 meters at confluence, could be excavated to maintain year round fish passage.
	6+534 m (RB)	60 m length wet in summer.

Need to record and monitor the water table, contact landowners for potential of accessing equipment if required.

8. Water Storage Potential – Within this report a study was not conducted on the feasibility of water storage. A potential site to study in Reach 2 would be Timberlands Lake.

9. Salmonid Fry Salvage – Organize crews, map sites, purchase required equipment to purchase required equipment to capture, hold and transport fry when salvaging from trapped areas of Haslam Creek, tributaries and off-channel habitat.

10. Large Woody Debris Signage – Unfortunately people have been accessing Haslam Creek from the BC Hydro right-of-way and other sites downstream in order to cut fire wood from large pieces of instream LWD. Due to the severe shortage of available coniferous LWD for fish habitat and channel stability, an effort could be made to post DFO "Fish Habitat Log" signs on the wood. In some cases this might dissuade wood from being removed. Considering the cost and effort to add LWD to the creek in restoration projects this would be a cost effective program.

11. Salmon Carcass Release – Due to the decline in salmonid populations in small streams such as Haslam Creek, a deficit in nutrient recharge from marine-derived sources is occurring. Research suggests that Pacific salmon carcasses can supply nutrients to both aquatic and terrestrial ecosystems, thereby having the potential to influence the structure and function of some stream systems and wildlife communities (Cederholm et al, 1999). Cederholm also states that future management will need to view spawning salmon and their carcasses as important habitat components for sustaining the production of fish as well as other salmon-dependent species within the watershed.

In 2004, Wright presented the East Coast Vancouver Island Salmon Carcass Implementation Program. This program was prepared for the MWLAP and Habitat Conservation Trust and presented the results of placing 9,225 salmon carcasses into upper reaches of Cruickshank River, Big Qualicum, Little Qualicum and Nanaimo River. The Nanaimo River Hatchery provided frozen post-spawn broodstock (421 chum, coho, and chinook salmon) to be transported to the North Nanaimo River watershed. Carcasses were either placed or tethered to LWD in the mainstem and Blackjack Creek tributary by the Nanaimo Fish and Game Club and Nanaimo River Hatchery.

Continuation of this program would be beneficial, involving placing taking chum and coho carcasses from the Nanaimo River Hatchery in October and releasing them at upstream and midway sites in Reach 2. There is easy access to the reach at the upstream logging bridge and midway at the BC Hydro Right-of Way.

12. Stream Fertilization Project - Presently there is an on-going program (sponsored by FsRBC for Year One) to assess the need for the addition of slow-release fertilizer in the Nanaimo River and its tributaries, including Haslam Creek. Water sampling and discharge measurements were completed in the summer of 2000 to determine the background levels of dissolved nutrients essential for primary productivity in the stream. It is proposed that if funding is available for Year Two, areas of low nutrient levels and high fisheries value would have slow release fertilizer briquettes (N-P-K, 7-40-0) added at various riffle locations.

The upstream logging bridge on Reach 2 was the sampling location for Haslam Creek. It was determined that Haslam Creek has low levels of micronutrients (soluble reactive ortho-phosphorus), possibly due to the lack of marine-derived nutrients in the water. The fertilizer is purchased from the United States, applied and monitored. In theory this program would continue on a yearly basis until background nutrient levels rise and are sustained naturally. Good results of this application have been seen in the Keogh River and Salmon River on Vancouver Island (Ashley and Slaney, 1997). Reach 2 is considered the highest priority reach, however all reaches would benefit from stream fertilization.

Please note that any future stream fertilization program is dependent on water sampling results.

5.6.3 Reach 3 Prescriptions

Due to the inaccessibility of Reach 3 and the generally stable fish habitat features, prescriptions are limited. This reach received the best overall rating for stream habitat parameters according to the USHP survey. It received fair scores on LWD input, instream boulder cover and crown cover.

1. LWD Placement - A-frame log spurs would create cover protection for adult and juvenile fish. The structure would also create scour pools, increasing pool depth. The rearrangement and modification of wood found on site using peaveys, pike poles, turfers, and chainsaw winches would be necessary as machine access is limited.

2. Riparian Vegetation Planting - Streamside planting of native conifers and low lying shrubbery would increase canopy cover along this reach. Cedar, Willows and Red Osier Dogwood are some examples of vegetation that can overhang into the stream. This would create instream vegetation cover for fish, as well as assist in decreasing the water temperature during the warm summer months.

3. Salmon Carcass Release - Chum and Coho salmon tethered to LWD would be beneficial within this reach as it would encourage adult salmon migration to upstream spawning habitat. See section 5.6.2 for further details.

5.6.4 Reach 4 Prescriptions

Reach 4 is heavily impacted by past and present logging practices with fresh cutblocks and falling boundary ribbon (2001) along the creek edge. This reach would benefit from the introduction of LWD, boulder clusters as well as streamside riparian planting. Nearby logging roads can act as an access route for trucks and heavy equipment.

1. LWD Placement – LWD is an integral device for protecting banks from erosion and creating pool scour or re-directing the flow. This reach has an erosion site of substantial length (66m) at 8+043m.LWD placement is required to replace the old growth trees that used to provide the habitat. The downstream portion of this reach has active logging roads running adjacent to the creek edge that can act as a route for trucking materials and heavy machinery in.

Upstream portions of this reach (9+999m to 12+079m) are not easily accessible by heavy machinery. Wood found on site can be reoriented and placed strategically to protect eroding stream banks and provide instream cover for juvenile and adult salmonids. Chainsaw winches, pike poles, peaveys and turfers would be used to place LWD by a trained field crew. The wood be anchored by wrapping 5/8" galvanized cable around large rooted conifers. Potential LWD sites are identified as shallow pools, erosion sites, as well as pools lacking instream cover in Form 4 (Appendix 7).

2. Riparian Vegetation Planting – Large cutblocks along the stream bank (8+499m, 10+499m and 11+517m) are found throughout this reach. Streamside planting is necessary to improve the vegetation depth and crown cover (8+011m and 9+982m) of the creek. Willow stakes along the creek edge would enhance bank stability (8+043m) and vegetation instream cover (8+011m, 8+994m, 9+982m, 10+968m, 11+971m). Conifer saplings (Douglas Fir and Western Red Cedar) should be planted stream side where the logging blocks have stripped the riparian vegetation. Potential planting locations at sites where erosion, logging and a lack of instream and crown cover are evident are highlighted in Form 4 of Appendix 7.

5.6.5 Reach 5 Prescriptions

This reach has portions confined by steep bedrock sidewalls that prevent machine access. Multiple erosion sites along this reach have caused bank failure and subsequent riparian vegetation loss, impacting almost 300m of bank length. This reach lacks instream complexity with little boulder and LWD cover. A natural anadromous barrier is found within this reach. There is no desire to promote upstream anadromous access.

1. Bank Repair – Steep bank slopes with adjacent cutblocks and logging roads are likely the major contributor to the large erosion sites (12+091m, 12+257m, 12+917m, 13+970m, 14+087m, 14+703m and 16+410m) and a large slide (16+976m) within this reach. Deactivation of logging roads is recommended to reduce the likelihood of landslides and sedimentation into the creek. Bank repair is identified in Form 5 (Appendix 7), as erosion and slide sites.

2. LWD Placement - Log jams (13+935m, 14+087m, 14+130m, 15+259m and 15+835m) are present within this reach and allow an opportunity to select appropriate pieces for bank protection and functional instream cover. Field crews would be utilized to manipulate the wood, as machine access is difficult. Potential LWD sites are identified in Form 5 (Appendix 7), as erosion sites, and sites that lack instream cover and pool depth.

3. Riparian Vegetation Planting – Large clear cut sections of forest are found adjacent the stream bank (12+091m, 12+564m, 12+889m, 13+062m and 13+559m). Planting of conifers would be advantageous, as this reach has portions of shallow vegetation depth and low percent crown cover. Potential planting locations at erosion and logged sites highlighted in Form 5 of Appendix 7.

5.6.6 Reach 6 Prescriptions

This reach was not physically surveyed due to difficult access in a steep canyon, however data obtained from Reaches 5 and 7 provide insight into the proposed prescriptions. Logging roads are found along steep bank and ridges, running adjacent the creek. Altered sites along the creek are present in the form of hydro lines and clear cuts.

1. Bank Repair – This reach likely has debris slides from unstable logging roads and limited sections of erosion, as the creek is confined within a steep bedrock canyon. The logging roads found within this reach have landslides blocking them, as well as washed out, undersized culverts (Pers. Comm.). Proper deactivation of these roads would prevent future slides and material from entering the creek.

2. LWD Placement – The canyon prevents heavy equipment from entering this reach. Strategic placement of LWD already on site would improve instream complexity and cover. Small hand-held equipment and materials are required for movement (Ex. chainsaw winch) and anchoring (cable, clamps, staples) of LWD.

5.6.7 Reach 7 Prescriptions

Machine access within this reach can be achieved through the bridge crossing at 22+119m. Logging roads are located adjacent the creek, allowing trucking of materials into the work site feasible. The lower 150m of this reach has deep bedrock pools with moderate cover. The middle section of this reach (21+905m to ~22700m) is on a low gradient, boulder-cobble substrate. This portion of the reach would benefit from improved instream cover, such as the introduction of LWD, boulder clusters, rip rap placement and riparian vegetation planting

1. Slide Stabilization – This reach has one known slide (21+769m to 21+782m) along the left bank (Appendix 7 – Form 7). The private land forestry owner and road contractor should be responsible for the repair to the road and for the slide stabilization.

2. LWD Placement – The low gradient section within this reach (21+905m to 22700m) lacks instream cover and pool depth. The substrate within this section is predominantly boulder, cobble and gravel. Placement of LWD would create scour, deepening pools and providing rearing habitat for resident trout. Wood would likely need to be trucked in, as there was limited wood on site. Potential LWD placement sites are identified as areas that lack pool depth, instream cover, as well as erosion sites (Appendix 7 – Form 7).

3. Boulder Cluster Placement – This reach had moderate instream cover, with poor boulder cover. Boulder clusters (1-3 rocks, ~0.5m in diameter) placed on the downstream end of riffles (21+864m, 22+029m, 22+076m) would improve trout rearing habitat (See Appendix 7 – Form 7 for site details).Rocks may be locally sourced from banks and pried into place with a bar.

5.6.8 Reach 8 Prescriptions

This reach was not physically surveyed. Searches for habitat assessments of Haslam Lake resulted in no data recovered. Vancouver Island Trout Hatchery has not stocked this lake since 2005, and past fish density surveys have not been done or recovered.

1. Fish Density Survey – Sites within the reach need to be selected where sampling will be carried out. Minnow trapping and seining of this lake would provide insight into resident trout population numbers within the lake. Length (Fork and total length), weights, sex and aging would provide valuable information on the productivity of this lake. Snorkel surveys are a less expensive method, as observational surveys provide a general indication of the species of fish present, the number observed, the life stage (parr, juvenile, adult) they are at and the activity being observed (migrating, incubating, spawning, rearing).

2. Habitat Assessment – Terrain and shoreline characteristics, riparian vegetation type and depth, recreational use, water quality and bathymetric surveys are just some of the lake inventory components expected by the BC Fisheries Information Services Branch (2001).

5.7 Overall Watershed Prescriptions

1. Landowner Awareness Program – this type of program could be very beneficial to the overall health of the watershed. Designing facts sheets (similar to those produced for streams with the boundaries of the City of Nanaimo) and distributing to landowners along the mainstem and tributaries of Haslam Creek. Making residents aware of the importance of maintaining vegetative buffers along any flowing watercourse or wetland. Using the RDN Environmentally Sensitive Areas Atlas, assist landowners in identifying areas on their property to protect. For example there is a wetland draining into Haslam Creek on the north side of Haslam Road, 600 meters east of the highway. Landowners should be made aware of the importance of this type of habitat, referred to as 'biological anchors' within the Haslam Creek drainage.

2. Nanaimo River Water Management Plan – This document was referred to in Section 2.3, and is a very important reference to the status and future of water quality in the Nanaimo River watershed. The Nanaimo Fish and Game Protective Association should have a copy of this plan, to assist them when in discussions with all parties on the matter of water usage within the watershed and whether the recommendations within the document have been reached. There are numerous recommendations within the plan pertinent to Haslam Creek, groundwater, surface water, and fisheries resources. Important recommendations such as; evaluation of surface water flows and instream requirements indicate that there is no flow available from the Nanaimo River, Haslam Creek or any tributaries, for additional extractive water uses for the three month period of July through September (p. 133 NRWMP, 1993). Involvement in annual and semi-annual meetings between all concerned parties, is recommended.

3. USHP Fish Habitat and Riparian Habitat Assessment – To date approximately 8.0 km of the 24.7 km of stream length have been assessed. Further inspections are always recommended – in part due to complete all areas, and re-visit surveyed areas where changes are occurring. Identifying fish access to upstream tributaries, obstructions and general stream channel conditions is important. Salmon spawner counts were discontinued by DFO in 2001 and should be considered as a to-do task.

4. Demonstration Forest
Recent communications with Darren Hebert (coordinator / instructor) Ph. (250) 753-3245 local 2264 at Malaspina College / University showed that there is an interest in establishing an ‘outdoor classroom’ in a local watershed to teach techniques in stream restoration and assessment. Establishing this educational component to Haslam Creek would be very important in protecting and highlighting the watershed.

5. Helicopter / Video Overview – A very good understanding of the watershed on a whole could be done by an one hour fly over of the watershed with video camera capabilities. The heliflite conducted in 2008, was not a complete documentation of the entire lake and creek. A video with commentary, as well as photographs would assist in understanding the current logging practices on the watershed, and the impacts logging and urban/rural development is having on this watershed.

6. Harmac Pacific Pulp Mill – Well “A” – Monitor water extraction from this well, during July to September when mean annual discharge (MAD) is 10% or less**.**

7. Fish Stocking – Lobby DFO and MELP for potential enhancement of fish stocking within the Haslam Creek watershed, where stocks are depressed. Given the recent budget cuts to these programs, increasing fish production is unlikely. The best effort is likely in fry salvage and plant them in the Napoleon Sidechannel or in wetter areas of Haslam such as upper Reach 2. Assessment of Timberlands Lake as an outplant lake could be done if the outlet channel allows smolt passage and agencies approve.

10. Air Photographs – Review series of air photos available, that were not included in this report to gain further insight to historical channel conditions and impacts of forestry harvesting.

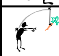
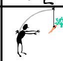
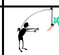
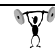
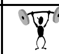
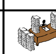
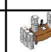
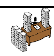
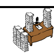
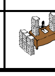
11. Forest Industry – Open communications with forest companies in the area to gain access to upper watershed and identify sensitive fish and wildlife habitat prior to harvesting.

12. Adult Salmon Enumeration – Maintain a yearly record of fish species and numbers returning to the river and its tributaries. Reach 1-5 and downstream tributaries.

5. 8 Project Restoration Timing

Table 23 shows a standard timeline for projects considered in this report. This table also shows the pre and post enhancement monitoring timing of a typical restoration activity.

Table 23.) Project Timeline per Year

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Planning & approvals												
Pre project fish density & photo assessments												
Instream work												
Post project analysis												
Project analysis year 2												
Report writing												
Report writing year 2												

Five Year Planning

Year One

- Assess summer water levels in all reaches
- Map reaches and tributaries that are not currently mapped correctly
- Choose project sites in the areas where the most benefit can be realized
- Assess fish densities in project sites
- Conduct restoration projects- expand year 1 project details where funding and landowner permission is available
- Conduct initial post project assessment
- Inventory any possible off channel sites
- Contact new land owners about future projects

Year Two

- Plan and conduct any new projects made available by landowner contact or inventories in year one.
- Assess year one activities
- Make any necessary changes to year one project sites

Year Three through Five

- Plan and conduct any new projects made available by landowner contact or inventories in past year.
- Assess past years activities
- Conduct maintenance on past project sites

5.9 Project Costing Estimates

Table 24.) – Restoration Activity Description & Cost Estimates

Priority 1 - Large Woody Debris

Item:	1	Activity:	LWD	Priority:	C	Timing:	Summer	Permits:	Yes
Description:	Improve the large woody debris for fish cover, pool scour and bank protection.								
Design:	Reposition logs/stumps at FHAP recommended density in critical reaches (Reaches 1 & 2 at sites: 0+300m to 0+350m, 1+411m to 2+382m, 3+468m to 4+386m, 6+239m to 6+890m). Reach 4 has one site 66m long, and Reach 5 has 290m of erosion.								
Costs:	2590m @ $300/m 2946m total @ $300/m							Total: $883,800.00	
References:	KWRP LWD SOP, KWRP Restoration Costs – W. Warttig/D.R. Clough								

Priority 2 – Off Channel Habitat

Item:	2	Activity:	Monitoring & Assessment	Priority:	M	Timing:	Summer	Permits	Collection permits
Description:	5 identified sites in reach 1 and reach 2								
Design:	Excavate site to prevent								
Costs:	705m @ $40/m							$28,200	
References:	Fish Habitat Rehabilitation Procedures								

Priority 3 – Gravel Bar Scalping

Item:	3	Activity:	Sediment Removal	Priority:	M	Timing:	Summer	Permits	Yes
Description:	Excavate large gravel bars in Reaches 1 and 2								
Design:	Excavate overburden material from flood damage causing direct bank erosion in lower reaches.								
Costs:	100hours @$130/hour, 5 Significant Gravel bars in reach 1. Exchange material for trucking for cost savings							$13,000	
References:	D.R. Clough 2007 & 2008 Haslam R1 projects with Nanaimo Airport Commission								

Priority 4 - Riparian Assessment

Item:	4	Activity:	Riparian Assessment	Priority:	M	Timing:	Fall/ Spring	Permits:	Yes
Description:	Enhance riparian vegetation where damaged or lost through logging practices. Assess site for planting native shrubs, trees, create wildlife habitat cavities/brush piles								
Design:	Assess and identify polygons by airphotos and field transects, write prescriptions.								
Costs:	4 days field, 4 days office ($500/day)							$4,000.00	
References:	Poulin et al (2000)								

Priority 5 – Bank Stabilization

Item:	5	Activity:	Bank Repair	Priority:	C	Timing:	Spring-Fall	Permits	Yes
Description:	Small erosion sites and unvegetated banks would benefit from bioengineering techniques and riparian planting								
Design:	2 Day Training Course for volunteers. Placement of willow stakes along unvegetated banks and gravel bars, wattle fences placed at small erosion sites.								
Costs:	Training and Equipment $2000							$2000	
References:	Soil Bioengineering Techniques – D. Polster								

Project Cost Estimates cont'd …

Priority 6 - Awareness Signs

Item:	6	Activity:	Awareness Signs	Priority:	L	Timing:	Any	Permits:	Yes
Description:		Establish Stream signage at road crossings and high use hiking areas.							
Design:		A standard Yellow Fish image on a metal plate, place one sign at the TCT suspension bridge, Rondalyn Resort and 2 on highway (4 total)							
Costs:		4 Signs, posts, anchors and hardware est $400/ea						$1600	
References:		Pacific Streamkeepers Web page; PSKF.ca							

Priority 7 - Stream Fertilization

Item:	7	Activity:	Stream Fertilization	Priority:	L	Timing:	Any	Permits:	Yes
Description:		Enhance instream nutrients of Reach 2 through placement of slow release fertilizer							
Design:		Fertilizer briquettes spread in a single layer in riffles							
Costs:		$250/Km @ 4.5Km						$1125	
References:		K.I. Ashley/P.A. Slaney (1997)							

Priority 8 - Salmon Carcass

Item:	8	Activity:	Salmon Carcass	Priority:	L	Timing:	Fall/Winter	Permits:	Yes
Description:		Enhance nutrient and primary productivity levels in stream and nearby riparian vegetation through the placement of salmon carcasses							
Design:		Tether or place ~400 salmon carcasses (from Nanaimo River Hatchery) in the first 2 reaches of Haslam Ck – conducted primarily by volunteers.							
Costs:		2 field days @ $400/day for a Project Biologist and $100 for supplies						$900	
References:		H. Wright (2002), Cederholm (1999)							

Haslam Creek Restoration Cost Summary:
Table 25 shows the total cost for the restoration of this project ($993,825). The majority of this budget will be spent on bank stabilization in the lower two lower reaches. Stabilizing the lower reach will minimize flood impacts, increase fish production and allow for riparian plants to establish to aid in the long health of the stream.

Table 25.) Total Restoration Cost Summary:

Priority 1 -LWD	$883,000
Priority 2- Off Channel habitat	$28,200
Priority 3- Gravel Bar Scalping	$13,000
Priority 4- Riparian Assessment	$4,000
Priority 5- Bank Stabilization	$2,000
Priority 6 – Awareness Signs	$1,600
Priority 7- Stream Fertilization	$1,125
Priority 8- Salmon Carcass	$900
Total	**$933,825**

Conclusion

After years of logging, urban and rural development encroaching on the creek, as well as high flows, Haslam Creek has lost substantial spawning and rearing habitat in the lower two reaches. Sediment movement and heavy bed loading have covered spawning beds, filled in pools and have created a flat 'highway' with little channel definition in Reaches 1 and 2. Summer wetted habitat is isolated and shallow. Benches of material are found at the confluence of tributaries, hindering upstream fish access during low flows. Large erosion sites are contributing to the sediment input, and loss of riparian vegetation. The current riparian vegetation is in poor shape, as logging blocks are found along the stream bank, as well as agricultural fields and housing nearby. Throughout this creek, a lack of instream cover is evident. Old logging roads in the upper reaches are creating landslides and large debris movements into the creek.

The USHP assessment has highlighted the impacts on Haslam Creek. It will take at least 3-5 years after restoration to see any improvements in salmon numbers. The restoration plan will have to continue for many years in order to see improvements, as this creek is in devastating shape.

The plans for continued bank repair in Reach 1 are a high priority within this creek. Stump revetments anchored by large rock appear successful, when combined with gravel bar scalping to relax the flow.. The major concerns within this creek are the lack of wetted area, pool depth and instream cover within the lower reaches, as a result of bank erosion and sediment flushes. This has been caused primarily by historic and current logging practices with increasing urban and rural development. We need to partner up with the logging companies so they know our concerns and convince them to work closely with us on recovery of the watershed; it is possible to log areas and recover the channel at the same time.

The extraction of water from the aquifer by the Pulp Mill and other sources is also a major conflict with fish survival. Lately, the only summer there was connected flow in Reach 1 occurred when the mill shut down the pump next to Haslam Creek for several months. We need to find a way to provide an offset of this water to the Mill.

Stream restoration can be a public activity and we encourage anyone in the community to become involved. This activity can be an educational, training or awareness activity for all ages and abilities. All of the softer engineering activities including some LWD placement, gravel placement, tree planting, fish sampling water quality and habitat measurements can be completed by just about anyone with some training and equipment.

Members of the Nanaimo Fish and Game Club, the Ladysmith Sportsmen Club, the Chemainus Rod and Gun Club, the Nanaimo Area Land Trust and Snuneymuxw First Nation- Fisheries Department are all community stewards that have the training and experience in the restoration techniques described above.

The formation of a Haslam Creek Watershed Recovery Plan Partnership of the above stated groups (and more) along with the property owners is the key to success.

Literature Cited

Ashley, K.I. and P.A. Slaney. 1997. Accelerating Recovery of Stream, River and Pond Productivity by Low-level Nutrient Replacement. *In* Watershed Restoration Technical Circular No. 9 - Edited by P.A. Slaney and D. Zaldokas. Ministry of Environment, Lands and Parks and Ministry of Forests. Chapter 13.

Babakaiff, S., Hay, D and C. Fromuth. 1997. Rehabilitating Stream Banks. *In* Watershed Restoration Technical Circular No. 9 - Edited by P.A. Slaney and D. Zaldokas. Ministry of Environment, Lands and Parks and Ministry of Forests. Chapter 6.

BC Fisheries Information Services Branch, 2001. Reconnaissance (1:20 000) Fish and Fish Habitat Inventory Standards and Procedures. Resources Inventory Committee Publications, British Columbia, Canada. Ch. 3.

Berris, Catherine Associates Inc. 2006. Nanaimo Estuary Management Plan. 34p.

Cederholm, C.J., Dominguez, L.G. and T.W. Bumstead. 1997. Rehabilitating Stream Channels and Fish Habitat Using Large Woody Debris. *In* Watershed Restoration Technical Circular No. 9 - Edited by P.A. Slaney and D. Zaldokas. Ministry of Environment, Lands and Parks and Ministry of Forests. Chapter 8.

Cederholm, C.J., Kunze, M.D., Murota, T., and A. Sibatani. 1999. Pacific salmon carcasses: Essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries. 24 (10): 6-15.

Clough, D.R. 2007. Haslam Creek Habitat Restoration Plan, 2007.

Clough, D.R. 2008. Haslam Creek Habitat Restoration Plan, 2008.

Clough, D.R. 2009. Haslam Creek Habitat Restoration Plan. 2009.

Community Mapping Network (CMNBC), 2007. SHIM Orthophoto Map 2007 Version, via internet at: http://squamish2010.ca/mapguide2010/SHIM/Shim.php

Environment Canada, Water Survey of Canada, Haslam Creek Near Cassidy, Archived Data Station 08HB003. www.wsc.gc.ca

FOC, 2000. Fisheries Information Summary System (FISS) database, via internet at http:// www=heb.pac.dfo-mpo.gc.ca/English/programs/fiss/reports.htm

Gaboury, M.N. and M. McCulloch. 2002. Fish Habitat Restoration Designs for East Vancouver Island Watersheds. Volume 1 of 2. LGL Limited and BCCF. Prepared for Ministry of Water, Land and Air Protection. Nanaimo, B.C. 1, 5-8p. plus appendices.

Griffith, R.P. 1990. Nanaimo River instream flow requirements for recreational fisheries. R.P. Griffith and Associates. Sidney, B.C. 93 p.

Griffith, R.P. 1992. Feasibility of fisheries enhancement undertakings in selected Vancouver Island streams. R.P. Griffith and Associates. Sidney, B.C. 159 p.

Hanelt, R. 2001. Haslam Creek fish and fish habitat assessment, prioritizing restoration & protection of the fisheries resource. Prepared for Nanaimo Fish and Game Protective Assoc., Nanaimo,BC

Koski, K.V. 1992. Restoring stream habitats affected by logging activities *in* Thayer, G. (ed) Restoring the Nation's Marine Environment. University of Maryland. 343 – 403.

Johnston, N.T. and P.A. Slaney, 1996, Fish Habitat Assessment Procedures, Watershed Restoration Technical Circular No. 8.

Jones and Annas. 1978. Vegetation. *in* Valentine, K., Sprout, P.N., Baker, T.E. and L.M. Lavkulich (eds.), The Soil Landscape of British Columbia. Ministry of Environment, Victoria, B.C. 1978.

Koning, C. W and E. R. Keeley. 1997. Salmonid Biostandards for Estimating Production Benefits of Fish Habitat Rehabilitation Techniques. *In* Watershed Restoration Technical Circular No. 9 - Edited by P.A. Slaney and D. Zaldokas. Ministry of Environment, Lands and Parks and Ministry of Forests. Chapter 3.

LGL Limited. 2002.Fish Distribution in the Nanaimo River Map. Accessed via the internet at: http://www.bccf.com/steelhead/pdf/map2_nanaimo.pdf.

Michalski, T.A. and M. Sala. 2007. Status of Fish Habitat in Small East Coast Vancouver Island Streams 1993-2003. B.C. Ministry of Environment. Nanaimo, BC.

Ministry of Environment, Lands and Parks. 1993. Nanaimo River Water Management Plan. Province of BC. Nanaimo, B.C. 147 p.

Ministry of Environment, Lands and Parks. 1995. Lake and Stream Inventory Standards and Procedures (Draft). Fisheries Branch. Province of BC. Victoria, B.C. 228 p.

Ministry of Environment, Lands and Parks. 2000a. Water Management Branch. Province of BC. Nanaimo, B.C. Unpublished Data.

Ministry of Environment, Lands and Parks. 2000b. Urban Salmon Habitat Program Assessment Procedures for Vancouver Island. Fisheries Section. Province of BC. Nanaimo, B.C. 69 p.

Ministry of Forests, Research Branch. Biogeoclimatic Units of the Vancouver Forest Region, Southern Vancouver Island and Sunshine Coast, Map Sheet 5 of 6. F.C. Nuszdorfer, K.L. Nuszdorfer, A.M. Scagel, K. Klinka, T. Lewis, P. Courtin and R.N. Green. Revised 1994.

Personal Communication Don Herriott – Forester. TimberWest Forest Corporation Nanaimo Lakes Operation. January 8, 2001.

Personal Communications. Dave Bramley – Laboratory & Environmental Supervisor. Harmac Pacific Inc. February 23, 2001.

Personal Communications Mike Copeland – Forestry Technician. South Island Forest District January 4, 2001.

Personal Communication. Dave Gatenby - Forester. Weyerhaeuser Company Ltd. South Island Timberland Division. January 8, 2001

Personal Communication, Steve Baillie. South Coast Area, Stock Assessment, Department of Fisheries and Oceans, February 8, 2010.

Polster, D.F. 2002. Soil Bioengineering Techniques for Riparian Restoration. Polster Environmental Services Ltd. Duncan, B.C. 230-239.

Poulin, V.A., Harris, C. and B. Simmons. 2000. Riparian Restoration in British Columbia: What's Happening Now, What's Needed for the Future. For the Watershed Restoration Program. Ministry of Forests. Victoria, B.C.

Reid, G., T. Michalski, T. Reid. 1999. Status of Fish Habitat in East Coast Vancouver Island Watersheds, in proceedings of a Conference on Biology and Management of Species and Habitats at Risk, 15-19. Kamloops B.C. 490 pp

Regional District of Nanaimo. 1987. Regional District of Nanaimo Land Use and Subdivision Bylaw No. 500. RDN Planning Department. Lantzville, B.C.

Valentine, K.W.N., Sprout, P.N., Baker, T.E. and L.M. Lavkulich. 1978. The Soil Landscapes of British Columbia. Ministry of Environment, Nanaimo, B.C.

Tennant Donald Leroy, 1976. Instream Flow Regimens for Fish, Wildlife, Recreation and Related Environmental Resources. Fisheries 1976; 1: 6-10

Ward, B.R. 1997. Using Boulder Clusters to Rehabilitate Juvenile Salmonid Habitat. *In* Watershed Restoration Technical Circular No. 9 - Edited by P.A. Slaney and D. Zaldokas. Ministry of Environment, Lands and Parks and Ministry of Forests. Chapter 10.

Ward, B.R., and P.A. Slaney. 1993. Habitat manipulations for the rearing of fish in British Columbia. Ministry of Environment, Vancouver, B.C. 142-148 p.

Wightman, J.C., Ward, B.R., Ptolemy, R.A. and F.N. Axford. 1998. A recovery plan for east coast Vancouver Island steelhead trout – Draft. Ministry of Environment, Lands and Parks, Fisheries Section. Nanaimo, B.C. 131 p. plus appendices.

Wright, H. 2004. East Coast Vancouver Island Salmon Carcass Program Implementation. BCCF. Prepared for MWLAP and Habitat Conservation Trust Fund Nanaimo, B.C. 5 p.

List of Appendices

Appendix 1. Haslam Creek Stream Flow Records

Station Name:	Haslam Creek Near Cassidy	**Location:**	
Station Number:	08HB008		
Natural or Regulated:	N	**Drainage Area(km^2):**	95.6

	Degrees	Minutes	Seconds
Latitude	49	2	24
Longitude	123	54	28

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1914	-	-	-	-	-	1.34	0.27	0.10	0.45	10.10	15.00	3.07	-
1915	5.21	5.38	5.74	4.96	0.61	0.46	0.17	-	-	-	-	-	-
1949	-	-	-	5.16	3.79	0.89	0.34	0.25	0.27	0.68	7.33	7.17	-
1950	4.94	8.07	6.50	7.92	6.88	4.18	0.51	0.31	0.18	5.07	6.16	10.00	5.04
1951	7.31	7.32	4.86	7.44	4.10	0.76	0.18	0.14	0.44	5.17	5.96	3.67	3.92
1952	3.30	8.37	3.76	6.68	5.95	1.67	0.42	0.33	0.33	0.33	1.91	7.34	3.35
1953	13.80	6.20	3.62	3.83	3.97	1.28	0.72	0.37	0.74	3.98	10.90	8.43	4.82
1954	6.86	10.80	6.90	6.79	5.32	2.21	1.15	0.42	0.97	2.93	14.80	11.40	5.84
1955	4.53	2.62	1.60	6.59	5.17	2.07	0.84	0.73	0.56	4.49	10.20	5.52	3.74
1956	5.60	1.56	5.18	10.30	10.10	5.18	0.77	0.25	0.48	-	-	12.50	-
1957	-	-	6.46	4.72	1.72	0.52	0.48	0.96	0.78	1.52	2.23	10.60	-
1958	-	-	3.77	5.63	1.83	0.46	0.22	0.17	0.51	2.04	5.30	-	-
1959	-	3.14	6.46	8.20	-	1.83	0.48	0.19	0.93	1.73	4.30	6.99	-
1960	5.08	8.89	4.27	7.50	3.55	1.06	0.51	0.49	0.35	2.09	7.21	6.89	3.96
1961	13.50	16.70	-	4.17	3.74	0.49	0.19	0.13	0.32	2.90	4.73	9.94	-
1962	8.68	4.28	2.90	-	-	1.64	0.35	-	-	-	-	-	-
1993	-	-	-	-	2.94	1.69	0.38	0.18	0.11	-	-	-	-
1994	-	-	-	3.82	1.11	0.65	0.20	0.10	0.12	-	-	-	-
1995	-	-	-	-	1.12	0.24	0.13	0.17	0.10	-	-	-	-
1996	-	-	-	-	2.13	0.74	0.17	0.07	0.13	-	-	-	-
1997	-	-	-	6.50	5.52	2.18	1.41	0.37	1.36	-	-	-	-
1998	-	-	-	-	1.04	0.37	0.31	0.10	0.05	-	-	-	-
Mean	7.16	6.94	4.77	6.26	3.72	1.45	0.46	0.29	0.46	3.31	7.39	7.96	4.38
Max	13.80	16.70	6.90	10.30	10.10	5.18	1.41	0.96	1.36	10.10	15.00	12.50	5.84
Min	3.30	1.56	1.60	3.82	0.61	0.24	0.13	0.07	0.05	0.33	1.91	3.07	3.35

Appendix 2. RDN Resource Management Documents

RDN Bylaw No. 500

This is an excerpt only from "Regional District of Nanaimo Land Use and Subdivision Bylaw No. 500, 1987" and should not be used for interpretive or legal purposes without reference to the entire Bylaw.

Section 6.4.74

RESOURCE MANAGEMENT 4[1] RM4

6.4.74.1 Permitted uses and Minimum Site Area

Permitted Uses	Required Site Area with: Community Water & Sewer System	Community Water System	No Community Services
(a) Agriculture	n/a	n/a	n/a
(b) Aquaculture	5000 m^2	5000 m^2	5000 m^2
(c) Domestic Industry Use	1000 m^2	1000 m^2	1000 m^2
(d) Extraction Use	2.0 ha	2.0 ha	2.0 ha
(e) Home Occupation Use	n/a	n/a	n/a
(f) Log Storage & Sorting Yard	1.0 ha	1.0 ha	1.0 ha
(g) Primary Processing	5.0 ha	5.0 ha	5.0 ha
(h) Residential Use	n/a	n/a	n/a
(i) Silviculture	n/a	n/a	n/a

6.4.74.2 Maximum Number and Size of Buildings and Structures

(a) Dwelling units/parcel	- 1
(b) Height	9.0 m
(c) Parcel coverage	10%

6.4.74.3 Minimum Setback Requirements

(a) Buildings and structures for housing livestock or for storing manure:
All lot lines - 30.0 m;

(b) All other buildings and structures
All lot lines - 20.0 m;

except where any part of a parcel is adjacent to or contains a watercourse then the regulations in Section 3 of this Part shall apply.

[1] Bylaw No. 500.253, adopted January 11, 2000

RDN Bylaw No. 500

This is an excerpt only from "Regional District of Nanaimo Land Use and Subdivision Bylaw No. 500, 1987" and should not be used for interpretive or legal purposes without reference to the entire Bylaw.

Section 6.4.87

RURAL 7[1] — RU7

6.4.87.1 Permitted uses and Minimum Site Area

Permitted Uses	Required Site Area with: Community Water & Sewer System	Community Water System	No Community Services
(a) Agriculture	n/a	n/a	n/a
(b) Aquaculture	5000 m^2	5000 m^2	5000 m^2
(c) Domestic Industry Use	1000 m^2	1000 m^2	1000 m^2
(d) Home Occupation Use	n/a	n/a	n/a
(e) Produce Stand	n/a	n/a	n/a
(f) Residential Use	n/a	n/a	n/a
(g) Silviculture	n/a	n/a	n/a

6.4.87.2 Maximum Number and Size of Buildings and Structures

(a) Accessory buildings — combined floor area 200 m^2
(b) Dwelling units/parcel:
  (i) on a parcel having an area of 2.0 ha or less - 1
  (ii) on a parcel having an area greater than 2.0 ha - 2
(c) Height - 9.0 m
(d) Parcel coverage - 25%

6.4.87.3 Minimum Parcel Area

Subject to Section 7.4.4, no parcel having an area less than the applicable subdivision district as stated in Section 7.1 may be created by subdivision, and for the purposes of this subsection, "parcel" includes a lot created by deposit of a strata plan under the **Condominium Act** (British Columbia) but excludes a bareland strata lot.

6.4.87.4 Minimum Setback Requirements

(a) Buildings and structures for housing livestock or for storing manure:
  All lot lines - 30.0 m;
(b) All other buildings and structures
  All lot lines - 8.0 m;

except where any part of a parcel is adjacent to or contains a watercourse then the regulations in Section 3 of this Part shall apply.

[1] Bylaw No. 500.253, adopted January 11, 2000

RDN Bylaw No. 500

This is an excerpt only from "Regional District of Nanaimo Land Use and Subdivision Bylaw No. 500, 1987" and should not be used for interpretive or legal purposes without reference to the entire Bylaw.

R U R A L 4 [1] RU4

Permitted uses and Minimum Site Area

Required Site Area with:

		Community Water & Sewer System	Community Water System	No Community Services
a)	Agriculture	n/a	n/a	n/a
b)	Aquaculture	5000 m^2	5000 m^2	5000 m^2
c)	Domestic Industry Use	1000 m^2	1000 m^2	1000 m^2
d)	Home Occupation Use	n/a	n/a	n/a
e)	Produce Stand	n/a	n/a	n/a
f)	Residential Use	n/a	n/a	n/a
g)	Silviculture	n/a	n/a	n/a

Maximum Number and Size of Buildings and Structures

Accessory buildings: combined floor area 200 m^2

Dwelling units/parcel:

a) on a parcel having an area of 2.0 ha or less - 1

b) on a parcel having an area greater than 2.0 ha - 2

Height 9.0 m [2]

Parcel Coverage 25%

Minimum Parcel Area

Subject to Section 7.4.4, no parcel having an area less than 2.0 ha may be created by subdivision, and for the purposes of this subsection, "parcel" includes a lot created by deposit of a strata plan under the Condominium Act (British Columbia).

Minimum Setback Requirements

1. Buildings and structures for housing livestock or for storing manure:
   All lot lines - 30.0 m
2. All other buildings and structures
   All lot lines - 8.0 m

except where:

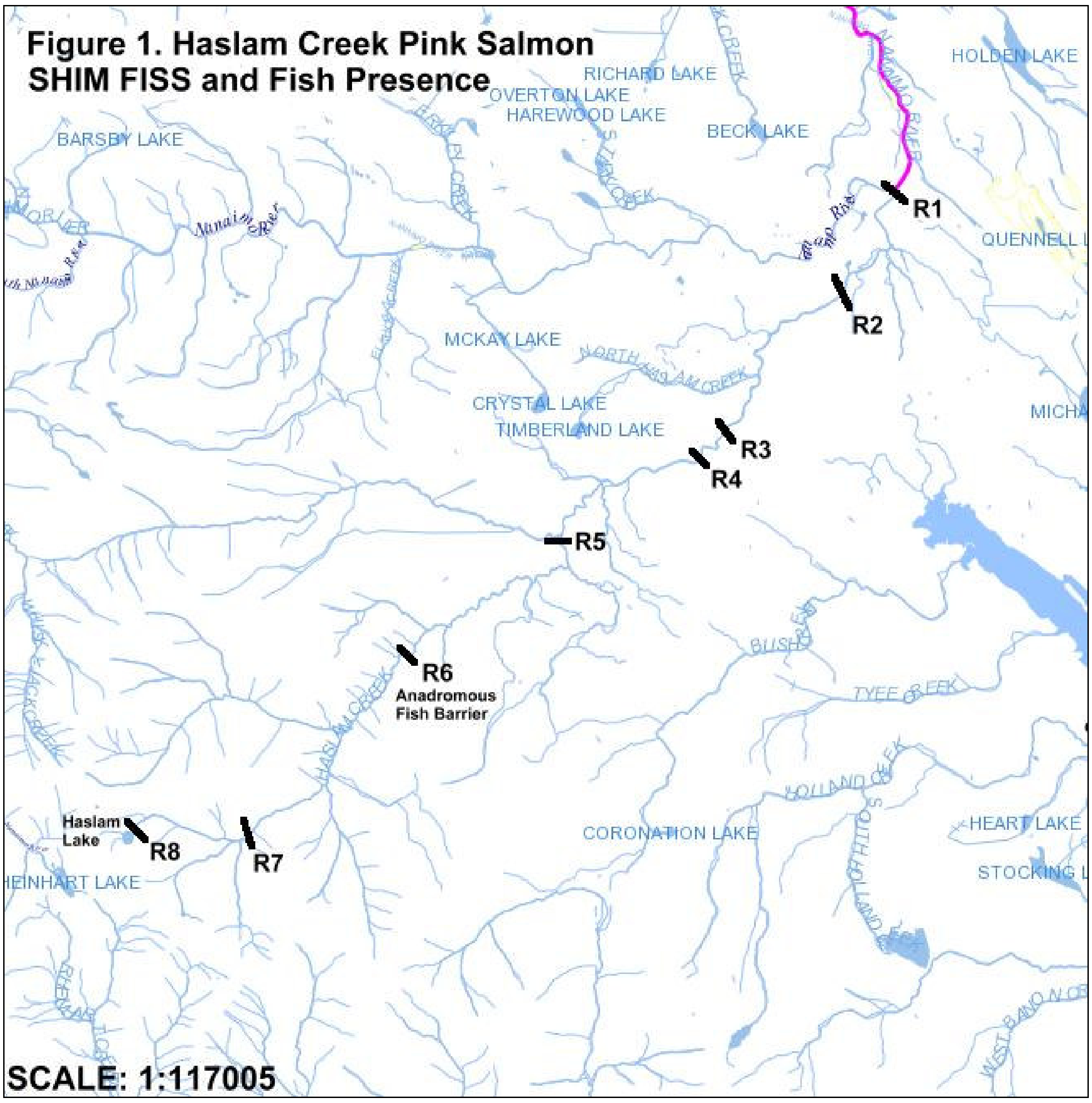
a) the parcel is less than 4000 m^2 in area then the setback from lot lines may be reduced to 2.0 m from an interior side lot line and to 5.0 m from other lot lines, excluding the front lot line;

b) any part of a parcel is adjacent to or contains a watercourse then the regulations in Section 3 of this Part shall apply.

definitions on the back

[1] Bylaw 500.206, adopted November 12, 1996
[2] Bylaw 500.246, adopted December 8, 1998

Appendix 3. Fish Distribution Orthophotos



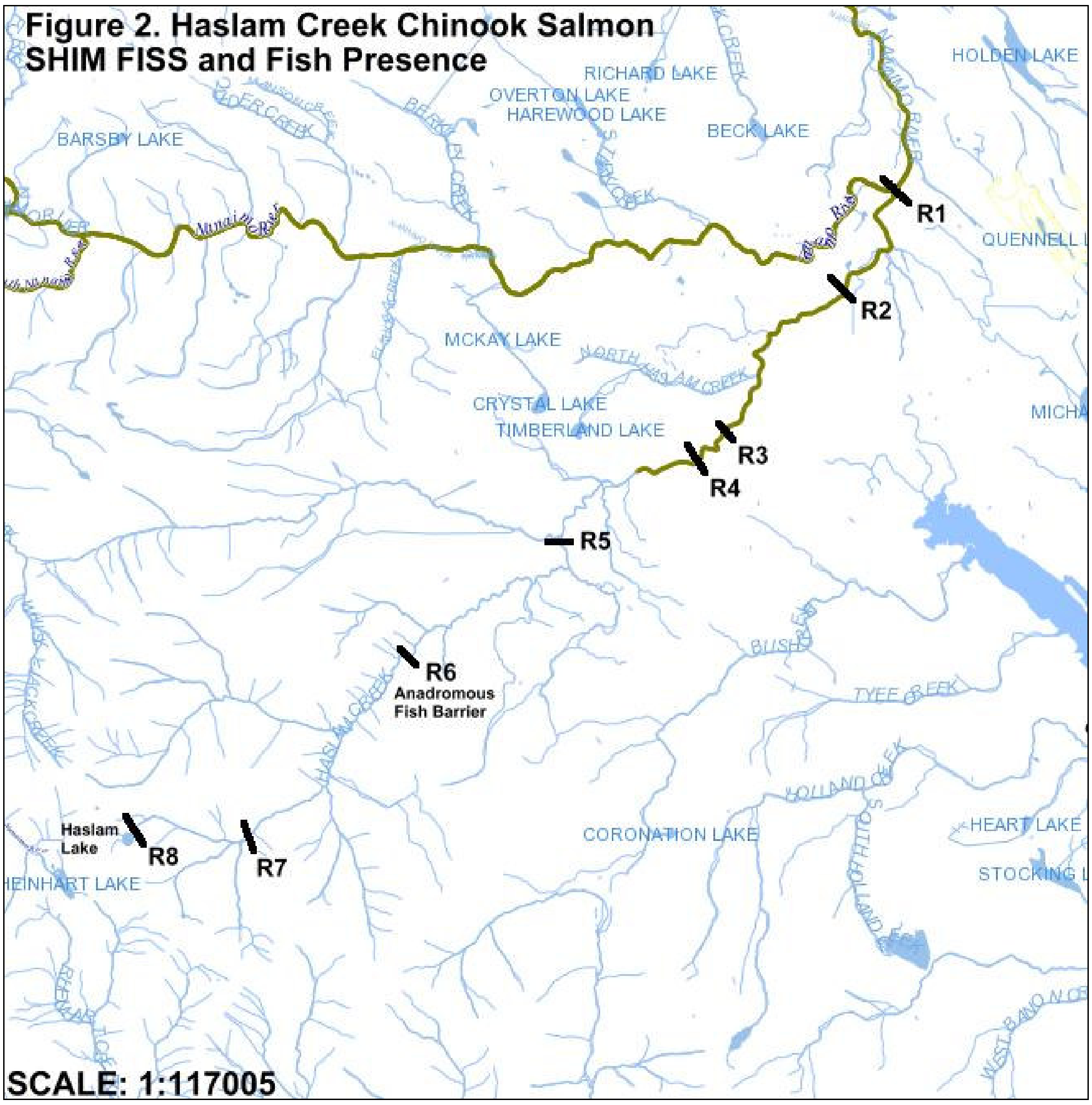


Figure 2. Haslam Creek Chinook Salmon SHIM FISS and Fish Presence
RICHARD LAKE
OVERTON LAKE
HAREWOOD LAKE
BECK LAKE
HOLDEN LAKE
BARSBY LAKE
R1
QUENNELL L
R2
MCKAY LAKE
NORTH HASLAM CREEK
CRYSTAL LAKE
TIMBERLAND LAKE
MICHA
R3
R4
R5
BUSH CREEK
R6
Anadromous
Fish Barrier
TYEE CREEK
HASLAM CREEK
HOLLAND CREEK
Haslam
Lake
R8
R7
CORONATION LAKE
HEART LAKE
STOCKING L
HEINHART LAKE
SCALE: 1:117005

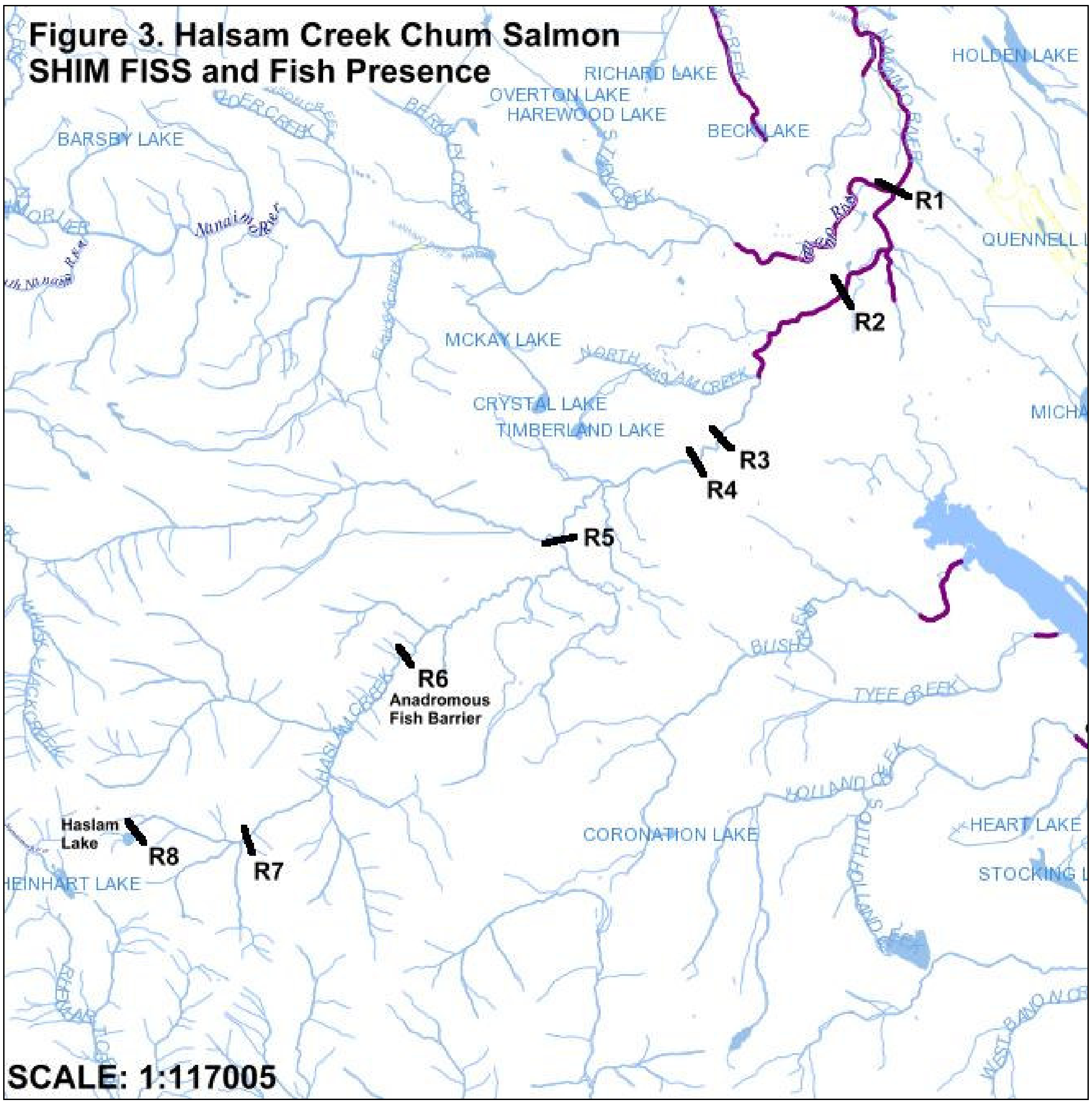


Figure 3. Halsam Creek Chum Salmon SHIM FISS and Fish Presence

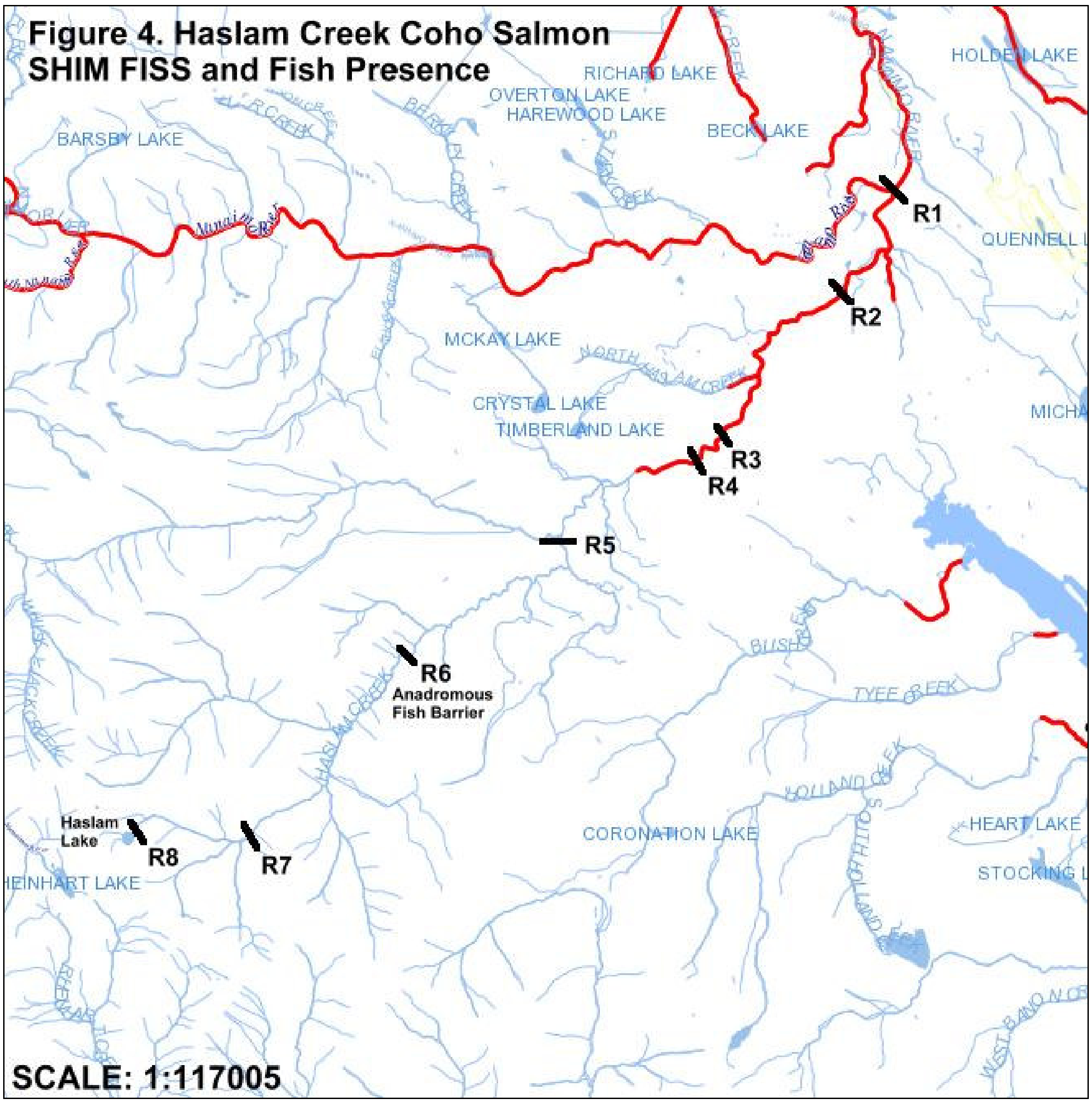


Figure 4. Haslam Creek Coho Salmon
SHIM FISS and Fish Presence
RICHARD LAKE
OVERTON LAKE
HAREWOOD LAKE
BECK LAKE
HOLDEN LAKE
BARSBY LAKE
R1
QUENNELL L
R2
MCKAY LAKE
NORTH HASLAM CREEK
CRYSTAL LAKE
TIMBERLAND LAKE
MICHA
R3
R4
R5
BUSH CREEK
TYEE CREEK
R6
Anadromous
Fish Barrier
HASLAM CREEK
HOLLAND CREEK
Haslam
Lake
R8
R7
CORONATION LAKE
HEART LAKE
STOCKING L
HEINHART LAKE
SCALE: 1:117005

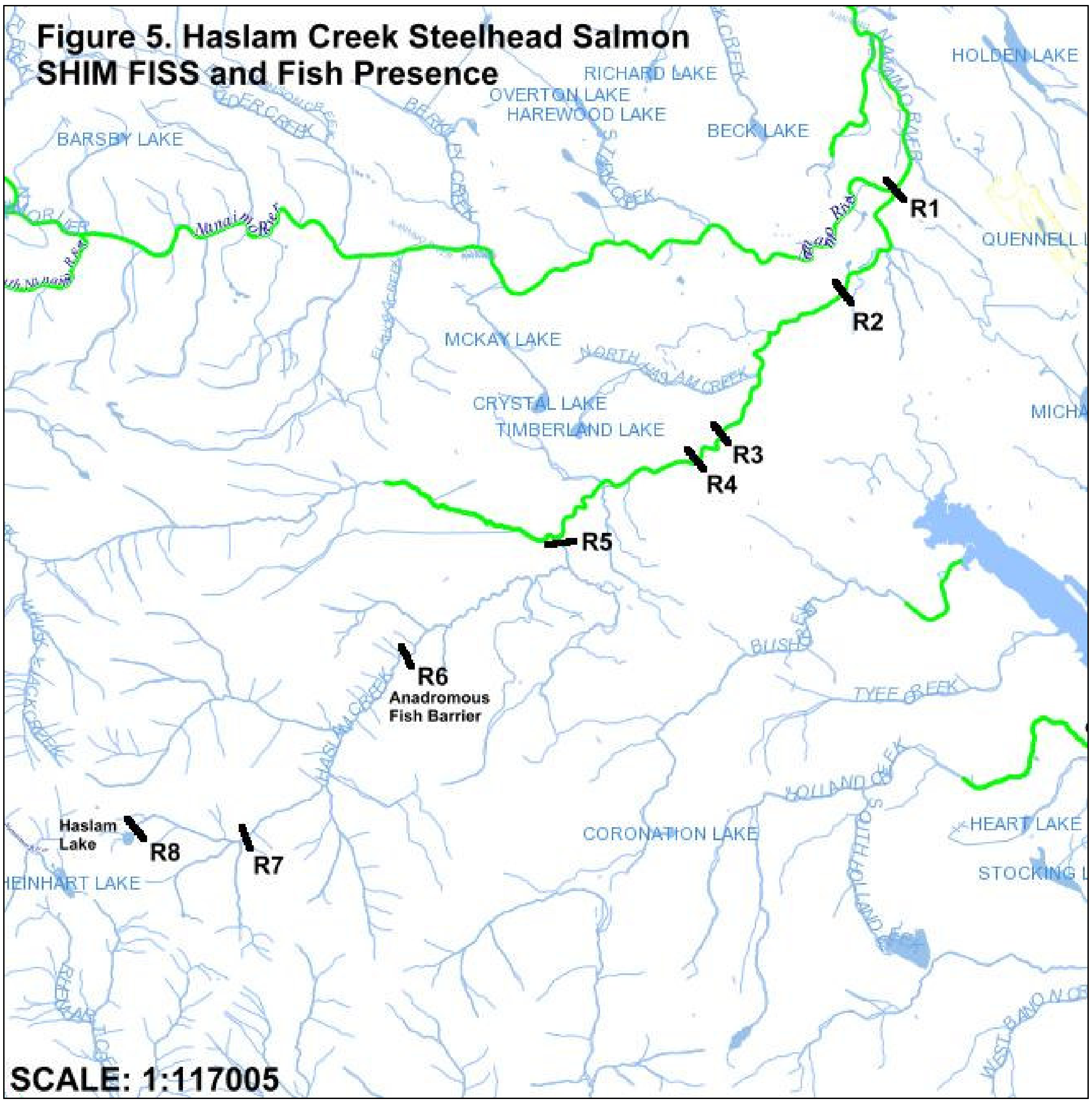


Figure 5. Haslam Creek Steelhead Salmon SHIM FISS and Fish Presence
RICHARD LAKE
OVERTON LAKE
HAREWOOD LAKE
BECK LAKE
HOLDEN LAKE
BARSBY LAKE
QUENNELL L
MCKAY LAKE
CRYSTAL LAKE
TIMBERLAND LAKE
MICHA
R1
R2
R3
R4
R5
R6
Anadromous Fish Barrier
R7
R8
Haslam Lake
HEINHART LAKE
CORONATION LAKE
HEART LAKE
STOCKING L
TYEE CREEK
SCALE: 1:117005

Appendix 4. Snorkel Surveys and Escapement Records

FILE NOTE

Date: January 9, 2001
File: 34560-20/SNORK
xf: 34560-27/*(Haslam)*

SNORKEL SURVEY REPORT
Haslam Creek (UPPER)

DATE: April 22, 1999

WEATHER: sunny, 25% overcast

WATER TEMP.(°C): 4.5

DISCHARGE: med/low

VISIBILITY (meters): 6

PERSONNEL: R. Ferguson and H. Wright

AREA. 500 m upstream of Rondalyn's Resort to Island Highway bridge, approx. 4.5 km.

1. **Fish Observed**:

Steelhead Adults: 3

- One dark wild male with a hatchery female kelt.
- One bright wild female about 7kg.

Juveniles: 10-15 Steelhead smolts.

2. **Notes**:

- The survey section contained many log jams which were easily avoided in medium to low flows.
- Overall the section had moderate steelhead rearing potential with many steep boulder riffles interspersed by small pools with gravel tail-outs.

Harlan Wright
Fisheries Technician, BCCF

cc: All Fisheries staff
G. Turnbull, District Conservation Officer, Nanaimo
R. Heusen, Conservation Officer, Nanaimo
Steelhead Crew

FILE NOTE

Date: January 9, 2001
File: 34560-20/SNORK
xf: 34560-27/*(Haslam)*

SNORKEL SURVEY REPORT
Haslam Creek (LOWER)

DATE: March 25, 1999

WEATHER: 50% overcast.

WATER TEMP.(°C): 5

DISCHARGE: low

VISIBILITY (meters): 5m on upper 2km, 3m on lower 1.5km.

PERSONNEL: M. Kissinger, H. Wright

AREA: 500m upstream of Island Highway bridge, downstream to the mouth, approx. 3.5km.

1. **Fish Observed**:

Adults:

3 winter steelhead.

- 1 wild male, 1 female of unknown origin, and 1 unclassified.
- fish were moderatley coloured, but in good condition.

Juveniles:

no juveniles observed.

2. **Notes**

- the decrease in visibility was associated with a farmer's field along the streambank about 1.5km above the Nanaimo/Haslam confluence

Harlan Wright
Fisheries Technician

cc: All Fisheries staff
Steelhead Crew
G. Turnbull, Conservation Officer, Nanaimo

FILE NOTE

Date: January 9, 2001
File: 34560-20/SNORK
xf: 34560-27/*(NANA)*

SNORKEL SURVEY REPORT
Haslam Creek (LOWER)

DATE: May 8, 2000
WEATHER: 30 % overcast, mild
WATER TEMP. (°C): 7.5 @ 1330 hrs
DISCHARGE (m^3/s): low spring flows
VISIBILITY (m): 4.5 decreasing to 3
PERSONNEL: J. Craig, H. Wright
AREA: Hwy 19 bridge to Nanaimo River confluence pool (~ 3.0 km)

1. Fish Observed:

Adults:

A total of 0 steelhead were observed for a density of 0 fish/km.

1 resident trout @ 25-35 cm (undetermined species)
1 chinook jack (bright, ~ 3kg)

Juveniles:

A very low abundance of trout parr was noted.
A low abundance of coho fry was noted.

2. Notes:

- No anglers or evidence of recent angling noted.
- Two suspected steelhead redds were observed.
- There was 1 female steelhead kelt, 2 wild cutthroat (@ 35-45 cm) and 1 chinook (~ 4kg) observed in the confluence pool of the Nanaimo River and Haslam Creek.

Brad Smith
Fisheries Technician
BC Conservation Foundation

cc: All Fisheries staff
Steelhead Crew
Nanaimo District Conservation Officers
Nanaimo CEDP Hatchery (Att. Henry Bob)

Appendix 4. FISS Haslam Creek Salmon Escapement Data 1950-2009.

Year	Chinook Fall Run	Chum Fall Run	Coho Fall Run	Pink Run 1	Sockeye Run 1
2009	No data for this year.				
2008	No data for this year.				
2007	No data for this year.				
2006	No data for this year.				
2005	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	No Data	No Data
2004	NOT INSPECTED	1600	175	No Data	No Data
2003	198	15464	1394	No Data	No Data
2002	1	287	946	NONE OBSERVED	NONE OBSERVED
2001	NOT INSPECTED	2683	488	NOT INSPECTED	NOT INSPECTED
2000	1	381	54	NONE OBSERVED	NONE OBSERVED
1999	NONE OBSERVED	140	NONE OBSERVED	NONE OBSERVED	NONE OBSERVED
1998	4	400	15	NONE OBSERVED	NONE OBSERVED
1997	NONE OBSERVED	630	NONE OBSERVED	NONE OBSERVED	NONE OBSERVED
1996	30	800	30	NONE OBSERVED	NONE OBSERVED
1995	100	450	100	NONE OBSERVED	NONE OBSERVED
1994	No Data	4000	25	No Data	No Data
1993	No Data	7000	No Data	No Data	No Data
1992	12	8000	295	No Data	No Data
1991	3	5000	40	No Data	No Data
1990	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1989	No Data	2500	450	No Data	No Data
1988	No Data	1000	250	No Data	No Data
1987	No Data	1500	450	No Data	No Data
1986	No Data	750	275	No Data	No Data
1985	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1984	No Data	3000	No Data	No Data	No Data
1983	NONE OBSERVED	1400	600	No Data	No Data
1982	145	18800	500	No Data	No Data
1981	6	3500	556	No Data	No Data
1980	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1979	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1978	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1977	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1976	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1975	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1974	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1973	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1972	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1971	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1970	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1969	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1968	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1967	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1966	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1965	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1964	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1963	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1962	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1961	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1960	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1959	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1958	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1957	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1956	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED
1955	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED	NOT INSPECTED

1954	**NOT INSPECTED**	**NOT INSPECTED**	**NOT INSPECTED**	**NOT INSPECTED**	**NOT INSPECTED**
1953	**NOT INSPECTED**	**NOT INSPECTED**	**NOT INSPECTED**	**NOT INSPECTED**	**NOT INSPECTED**
1952	**No data for this year.**				
1951	**No data for this year.**				
1950	**No data for this year.**				

Appendix 5. CEDP Hatchery Broodstock and Stocking Records

Table 1. Coho Salmon Broodstock From Haslam Creek – Nanaimo River Hatchery

Year	Male	Female
1995	6	7
1992	9	6
1991	11	10
1988	5	10
1987	12	11
1983	4	4

Table 2. Coho Salmon Fry Stocking of Haslam Creek – Nanaimo River Hatchery

Year	Coho Fry #	Year	Coho Fry #
2000	30,000	**1989**	31,905
1999	30,000	**1988**	30,877
1998	42,151	**1987**	30,630
1997	74,204	**1986**	9,546
1996	9,018	**1985**	15,369
1995	22,234	**1984**	20,128
1994	57,127	**1983**	50,000
1993	59,015	**1982**	43,794
1992	-	**1981**	-
1991	8,073	**1980**	15,633
1990	24,000		

Appendix 6. Reach Map Orthophotos

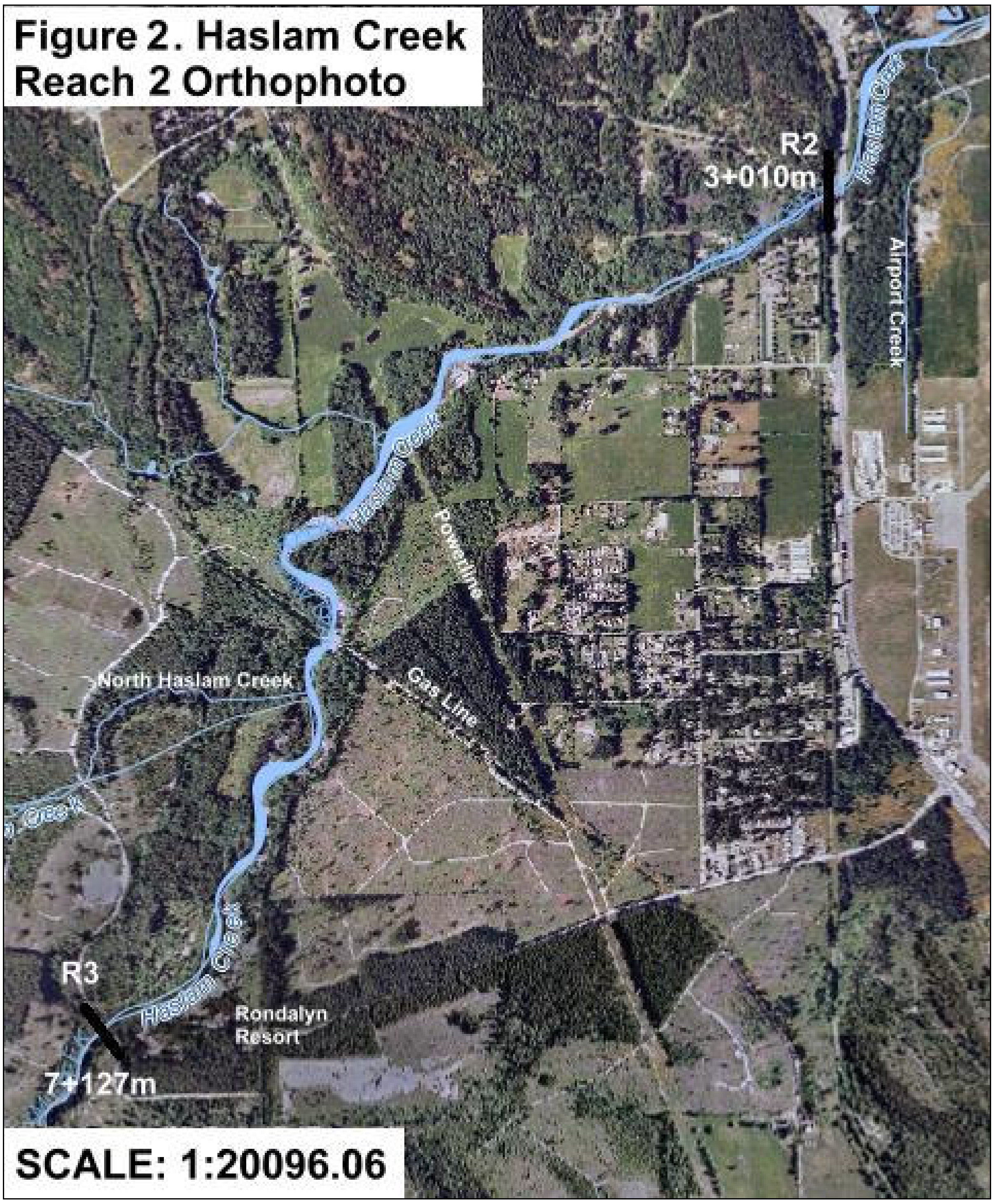


Figure 2. Haslam Creek Reach 2 Orthophoto
R2
3+010m
Haslam Creek
Airport Creek
Haslam Creek
Powerline
North Haslam Creek
Gas Line
Haslam Creek
R3
7+127m
Rondalyn Resort
SCALE: 1:20096.06


Figure 3. Haslam Creek Reach 3 Orthophoto
R3
7+127m
Haslam Creek
Logging Road Bridge
Haslam Creek
TCT Suspension Bridge 7+968m
R4
7+999m
Haslam Creek
SCALE: 1:7439.32

Figure 4. Haslam Creek Reach 4 Orthophoto

Figure 5. Haslam Creek Reach 5 Orthophoto

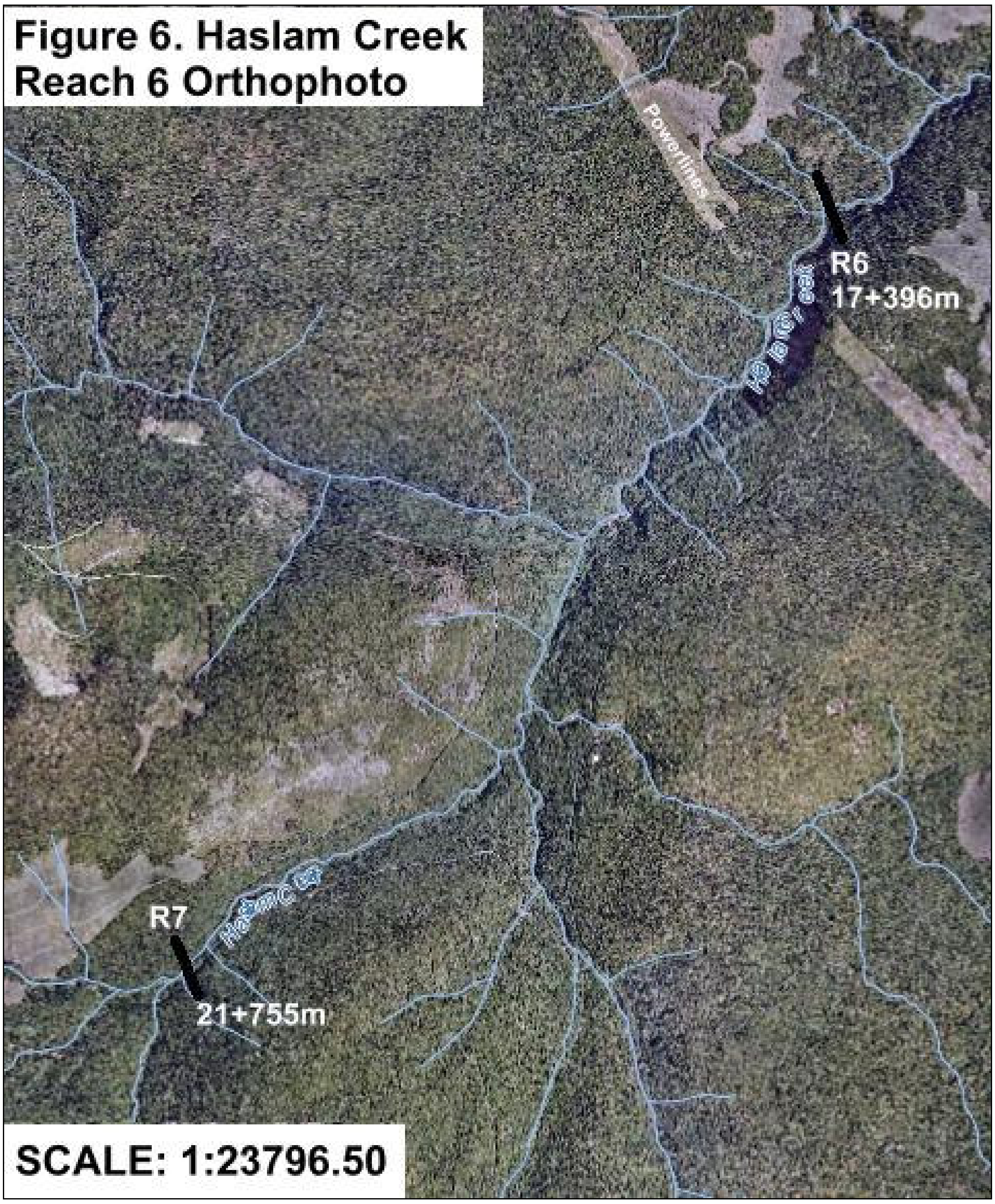
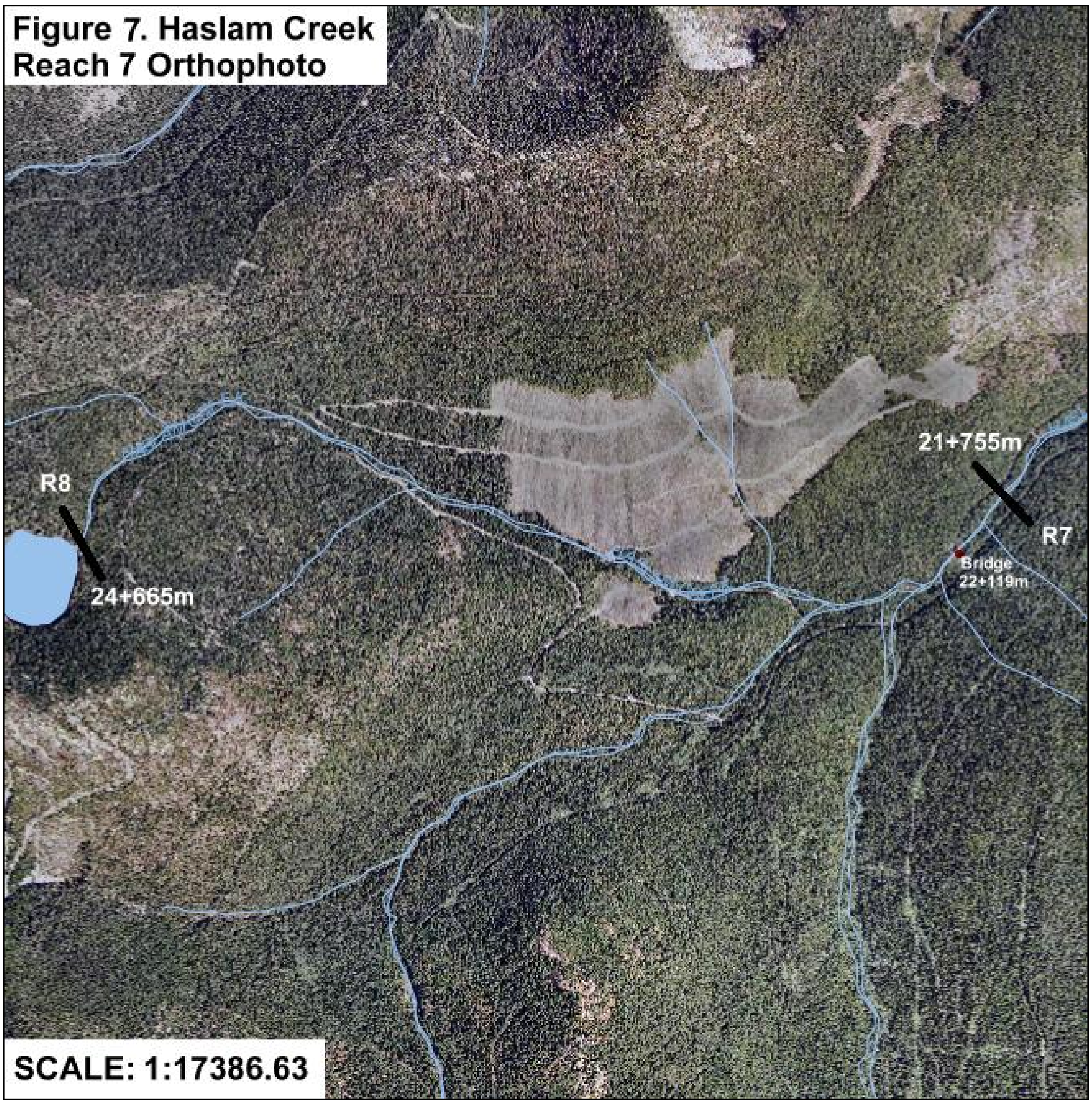


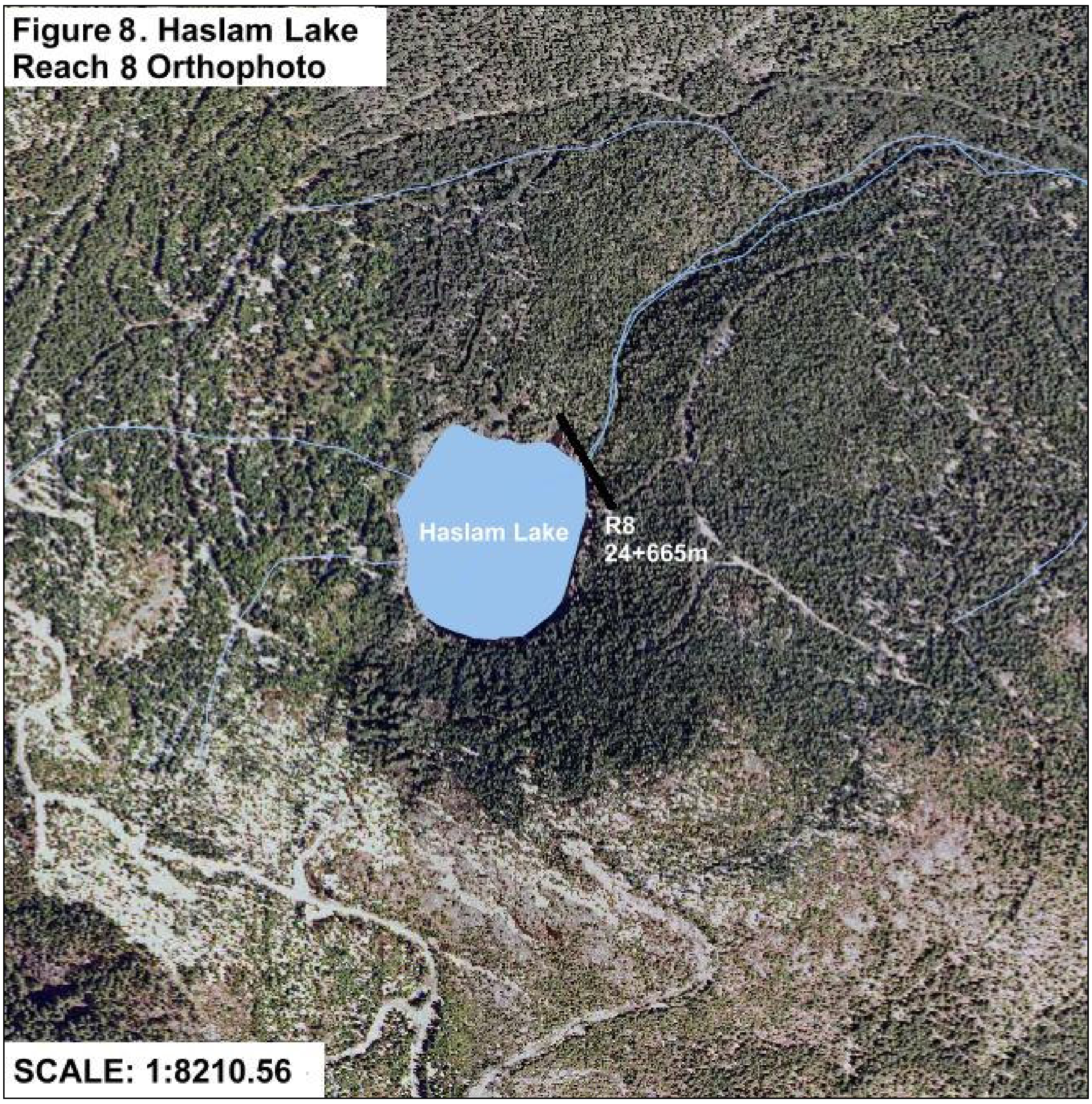
Figure 6. Haslam Creek Reach 6 Orthophoto

Figure 7. Haslam Creek Reach 7 Orthophoto



SCALE: 1:17386.63

Figure 8. Haslam Lake Reach 8 Orthophoto



SCALE: 1:8210.56

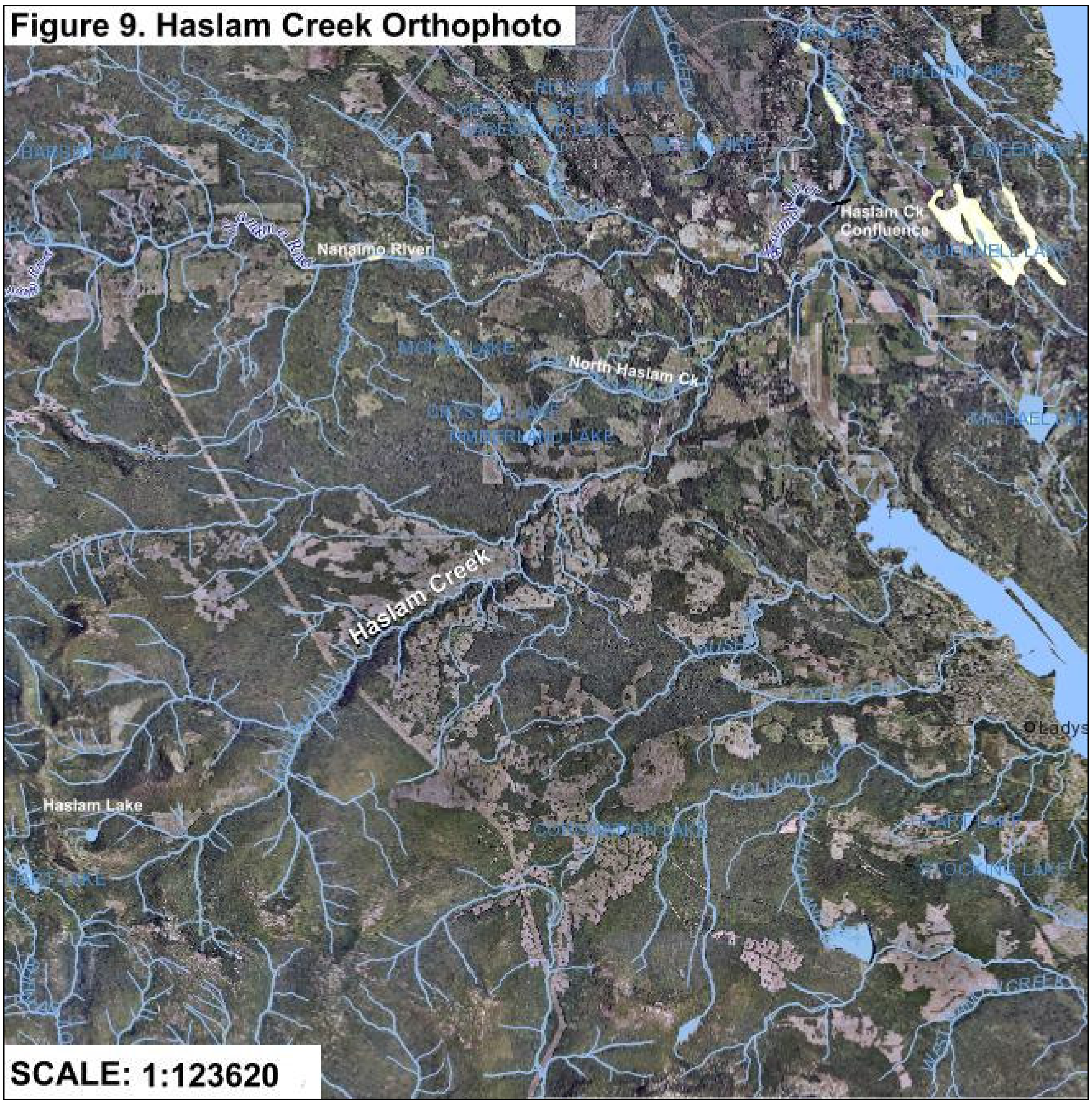
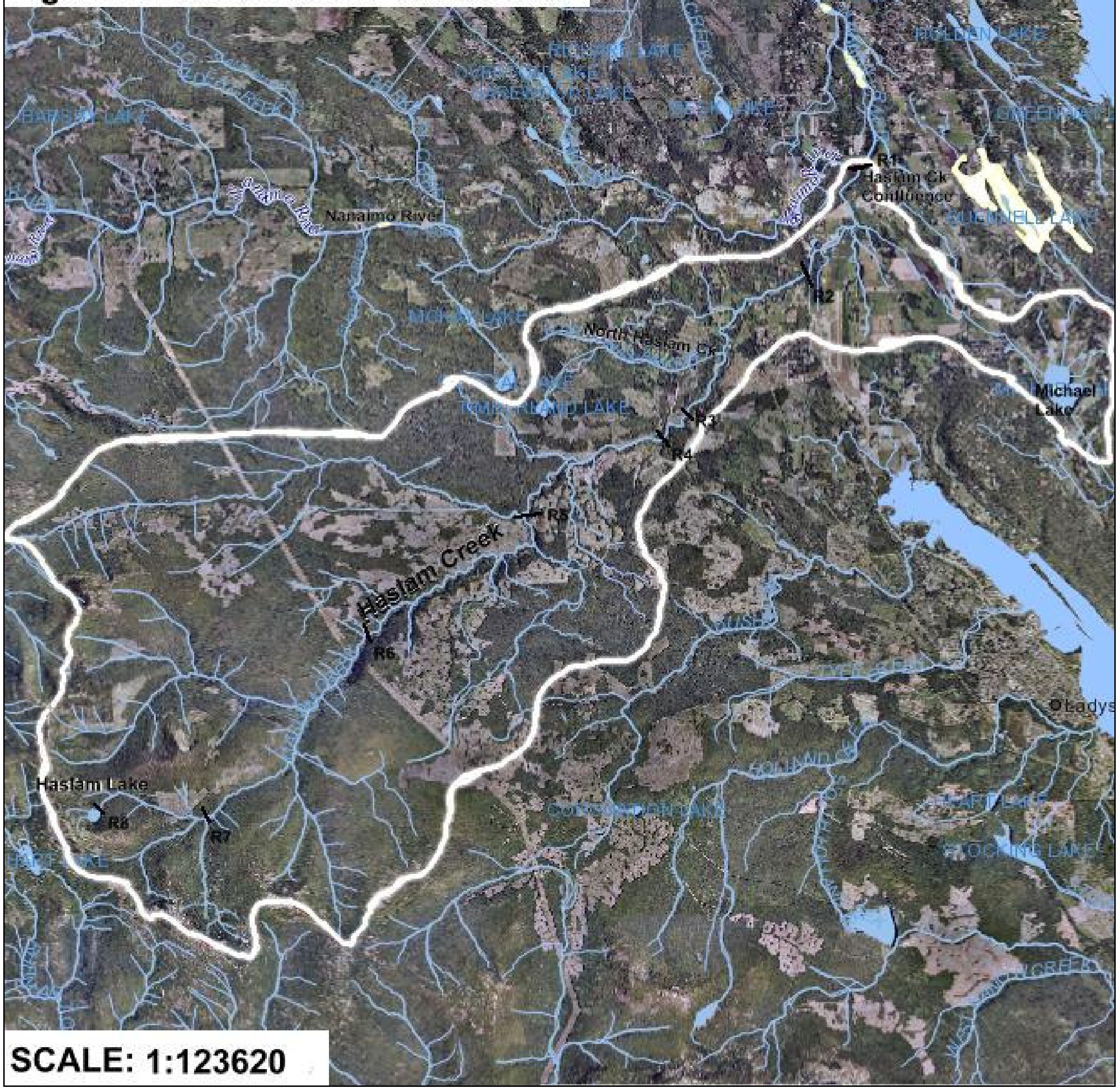


Figure 9. Haslam Creek Orthophoto

Figure10.Haslam Creek Watershed



SCALE: 1:123620

Appendix 7. Haslam Creek Habitat and Riparian Assessment Data and Reach Photographs

FORM 1.

Haslam Creek
Reach 1 Habitat and Riparian Assessment Data

Haslam Creek		Watershed Code	920-386400-11200	Date	Aug. 14 2000	Reach Name	1			Discharge Depth #1	0.32	Velocity	
Water Quality Information					Field Crew		Patti M, Henry B, Larry P					T1 12	Site Length
Dissolved Oxygen	9.80	pH	7.80	Total Dissolved Solids	20.00	Temp C	18.00	Chainage at Beginning of Reach	0.00	Discharge Depth #2	0.50	T2 16	5.00
Velocity (m/s)	0.37	Average Depth (at flow site)	0.42	Wetted Width (at flow site)	7.80	Discharge (m3/s)	1.22	Chainage at End of Reach	3010.00	Discharge Depth #3	0.45	T3 13	

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Sed	Slt	Cob	Grv	Fine	Percent Instream Cover Boul	LWD	Cutbk	Veg	Other	Percent Crown Cover	Large Woody Debris	SW Dbank full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off Channel Habitat (length)	Off Channel Habitat (width)	Off Channel Habitat (bank side)	Land Use Right	Land Use Left	Vegetation Type Right	Vegetation Type Left	Riparian Slope Right	Riparian Slope Left	Stability Right	Stability Left	Vegetation Depth Right	Vegetation Depth Left	Livestock Access Right	Livestock Access Left	Photos	Comments
Riffle	0.00	44.00		16.30	2.30			0.12	2.50	23.00		0	0	80	10	10						10.00									FC	Nat	Ws	Con	2	30	High	High		30			1,2,3	
Pool	44.00	57.00	13.00	11.00	143.00																										0	0	0	0			0	0						1
Pool	81.00	124.00	43.00	6.90	297.00																		2								FC	Nat	Ws	Con	1	1	High	High	20	30			4	
Riffle	201.00	300.00		17.50	2.50			0.12	1.00	25.00		0	0	70	25	5	0	0	5	0	0	30.00	1								Nat	Nat	Ws	Ma	1	1	High	High	30	30				Benched at 3m both sides
Riffle	300.00	312.00		15.50	2.50																										FC	Nat	Ws	Ma	1	1	High	High	5	30			5	3m bench Napoleon Creek enters (L3)
Pool	312.00	349.00	37.00	12.30	455.10																										0	0	0	0			0	0						
Riffle	400.00	446.00		11.80	2.50			0.05	1.00	22.00		0	5	60	25	10						30.00									FC	Nat	Ws	Ma	1	1	High	High	5	30				3 m vertical bench (R3)
Pool	446.00	462.00	16.00	6.30	17.00																										0	0	0	0			0	0						
Pool	466.00	476.00	10.00	6.00	60.00																										0	0	0	0			0	0						
Pool	506.00	514.00	8.00	3.00	24.00																										0	0	0	0			0	0						
Riffle	520.00	611.00		4.30	2.50																										FC	Nat	Ws	Ma	1	1	High	High	5	30			6	3 meters vertical bench (R3)
Pool	611.00	655.00	44.00	7.50	330.00																										0	0	0	0			0	0						
Pool	571.00	659.00	88.00	8.00	704.00			0.50	2.50	21.00		0	5	50	25	20	5	0	20	0	0	50.00	10								FC	Nat	Gr	Ma	1	2	Low	High	0	30			7	benched sides, fence right and erosion (see Photo)
Pool	695.00	771.00	76.00	14.30	1086.80																		3								FC	Nat	Gr	Ma			Med	High	5	30				fence right, bench at 2m
Pool	782.00	803.00	21.00	9.00	189.00			0.20	1.00	19.50		0	10	70	10	10	2	0	0	0	0	2.00									I		Gr	Gr	1	1	Med	Med	10	10			8	Altered site. Water pipeline crossing; benched at 2m vert.
Pool	817.00	839.00	22.00	6.00	132.00																										0	0	0	0			0	0						
Pool	862.00	871.00	9.00	6.00	54.00																										0	0	0	0			0	0						
Pool	880.00	893.00	13.00	6.00	78.00																										0	0	0	0			0	0						
Riffle	901.00	914.00		4.00	2.50																										Nat	FC	Ws	Ma	2	2	Med	Med	5	30				benched at 2m vert; fencing on R&L
Pool	918.00	947.00	29.00	8.00	232.00																										0	0	0	0			0	0						
Pool	942.00	1159.00	217.00	13.30	2926.00			0.20	1.00	27.00		0	5	25	50	20	5	0	5	50	5	70.00	2								FC	FC	Ws	Ma			Med	Med	10	30			9	benched at 3m vert, fence R&L
Pool	1161.00	1166.00	5.00	5.00	75.00																										0	0	0	0			0	0						
Riffle	1200.00	1253.00		2.50	2.50			0.05	2.50	21.00		0	0	15	75	10	0	0	0	25	0	20.00									FC	FC	Ws	Ma			Med	Med	20	30			10,11,12,13	Possible see photos on channel
Pool	1253.00	1365.00	112.00	10.00	1120.00																							250	2	Left	FC	Nat	Gr	Ma			High	High	5	30			14, 15	DCH enters at 1260 m, LB 2m & RB 5m bench, Holloway Cr (R&B)
Dry	1400.00			3.00						43.00		0	0	50	35	15						30.00									Nat	Nat	Ws	Ma	1	1	Med	Med	30	30				2m bench both sides
Pool	1411.00	1453.00	42.00	6.00	252.00																		5								0	0	0	0			0	0					16	Haslam Creek enters right, pool covered in algae
Dry	1500.00			3.00						35.00		0	0	50	35	15							4					50	2	Right	Nat	Nat	Ws	Ma			Low	Low	30	30				2m bench both sides, side channel enters right
Pool	1548.00	1560.00	12.00	3.00	36.00																										0	0	0	0			0	0					17	creek splits
Pool	1574.00	1580.00	6.00	3.00	18.00																										0	0	0	0			0	0					18	River splits and channel
Dry	1600.00			3.00					1.00	27.00		0	0	50	30	20						10.00	17								Nat	Nat	Ws	Ma	2	2	Med	Med	30	30			19	lots of LWD but creek dry
Pool	1620.00	1625.00	5.00	2.00	10.00																		1					20	2	Left	0	0	0	0			0	0						DCH left bank
Dry	1700.00			3.00					1.00	22.00															50						Nat	Nat	Ws	Ma	2	2	Low	Low	30	30			20	Photo: erosion site
Dry	1800.00			3.00					1.00	41.00		0	1	60	30	9						10.00	3								FC	Nat	Ws	Ma			Low	Low	30	30				1.5m bench both sides, river splits at 1775m
Pool	1867.00	1873.00	6.00	1.50	4.50																										0	0	0	0			0	0					21	algae covered pool
Dry	1900.00			3.00						24.00												2.00			50						FC	Nat	Gr	Gr	2	2	Low	Low	2	30			22	1m bench both sides. Photo: erosion end of airport
Dry	2000.00			3.00					3.00	21.00		0	20	10	30	30						25.00									FC	Nat	Gr	Gr	2	2	Low	Low	15	30			23	photo: rip rap site, no fencing and 2.5m bench (R&B)
Dry	2100.00			3.00					1.00	27.70																					Nat	Nat	Gr	Gr			Low	Low	30	30				2m bench
Pool	2200.00	2205.00	5.00	3.00	15.00			0.20		45.00		0	0	20	55	25						30.00	1		50						Nat	Nat	Gr	Gr			Low	Low	30	5			24	photo: erosion site, 2.5 m bench
Pool	2253.00	2256.00	3.00	2.00	6.00																										0	0	0	0			0	0						
Pool	2260.00	2263.00	3.00	2.00	6.00							0	0	10	60	20	5	0	0	0	0										0	0	0	0			0	0						
Riffle	2305.00	2325.00		6.00	2.50																										Nat	Nat	Ws	Gr			Med	High	20	2				2m bench
Pool	2325.00	2428.00	103.00	10.00	1030.00			0.45	1.00	19.00		0	10	30	45	15	10	0	5	0	5	10.00				178					Nat	Nat	Ws	Ma			Med	High	30	30			25	photo: pool access road, rip rap part of Hamrack Well A (R&B)
Pool	2431.00	2458.00	27.00	6.70	180.90																										0	0	0	0			0	0						
Pool	2497.00	2558.00	61.00	2.90	177.10																		2								Nat	H	Ws	Ma			Med	High	30	5			26,27	photo of rip rap, 4m bench left, 2m bench right
Pool	2545.00	2549.00	4.00	6.30	25.20																										0	0	0	0			0	0						
Riffle	2600.00	2619.00		4.50	2.50			0.30	2.50	40.00		0	10	60	25	5	5	0	5	0	5	20.00	5			27					H	H	Gr	Gr	1	1	Med	High	10	5			28,29	Trans Canada Hwy on left
Riffle	2619.00	2700.00		4.50	2.50																		1								0	0	0	0			0	0					30	Photo: erosion on left bank
Riffle	2700.00	2756.00		4.50	2.50																										H	H	Gr	Gr	1	1	Med	Med	30	15				2m bench both sides
Pool	2709.00	2773.00	64.00	11.00	704.00																										0	0	0	0			0	0					31,32	photo: erosion on left
Pool	2777.00	2891.00	114.00	11.20	1276.80			0.45		22.20		0	10	20	45	5	0	0	5	0	5	10.00									H	H	Gr	Ma			High	Med	30	5			33,34	Photo end of reach and gabions, riprap on right
Riffle	2900.00	2930.00		7.20	2.50				1.30																						H	H	Ws	Ma		1	High	High	0	5			35,36	under bridge of hwy, rip rap on both banks, 5m bench
Pool	2930.00	2956.00	26.00	11.20	342.20																					15					0	0	0	0			0	0					1,2	photo: concrete wall at Spruston Rd.
Riffle	2956.00	3010.00			2.50				2.30																						0	0	0	0			0	0					3,4,5,6	Photo end of reach, gabions and looking d/s
																															0	0	0	0			0	0						
																															0	0	0	0			0	0						
Reach Totals and Averages		3010.00	1260.00	6.37	12765.30	19159.81	66.52	0.24	1.28	29.67	21.45	0	5	43	38	14	2	1	3	8	0	40.63	66	0.65	5	7	0	11			65	51			18	17	65	73	17.76	20.55	0	0		

Appendix 7. Haslam Creek Reach 1 Photo Page


1.) Airphoto of channel braiding looking downstream at 1+700m.


2.) Airpohoto of sediment wedge looking upstream at 1+874m.


3.) Airphoto of Harmac Well looking downstream at 2+300m.


4.) Right bank erosion site looking upstream at 2+400m (2009).

FORM 2.

Haslam Creek
Reach 2 Habitat and Riparian Assessment Data

Appendix 7. Haslam Creek Reach 2 Photo Page

1.) Typical substrate and lack of LWD found in reach.

3.) Debris jam located downstream of creek braids at 4+300m.

2.) Right bank braid showing riparian loss and erosion at 4+800m.

4.) Airphoto of 4+300m site looking downstream.

FORM 3.

Haslam Creek
Reach 3 Habitat and Riparian Assessment Data

Haslam Creek		Watershed Code	920-384400-11200	Date	Aug 29 2000	Reach Name	3		Dischrge Depth #1	0.50	Velocity	
Water Quality Information					Crew	Patti M, Henry B, Larry P					T1 21.0	Site Length
Dissolved Oxygen	10.90	pH	8.00	Total Dissolved Solids	57.00	Temp C	15.90	Chainage at Start of Reach 0.0	Dischrge Depth #2	0.37	T2 23.0	5.00
Velocity (m/s)	0.23	Average Depth (at flow site)	0.41	Wetted Width (flow site)	3.30	Discharge (m3/s)	0.32	Chainage at End of Reach 872.0	Dischrge Depth #3	0.37	T3 20.0	

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	Percent Crown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Left	Vegetation Type Right	Left	Riparian Slope Right	Left	Stability Right	Left	Vegetation Depth Right	Left	Livestock Access Right	Left	Photos	Comments
Riffle	0.00	31.00		10.00	0.00			0.30	1.00	16.00		10	70	10	8	2	30	0	0	0	0	50.00				30					C	C	Mix	Sr	2	2	High	High	30	30			23	Reach break, altered site bridge area
Pool	31.00	81.00	50.00	14.90	745.00																		4								0	0	0	0			0	0						
Riffle	100.00	131.00			0.00																										Nat	C	Mix	Ma	0		High	High	100	30				left bank canyon
Pool	131.00	154.00	23.00	8.00	184.00																		1								0	0	0	0			0	0						
Pool	187.00	230.00	43.00	14.30	614.90			0.75	4.00	15.10		50	30	2	8	10	30	0	0	0	0	40.00	1								Nat	Nat	Mix	Ma			High	High	30	30			1,2	Photo d/s & u/s at 200m. Inside canyon
Pool	232.00	258.00	26.00	4.30	111.80																		17								0	0	0	0			0	0					3	d/s at log jam 258
Pool	259.00	270.00	11.00	6.00	66.00																		30								0	0	0	0			0	0						
Pool	284.00	308.00	24.00	14.70	352.80																										Nat	Nat	Mix	Ma			High	High	30	30			4,5	Photo: u/s & d/s at 308m in canyon
Pool	320.00	325.00	5.00	4.00	20.00																										0	0	0	0			0	0						
Pool	339.00	345.00	6.00	6.00	36.00																										0	0	0	0			0	0						
Pool	367.00	420.00	53.00	11.00	583.00			4.00	3.00	17.00		75	5	10	5	5	50	0	0	0	0	80.00									Nat	Nat	Mix	Sr	4	2	High	High	100	100			7,8	end of canyon - Photo u/s & d/s at 400m
Pool	443.00	477.00	34.00	6.50	221.00																										0	0	0	0			0	0						
Pool	487.00	519.00	32.00	6.00	192.00																										Nat	Nat	Mix	Ma	5	2	High	High	100	100			9, 10	photo: u/s and d/s at 487m
Riffle	500.00	532.00		11.20	0.00			0.20	1.00	26.00		0	60	25	10	5	10	1	0	0	0	90.00	1								Nat	Nat	Mix	Ma	5	1	High	High	100	100			11,12	photo: d/s and u/s
Pool	522.00	556.00	24.00	4.10	98.40																										0	0	0	0			0	0						
Pool	571.00	580.00	9.00	4.50	40.50												0	0	5	0	0		1								0	0	0	0			0	0						
Pool	692.00	703.00	11.00	6.00	66.00												0	0	5	0	0										Nat	Nat	Mix	Ma	2	2	High	High	100	100				
Pool	747.00	769.00	22.00	4.50	99.00																										0	0	0	0			0	0						
Pool	775.00	806.00	31.00	4.00	124.00			0.60		26.00		0	60	20	10	10	10	0	0	0	0	80.00	1								Nat	Nat	Mix	Ma	4	5	High	High	100	100			13,14	Photo: d/s & u/s at 800m mark
Pool	816.00	872.00	56.00	15.40	862.40																										0	0	0	0			0	0					15	suspected end of reach
																															0	0	0	0			0	0						
																															0	0	0	0			0	0						
																															0	0	0	0			0	0						
Reach Totals and Averages	0.00	872.00	460.00	8.22	4416.80	7168.78	61.61	1.37	2.25	20.63	36.87	27	45	13	8	6	19	0	1	0	0	70.00	56	1.32	0	0	0	0			11	10			7	6	9	9	76.67	68.89	0	0		

Appendix 7. Haslam Creek Reach 3 Photo Page

1.) Airphoto looking downstream of lower 300m and reach break.

2.) Airphoto looking upstream at 7+750m.

3.) Airphoto of left bank logging blocks at 7+850m.

4.) Airphoto looking downstream at TCT suspension bridge reach break.

Form 4

Reach4 Habitat and Riparian Assessment Data

Stream Name	Haslam Creek	Watershed Code	9200844112	Date	14/09/01	Reach Name	Reach 4			Discharge Depth #1	0.50	Velocity T1	7.00 Site Length
Water Quality Information					Field Crew		Chuck, Clint, Wayne, Patti						
Dissolved Oxygen	9.30	pH	8.40	Total Dissolved Solids	49.00	Temp C	18.20	Chainage at Beginning of Reach	12.30	Discharge Depth #2	0.50	T2	8.00 1.80
Velocity (m/s)	0.23	Average Depth (at flow site)	0.47	Wetted Width (at flow site)	5.40	Discharge (m3/s)	0.59	Chainage at End of Reach	4000.00	Discharge Depth #3	0.40	T3	8.00

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Sld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	Percent Crown Cover	Large Woody Debris	LWD/bank full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Left	Vegetation Type Right	Left	Riparian Slope Right	Left	Stability Right	Left	Vegetation Depth Right	Left	Livestock Access Right	Left	Photos	Comments
Pool	12.30	27.30	15.00	9.80	148.52			3.30	3.00	33.00		10	45	40	5	0	0	0	25	0	0	50.00	0		0	0	0				C	C	Sr	Mx	2	5	High	High	30	30	0	0	21,22	river right
Riffle	44.30	110.00			0.00																				50						0	0	0	0			0	0					P23	comments
Pool	140.00	170.00	30.00	12.00	360.00																										0	0	0	0			0	0					P24	fish present
Pool	220.00	252.00	32.00	8.50	272.00																										0	0	0	0			0	0					looking	
Pool	264.00	266.00	2.00	16.40	32.80																										0	0	0	0			0	0					looking	
Pool	270.00	286.00	16.00	5.40	86.40																										0	0	0	0			0	0					P1/P2	river right steep
Pool	347.00	376.00	29.00	4.00	116.00																										0	0	0	0			0	0					P3	@318m RL
Pool	382.00	400.00	18.00	18.00	324.00																										0	0	0	0			0	0					P4/P5	RL @400m;
Pool	468.00	481.00	13.00	2.00	26.00																										0	0	0	0			0	0						
Riffle	500.00			10.30	0.00																		0			334					1	1	Mx	0	benc	benc	High	High	30	5			P6	continues
Pool	735.00	755.00	20.00	12.00	240.00																										0	0	0	0			0	0						
Pool	767.00	795.00	28.00	8.00	224.00																										0	0	0	0			0	0					P7/P8	right @827 m
Pool	853.00	917.00	64.00	14.00	896.00							15	10	20	40	20															0	0	0	0			0	0					P9	upstream
Pool	995.00	1015.00	20.00	6.00	120.00			3.50	1.50	25.00		10	0	80	10	0	2	0	0	0	0	80.00									1	1	Mx	Mx	3	2	High	Med	20	20			P10, P11	
Pool	1025.00	1051.00	26.00	3.20	83.20																										0	0	0	0			0	0						
Pool	1073.00	1095.00	22.00	6.00	132.00																										0	0	0	0			0	0					P12/P13	1200m
Riffle	1500.00			10.30	0.00					20.00																					Nat	Nat	Mx	Mx	4	2	High	High	30	30			P14, P15	@1500m
Pool	1525.00	1565.00	33.00	3.50	152.00																										0	0	0	0			0	0						
Pool	1586.00	1600.00	14.00	12.00	168.00																										0	0	0	0			0	0						
Pool	1724.00	1744.00	20.00	6.00	120.00																										0	0	0	0			0	0						
Pool	1825.00	1939.00	114.00	3.00	342.00																										0	0	0	0			0	0					P16/P17	1821m
Pool	1983.00	2000.00	17.00	9.00	152.00			3.30	2.00	17.00		80	1	10	8	1	1	0	0	0	0	50.00									Nat	Nat	Mx	Mx	5	20	High	Med	20	20			P18/P19	creek bed RL
Pool	2185.00	2210.00	25.00	11.00	275.00																										0	0	0	0			0	0					P 20	@ 2149m
Pool	2244.00	2257.00	13.00	6.00	78.00																										0	0	0	0			0	0						
Pool	2287.00	2309.00	22.00	6.00	132.00																										0	0	0	0			0	0						at 2540m RH
Pool	2383.00	2417.00	34.00	5.00	170.00																										0	0	0	0			0	0					P21-23	
Pool	2402.00	2423.00	21.00	5.00	105.00																										0	0	0	0			0	0					P24-25	continues;
Pool	2500.00	2512.00	12.00	6.00	72.00																		1			180					EX	Nat	Sh	Mx			0	0	0	30			(group	ends
Pool	2595.00	2616.00	21.00	4.00	84.00																										0	0	0	0			0	0						
Pool	2650.00	2667.00	17.00	2.50	42.50																										0	0	0	0			0	0					P2-3	
Pool	2679.00	2705.00	26.00	6.00	156.00																										0	0	0	0			0	0					P4	end pool @
Pool	2734.00	2763.00	29.00	12.00	348.00																										0	0	0	0			0	0						
Pool	2785.00	2820.00	35.00	5.00	175.00																										0	0	0	0			0	0						
Pool	2882.00	2919.00	37.00	8.00	296.00																										0	0	0	0			0	0						
Pool	2969.00	3000.00	31.00	5.00	155.00			3.50	10.00	16.00		15	1	64	25	0	25	0	0	0	0	80.00									Nat	Nat	Con	Mx	30	50	High	High	20	30			P5 & 6	@3010m
Pool	3134.00	3165.00	31.00	5.00	155.00																		1								0	0	0	0			0	0					P7-9	upstream ds
Pool	3221.00	3295.00	74.00	12.00	888.00																					317					0	0	0	0			0	0					P10-11	
Pool	3320.00	3356.00	36.00	6.00	216.00																										0	0	0	0			0	0						
Riffle	3443.00				0.00																										0	0	0	0			0	0						
Pool	3462.00	3474.00	22.00	6.50	142.00																										0	0	0	0			0	0					P12	enters RL
Riffle	3518.00			6.50	0.00																		1								EX	1	Mx	Con	bank	25	High	Low	0	5			logging	bank
Pool	3526.00	3559.00	33.00	5.00	165.00																										0	0	0	0			0	0						
Pool	3532.00	3544.00	12.00	5.00	260.00																										0	0	0	0			0	0						
Pool	3706.00	3760.00	54.00	15.00	810.00																		1								0	0	0	0			0	0					P14	upstream at
Pool	3842.00	3885.00	43.00	8.50	365.50																		1								0	0	0	0			0	0					P15	pool and water
Pool	3872.00	4000.00	28.00	10.00	280.00			3.50	3.50	18.00		90	1	2	6	1	2	0	0	0	0	70.00									1	1	Sr	Mx	75	45	High	High	30	30				
Pool	4025.00	4049.00	24.00	4.00	96.00																										0	0	0	0			0	0						
Riffle	4000.00				0.00																										0	0	0	0			0	0						End of Reach
																															0	0	0	0			0	0						
																															0	0	0	0			0	0						
Reach Totals and Averages		4067.70	1250.00	7.82	9477.10	31803.65	29.74	3.42	3.40	21.50	36.43	36	10	36	15	4	6	0	5	0	0	66.00	5	0.00	2	17	0	0			21	27			20	16	8	18	22.22	24.44	0	0		

Appendix 7. Reach 4 Photo Page


1.) Airphoto looking downstream at 8+100m and lower reach break.


3.) River left debris jam at 8+317m.


2.) Typical substrate and summer flow conditions.


4.) Airphoto looking at left bank logging blocks at 9+101m.

Form 5

Reach Habitat and Riparian Assessment Data

[illegible]

Appendix 7. Reach 5 Photo Page 1

1.) Right bank logging block at 13+080m.

3.) Left bank erosion site at 15+835m.

2.) Typical substrate and lack of LWD at 14+280m.

4.) Start of vertical canyon looking upstream at 16+219m.

Appendix 7. Reach 5 Photo Page 2

5.) Large debris slide plugging creek looking upstream at 16+976m.

6.) Large sediment looking upstream at 17+000m.

7.) Upper reach break at vertical falls looking upstream at 17+396m.

Form 6

Haslam Creek
Sidechannel Habitat and Riparian Assessment Data

Haslam Creek	Watershed Code	920-366400-11200	Date	Aug. 14 2000	Reach Name	Reach 2 at 2662m channel splits				
							Discharge Depth #1		Velocity T1	Site Length
Water Quality Information				Field Crew	Patti, Tracy, Harry, Larry					
Dissolved Oxygen	.	pH	Total Dissolved Solids	Temp C	Chainage at Start of Reach	2673.00	Discharge Depth #2		T2	
Velocity (m/s)	.	Average Depth (at flow site)	Wetted Width (at flow site)	Dischg (m3/s)	Chainage at End of Reach	2858.00	Discharge Depth #3		T3	

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	% Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width (m)	Average Percent Wetted Area	Substrate Percent Bed	Sld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other	Percent Overhead Cover	Large Woody Debris	LWD/bank full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstruct (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Land Use Left	Vegetation Type Right	Vegetation Type Left	Riparian Slope Right	Riparian Slope Left	Stability Right	Stability Left	Vegetation Depth Right	Vegetation Depth Left	Livestock Access Right	Livestock Access Left	Photos	Comments
Pool	2673.00	2684.00	11.00	2.80	61.80																										0	0	0	0			0	0						
Riffle	2630.00			2.70	0.00			0.20	1.20	14.00		0	2	48	40	10	10	10				70.00									Nat	Nat	Mx	Mx	2	2	Med	Med	100	20			24,25	Photo: d/s & u/s on side channel
Pool	2637.00	2651.00	24.00	5.10	125.40																		2								0	0	0	0			0	0						
Pool	2648.00	2658.00	15.00	11.50	172.50																		2								0	0	0	0			0	0						
Pool	2671.00	2721.00	84.00	9.30	404.40																		2								Nat	Nat	Mx	Mx	1	1	Med	Med	100	100			and 26	photo: d/s & u/s at 2671m and looking up at fork
Pool	2735.00	2746.00	11.00	2.00	22.00																										0	0	0	0			0	0						
Pool	2740.00	2758.00	11.00	4.30	48.30																		1								0	0	0	0			0	0					36	Photo: LJ sed 3.0m x 7.0m. No access over LJ p35,36 log jam
																															0	0	0	0			0	0						
																															0	0	0	0			0	0						
Reach Totals and Averages	0.00	185.0	118.0	5.8	827.5	1078.8	77.6	0.2	1.2	14.0	61.4	0	2	48	40	10	10	10				70.00	10	0.98	0	0	0	0			2	2			2	2	5	5	100.0	60.0	0	0		

Form 7

Reach 7 Habitat and Riparian Assessment Data

Stream Name: Haslam Creek | Watershed Code: 9203044112 | Date: Oct 8/09 | Reach Name: 6.00 | Discharge Depth #1 | Velocity T1 | Site Length

Field Crew: DRC, BRR

Water Quality Information

Dissolved Oxygen: . | pH | Total Dissolved Solids | Temp C | Chainage at Beginning of Reach: 0.00 | Discharge Depth #2 | T2

Velocity (m/s): . | Average Depth (at flow site) | Wetted Width (at flow site) | Discharge (m3/s) | Chainage at End of Reach: 374.00 | Discharge Depth #3 | T3

Habitat Information (All Pool and Cross Section Data)

Habitat Type	Start (chainage at start)	Finish (chainage at end)	Unit Length	Wetted Width	Pool Area	Wetted Reach Area	%Pool Area	Habitat unit Depth (m)	Percent Gradient	Bankfull Width(m)	Average Percent Wetted Area	Substrate Percent Bed	Bld	Cob	Grv	Fine	Percent Instream Cover Bold	LWD	Cutbk	Veg	Other
Pool	0.00	5.00	5.00	3.70	18.50			0.20	4.00	8.60		10	40	30	20	0	10				
Riffle	5.00	24.00		2.10	0.00				4.00	8.70		10	40	30	20	0	10				
Pool	24.00	33.00	9.00	3.60	32.40			0.20		8.60		20	40	30	5	5					
Riffle	33.00	53.00		2.10	0.00				4.00	8.80		0	40	30	25	5					
Pool	53.00	74.00	21.00	3.10	65.10			0.25	0.00	8.80		0	40	30	25	5					
Riffle	74.00	86.00		1.80	0.00				11.00												
Pool	86.00	91.00	5.00	3.10	15.50			0.25	0.00	6.60		15	25	30	20	10	5				
Riffle	91.00	100.00			0.00				4.00												
Pool	100.00	111.00	11.00	4.20	46.20			0.80	0.00	9.60											
Riffle	111.00	165.00			0.00				6.00												
Pool	165.00	178.00	13.00	3.50	45.50			0.60	0.00	8.10		0	40	40	10	10			5		
Riffle	178.00	204.00		2.20	0.00			0.10	4.00	12.80											
Pool	204.00	218.00	14.00	3.20	44.80			0.40	0.00	7.80		0	30	10	20	40	5				
Riffle	218.00	228.00			0.00				4.00												
Riffle	228.00	241.00		2.10	0.00				16.00			65	20	15			5				
Pool	241.00	250.00	9.00	5.10	45.90			0.80	0.00	10.70		20	40	10	10	20	10				
Riffle	250.00	264.00		2.50	0.00				16.00												
Pool	264.00	281.00	17.00	3.90	66.30			1.40	0.00	8.20		90	10				10				
Riffle	281.00	304.00		1.50	0.00				3.00			30	40	20	5	5	10				
Riffle	304.00	320.00			0.00				18.00												
Pool	320.00	332.00	12.00	5.00	60.00			1.50	0.00	10.00		75	5	10	10		5				
Riffle	332.00	350.00			0.00				48.00												
Pool	350.00	360.00	10.00	4.00	40.00			1.00	0.00	6.00		80	20	0	0	0					
Riffle	360.00	374.00			0.00																
0																					
Reach Totals and Averages		374.00	126.00	3.15	480.20	1178.10	40.76	0.63	6.45	8.81	35.77	30	31	22	14	9	8		5		

Habitat Type	Percent Crown Cover	Large Woody Debris	LWD/bank-full channel width	Erosion Sites (length)	Altered Stream Sites (length)	Obstructions (number)	Off-Channel Habitat (length)	Off-Channel Habitat (width)	Off-Channel Habitat (bank side)	Land Use Right	Left	Vegetation Type Right	Left	Riparian Slope Right	Left	Stability Right	Left	Vegetation Depth Right	Left	Livestock Access Right	Left	Photos	Comments
Pool	85.00	0			10					Nat	Nat	Mix	Mix	5	5	Med	Med	20	20			0	start at
Riffle	85.00									Nat	Nat	Mix	Mix	5	5	0	0	25	25				creekwalking
Pool										Nat	Nat	0	0			0	0						
Riffle		0			53					0	0	0	0			0	0						starting a5
Pool	85.00	0			21					Nat	Nat	0	0	5	5	Med	Med	30	30				logged
Riffle		0			12					Nat	Nat	0	0			0	0						at 86m
Pool		1					5		left	Nat	Nat	Mix	Mix	10	5	Med	Med	50	50				left bank at
Riffle							9		left	Nat	Nat	0	0			0	0						continues on
Pool		1			3		11		left	Nat	Nat	0	0	10	15	Med	Med	25	15				side), pic at
Riffle										Nat	Nat	0	0			0	0						
Pool										0	0	0	0	10	20	0	0						overhang
Riffle										Nat	Nat	0	0			0	0						
Pool	85.00	0								Nat	Nat	Mix	Mix	10	20	Med	Med	25	25				Rb, no cover
Riffle		0								0	0	0	0			0	0						
Riffle	85.00	0								0	0	0	0	20	20	Med	Med	25	25				gradient
Pool	85.00	0								Nat	Nat	Mix	Mix	30	30	Med	Med	30	30				0.25
Riffle										Nat	Nat	0	0			0	0						
Pool	85.00	0								Nat	Nat	Mix	Mix	30	30	Med	Med	30	30				canyon RD
Riffle	85.00	0								Nat	Nat	0	0			0	0	30	30				begins at 304
Riffle										Nat	Nat	0	0	30	30	Med	Med	50	50				boulder
Pool	80.00	0								Nat	Nat	0	0	40	40	0	Med	50	50				5m RDF at
Riffle						1				Nat	Nat	0	0			0	0						1m wide
Pool										0	0	0	0			0	0						360m, pic
Riffle					13					0	0	0	0			0	0						wide on 75%,
										0	0	0	0			0	0						
0										0	0	0	0			0	0						
										0	0	0	0			0	0						
Reach Totals and Averages	84.44	2	0.05	0	30	1	7			18	18			12	12	27	30	32.50	31.67	0	0		

Appendix 7. Reach 7 Photo Page

1.) Right bank slide at 21+782m.

2.) Bedrock substrate looking downstream at 21+880m.

3.) Right bank pool looking upstream at 22+075m.

4.) Looking upstream at bridge crossing at 22+119m.

Form 8

Haslam Creek Summary and Ratings Table

Haslam Creek **Watershed Code** 920-384400-11200

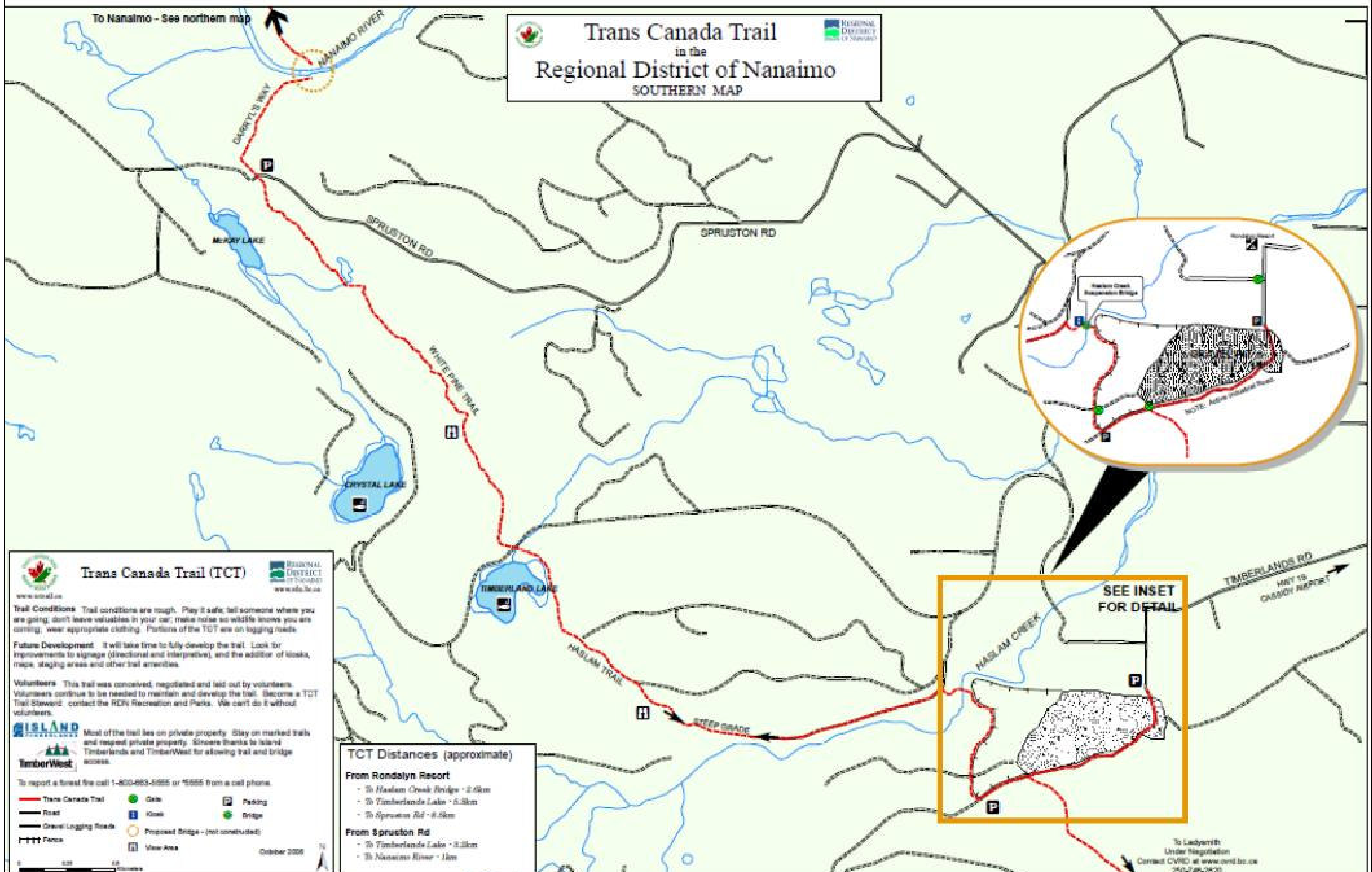
Habitat Parameter	Reach 1	Ratings	Reach 2	Ratings	Reach 3	Ratings	Reach 4	Ratings	Reach 5	Ratings	SCH @ 2562m	Ratings	Total R1-R5
% Pool Area	66.5	1	68.6	1	61.6	1	29.7	5	37.6	5	77.6	1	13
Large Woody Debris/Bankfull Channel Width	0.7	5	2.3	1	1.3	3	0.0	5	0.1	5	1.0	5	19
% Cover in Pools	14.7	3	23.4	1	20.1	1	11.0	3	14.8	3	20.0	3	11
Average% Boulder Cover	2.4	5	4.9	5	18.6	3	6.0	5	14.8	3	10.0	3	21
Average % Fines	14.1	3	7.6	1	6.4	1	3.7	1	2.3	1	10.0	3	7
Average % Gravel	37.6	not rated	32.3	not rated	8.2	not rated	15.3	not rated	13.7	not rated	40.0	not rated	--
% of Reach Eroded	5.0	1	10.0	5	0.0	1	1.6	1	6.0	3	0.0	1	11
Obstructions	0.0	0	0.0	0	0.0	0	0.0	0	1.0	1	0.0	0	1
% of Reach Altered	7.3	3	2.9	1	3.4	1	17.4	5	12.9	5	0.0	1	15
% Wetted Area	21.5	5	18.8	5	39.9	5	36.4	5	26.7	5	41.4	5	25
Dissolved Oxygen	9.8	1	10.9	1	10.9	1	9.3	1	9.1	1	.		5
pH	7.8	1	8.0	1	8.0	1	8.4	5	8.5	5			13
Totals		28		22		18		36		37		23	141

Off-Channel Habitat as % of Reach	11		10		0		0		0		0	5	20
Reach Lengths	3010	not rated	4117	not rated	872	not rated	4068	not rated	4678	not rated	186	not rated	16931

Riparian Ratings

Reach	Reach 1	Ave. Ratings	Reach 2	Ave. Ratings	Reach 3	Ave. Ratings	Reach 4	Ave. Ratings	Reach 5	Ave. Ratings	SCH @ 2562m	Ave. Ratings	Total R1-R5
Land Use	156	3	120	2	24	1	58	3	34	2	4	1	11
Riparian Slope	36	1	94	1	13	1	36	2	56	4	4	1	9
Bank Stability	158	3	208	3	18	1	24	2	36	3	12	3	11
		Ratings		Ratings		Ratings		Ratings		Ratings		Ratings	--
% Crown Cover	40.63	3	37.25	5	70.00	3	66.00	3	28.00	5	70.00	3	19
Average Vegetation Depth	20.65517	5	57	3	73	1	23	5	23	5	83	1	19
Totals		14		14		7		15		19		9	69

Appendix 8. Trans Canada Trail in the Regional District of Nanaimo (Southern Map).



Appendix 9.
Figure 1. Haslam Creek Habitat Prescriptions (Gaboury and McCulloch, 2002)

Table 8. Construction notes for specific restoration sites in Haslam Creek.

Chainage to Structure (m)	Site Number	Structure Type	Right or Left Bank		Restoration Objectives and Construction Notes
0+000 m - starting at mouth of Haslam Creek and progressing upstream					
0+183	1	LT-6	Right	Rest. Obj.	To provide pool with LWD cover near right bank.
				1	Place bracing logs in crotch of overhanging trees.
0+250	2	LT-6	Left	Rest. Obj.	To provide pool with LWD cover near left bank.
				1	Excavate streambed to create a long narrow pool (2 m wide x 6 m long) with residual water depth of 0.6 m prior to constructing LWD structure.
				2	Alder, cedar and hemlock on bank for anchoring.
0+278	3	LSP-5	Right	Rest. Obj.	To narrow channel slightly and deflect flow to structure at 0+250 m; to provide pool with LWD cover near right bank.
				1	Place one long partial spanning log at a 30-45^{0} angle downstream to deflect flow to 0+250 m structure; structure should be porous to promote local scour and cover close to right bank.
0+300			Left		Napoleon Creek confluence
0+324	4	LO-4	Right	Rest. Obj.	To provide pool with LWD cover near right bank.
				1	Excavate streambed to create a long narrow pool (2 m wide x 6 m long) with residual water depth of 0.6 m prior to constructing LWD structure.
0+438	5	LT-6	Right	Rest. Obj.	To provide pool with LWD cover near right bank.
0+575	6	Existing LWD	Left	Rest. Obj.	To provide pool with LWD cover near left bank.
				1	Existing LWD: 3 cedars with 2.5 m rootwads-0.7, 0.8, 0.9 x 30 m; 1 cedar-0.3x20 m; 1 doug. fir with 2 m rootwad-0.8x30 m; anchor most of existing LWD in its present position; rearrange some of the LWD to protect point of attack and erosion on bank; anchor to cedar on streambank; pool 1 m deep.
0+600	7	LSP-5	Left	Rest. Obj.	To act as a spur and deflect flow away from eroding bank; to provide pool with LWD cover near left bank.
				1	To reduce erosion behind each structure along the bank face, ensure structure is tight to the bank and add additional large and small woody debris to its core to decrease porosity.
0+686	8	LO-4	Left	Rest. Obj.	To provide pool with LWD cover near left bank.
				1	Excavate streambed to create a long narrow pool (2 m wide x 6 m long) with residual water depth of 0.6 m prior to constructing LWD structure.
0+768	9	LT-6	Right	Rest. Obj.	To provide pool with LWD cover near right bank.
				1	Due to steepness of bank (~3 m), brace logs should be laid in on the side of the bank or excavated into trenches.
0+830	10	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	First upstream log in structure should be upstream of large maple overhanging pool.

Page 1 of 5

Chainage to Structure (m)	Site Number	Structure Type	Right or Left Bank		Restoration Objectives and Construction Notes
1+049	11	LO-4-Sweeper	Right	Rest. Obj.	To provide pool with LWD cover near right bank.
				1	Pool 0.7 m deep with shale bedrock bottom; good anchor trees on streambank.
1+125	12	LO-3 + Existing LWD	Left	Rest. Obj.	To provide pool with LWD cover near left bank.
				1	Incorporate existing log into structure; place one LO-1 upstream of existing log and the other two LO-1's downstream; existing log is 0.9 x 25 m hemlock; existing pool is 1.1 m deep.
1+289	13	LO-4	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Poor quality anchoring to alder/maple trees on bank; maple log (0.8 x 30 m) on bar at 1+319 m.
				2	Riprap on bank but addtional boulder ballast required.
1+946	14	LSP-5	Right	Rest. Obj.	To act as a spur and deflect flow away from bank; to reduce bank erosion; to provide pool with LWD cover along right bank during moderate flows.
				1	Four LSP-5 structures should be constructed, extending through section with no trees in riparian zone.
				2	To reduce erosion behind each structure along the bank face, ensure structure is tight to the bank and add additional large and small woody debris to its core to decrease porosity.
2+044	15	LO-1-Sweeper	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Locate structure upstream of existing slab that is creating a 0.8 m deep scour pool; sweeper should extend over this scour pool.
2+108	16	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Embed existing cedar log into bank, and use as the first upstream log in the structure; rootwad on right bank about 10 m upstream that can be used in structure.
2+200	17	LSP-5	Right	Rest. Obj.	To act as a spur and deflect flow away from bank; to reduce bank erosion; to provide pool with LWD cover along right bank during moderate flows.
				1	Four LSP-5 structures should be constructed, extending through section where maple trees are being undermined on eroding bank (2+150 to 2+250 m).
				2	To reduce erosion behind each structure along the bank face, ensure structure is tight to the bank and add additional large and small woody debris to its core to decrease porosity.
2+303	18	LT-3	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Construct around existing rootwad and cottonwood; location is an old bridge site and has good access.
2+362	19	LO-1-Sweeper	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Construct two structures in existing pool (1 m deep); anchor to cottonwoods and maple on bank.

Page 2 of 5

Chainage to Structure (m)	Site Number	Structure Type	Right or Left Bank		Restoration Objectives and Construction Notes
2+810	20	LO-4	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	At upstream end of structure, rootwad of log should be located just downstream of riprap spur; balance of LWD should be located in thalweg away from eroding bank about 3-4 m.
3+109	21	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Locate upstream end of structure at base of existing riffle; incorporate existing LWD into structure.
3+185	22	LT-6	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Locate upstream end of structure at base of existing riffle; leave a gap between the first and last three LWD to reduce sedimentation within the structure.
3+410	23	LO-1-Sweeper	Right & Left	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Construct two structures, one adjacent to large (>2 m diameter) boulder near right bank and the other downstream along left bank.
3+517	24	Sweeper	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Provide cover over bedrock controlled pool ~1.8 m deep; provide adequate boulder ballast as bedrock appears unsuitable for anchoring; place some of the boulder ballast on bedrock benches above water.
3+746	25	DJ-5	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Construct near downstream end of meander bend and in ~1.2 m deep pool; good road access.
3+892	26	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Excavate streambed to create a long narrow pool (2.5 m wide x 15 m long) with residual water depth of 0.6 m prior to constructing LWD structure.
3+989	27	Existing LWD	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Use existing large boulders on bank to reduce buoyancy; two cedar logs - 0.5 and 0.7 x 30 m, and 1 hemlock - 0.5 x 24 m.
4+116	28	LO-1-Sweeper	Left	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Construct two structures, with LO-1 portion in the thalweg and the sweeper anchored to trees on the streambank.
4+210	29	LT-6	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Locate upstream end opposite existing maple on gravel bar; move maple 2-3 m towards the left bank and anchor.
4+279	30	LT-6	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Locate opposite cottonwood on bank, about 10 m downstream of LSP-5 at 4+290 m.

Page 3 of 5

Chainage to Structure (m)	Site Number	Structure Type	Right or Left Bank		Restoration Objectives and Construction Notes
4+290	31	LSP-5	Right	Rest. Obj.	To act as a spur and deflect flow away from bank; to reduce bank erosion; to provide pool with LWD cover along right bank.
				1	Locate structure at cedar rootwad and point of attack on streambank
				2	To reduce erosion behind each structure along the bank face, ensure structure is tight to the bank and add additional large and small woody debris to its core to decrease porosity.
4+373	32	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Locate upstream end of structure at base of existing riffle; incorporate existing LWD into structure; excavate streambed to create a long narrow pool (2.5 m wide x 10 m long) with residual water depth of 0.6 m prior to constructing LWD structure. .
4+504	33	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Locate upstream end of structure at base of existing riffle; excavate streambed to create a long narrow pool (2.5 m wide x 10 m long) with residual water depth of 0.6 m prior to constructing LWD structure.
4+596	34	Sweeper	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Locate sweeper downstream of existing fir rootwad; minimize boulder ballast instream by placing ballast on the bank and by anchoring to alder/cottonwood trees.
4+900	35	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Incorporate existing LWD with rootwad into structure; locate upstream end about 10 m downstream of LSP-5 at 4+929 m..
4+929	36	LSP-5	Left	Rest. Obj.	To act as a spur and deflect flow away from bank; to reduce bank erosion; to provide pool with LWD cover along left bank.
				1	Locate structure at cedar rootwad and point of attack on streambank
				2	To reduce erosion behind each structure along the bank face, ensure structure is tight to the bank and add additional large and small woody debris to its core to decrease porosity.
5+015	37	DJ-5	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Locate in deep pool (~1.8 m).
5+834	38	LT-6	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Locate upstream end of structure at base of existing riffle; bulk of structure in deep pool (0.9 m).
6+059	39	Existing Sweeper	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Anchor existing log using boulder ballast.
6+299	40	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Locate in deep pool (~0.7 m); tie structure into existing fir rootwad on bank.
6+332	41	LT-3	Left	Rest. Obj.	To provide pool with LWD cover along left bank.

Page 4 of 5

Chainage to Structure (m)	Site Number	Structure Type	Right or Left Bank		Restoration Objectives and Construction Notes
				1	Locate upstream end of structure at base of existing riffle; incorporate existing LWD into structure; excavate streambed to create a long narrow pool (2.5 m wide x 10 m long) with residual water depth of 0.6 m prior to constructing LWD structure. .
6+405	42	LT-3	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Locate upstream end of structure at base of existing riffle; incorporate existing LWD into structure; excavate streambed to create a long narrow pool (2.5 m wide x 5 m long) with residual water depth of 0.6 m prior to constructing LWD structure. .
7+049	43	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Remove existing blowdown from steep bedrock bank and anchor to bedrock as an LT-6 type structure; pool 1.8-2.0 m deep.
0+000 m - starting at mouth of right bank overflow channel located at 5+341 m in Haslam Creek and progressing upstream					
0+020	44	LT-6	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Locate structure in deep pool (1.0 m).
0+062	45	LT-6	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Locate structure in deep pool (1.1 m); rootwad on bank that could be used in structure.
0+095	46	LT-6	Right	Rest. Obj.	To provide pool with LWD cover along right bank.
				1	Locate first log of structure upstream of instream rootwad, and bulk of structure in deep pool (1.3 m).
0+189	47	LT-3	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Incorporate existing LWD fon left bank into structure; excavate streambed to create a long narrow pool (2.5 m wide x 10 m long) with residual water depth of 0.6 m prior to constructing LWD structure.
0+226	48	Boulder Cluster	Right	Rest. Obj.	To increase boulder cover in scour pool of riffle.
				1	Place four 0.6 m diameter boulders in scour pool.
0+267	49	LT-3	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Locate structure in deep pool (1 m); project into channel up to 50% of width.
0+000 m - starting at mouth of left bank overflow channel located at 5+515 m in Haslam Creek and progressing upstream					
0+046	50	LT-3	Left	Rest. Obj.	To provide pool with LWD cover along left bank.
				1	Locate structure in pool; using an existing log on the bank, construct a single log deflector at a 30° angle downstream to concentrate flows on left bank.
0+150	51	LT-6	Right	Rest. Obj.	To provide pool with LWD cover along right bank.

Note: Unless stated otherwise, it is assumed that:

1 - A sufficient number and size of rock do not exist on site to ballast LWD structure. Additional ballast rock will need to be brought to the site.

2 - Anchor LWD to live trees or stumps on streambank with diameter >20 cm. Alder, cedar, hemlock or maple common on streambanks. Alternatively, embed tops of logs 2-3 m horizontally and 1 m vertically into the bank. Backfill trench with spoil from excavation.

Table 9. Summary of materials required for LWD and boulder structures in Haslam Creek.

						LWD Ballast		Boulders	
Site	Chainage (m)	Structure Type	Right or Left Bank	LWD Required	LWD Size (m)	Boulders Required	Diameter (m)	Diameter (m)	Comments
0+000 m - starting at mouth of Haslam Creek and progressing upstream									
1	0+183	LT-6	Right	6	0.5 x 8-10	12	0.8		With rootwads
2	0+250	LT-6	Left	6	0.5 x 8-10	28	0.8		With rootwads
3	0+278	LSP-5	Right	5	0.5 x 8-10	6	0.8		Without rootwads
4	0+324	LO-4	Right	4	0.5 x 6	13	0.8		With rootwads
5	0+438	LT-6	Right	6	0.5 x 8-10	12	0.8		Without rootwads
6	0+575	Existing LWD	Left	0	0.7-0.9 x 20-30	22	0.8		With rootwads; anchor only
7	0+600	LSP-5	Left	5	0.5 x 8-10	6	0.8		Without rootwads
8	0+686	LO-4	Left	4	0.5 x 6	13	0.8		With rootwads
9	0+768	LT-6	Right	6	0.5 x 8-10	12	0.8		With rootwads
10	0+830	LT-6	Left	6	0.5 x 8-10	12	0.8		Complex Alcove
11	1+049	LO-4-Sweeper	Right	6	0.5 x 6/12	17	0.8		Four 6 m LO-1 with rootwads; Two 12 m long
12	1+125	LO-3	Left	3	0.5 x 6	10	0.8		With rootwads
12	1+125	Existing LWD	Left	0	0.9 x 25	13	0.8		Ballast only
13	1+289	LO-4	Right	4	0.5 x 6	13	0.8		With rootwads
14	1+946	LSP-5	Right	20	0.5 x 8-10	22	0.8		Without rootwads
15	2+044	LO-1-Sweeper	Left	2	0.5 x 6/12	5	0.8		6 m LO-1 with rootwad; 12 m long Sweeper
16	2+108	LT-6	Left	6	0.5 x 8-10	12	0.8		With rootwads
17	2+200	LSP-5	Right	20	0.5 x 8-10	22	0.8		Without rootwads
18	2+303	LT-3	Right	3	0.5 x 8-10	6	0.8		With rootwads
19	2+362	LO-1-Sweeper	Left	4	0.5 x 6/12	11	0.8		Two 6 m LO-1 with rootwad; Two 12 m long
20	2+810	LO-4	Right	4	0.5 x 6	13	0.8		With rootwads
21	3+109	LT-6	Left	6	0.5 x 6	12	0.8		With rootwads
22	3+185	LT-6	Right	6	0.5 x 6	12	0.8		With rootwads
23	3+410	LO-1-Sweeper	Right & Left	4	0.5 x 6/12	11	0.8		Two 6 m LO-1 with rootwad; Two 12 m long Sweeper
24	3+517	Sweeper	Right	3	0.5 x 12	6	0.8		With branches
25	3+746	DJ-5	Right	5	0.5 x 8-10	7	0.8		Two logs with rootwads, three without

Page 1 of 2

						LWD Ballast		Boulders	
Site	Chainage (m)	Structure Type	Right or Left Bank	LWD Required	LWD Size (m)	Boulders Required	Diameter (m)	Diameter (m)	Comments
26	3+892	LT-6	Left	12	0.5 x 8-10	25	0.8		With rootwads
27	3+989	Existing LWD	Right	0		0	0		Use boulders and LWD on site
28	4+116	LO-1-Sweeper	Left	4	0.5 x 6/12	11	0.8		Two 6 m LO-1 with rootwad; Two 12 m long
29	4+210	LT-6	Right	6	0.5 x 8-10	12	0.8		With rootwads
30	4+279	LT-6	Right	6	0.5 x 8-10	12	0.8		With rootwads
31	4+290	LSP-5	Right	5	0.5 x 8-10	6	0.8		Without rootwads
32	4+373	LT-6	Left	6	0.5 x 8-10	12	0.8		With rootwads
33	4+504	LT-6	Left	6	0.5 x 8-10	12	0.8		With rootwads
34	4+596	Sweeper	Right	1	0.5 x 12	2	0.8		With branches
35	4+900	LT-6	Left	6	0.5 x 8-10	12	0.8		With rootwads
36	4+929	LSP-5	Left	5	0.5 x 8-10	6	0.8		Without rootwads
37	5+015	DJ-5	Left	5	0.5 x 8-10	7	0.8		Two logs with rootwads, three without
38	5+834	LT-6	Right	6	0.5 x 8-10	12	0.8		With rootwads
39	6+059	Existing Sweeper	Right	0	0.5 x 12	3	0.8		Anchor only
40	6+299	LT-6	Left	6	0.5 x 8-10	12	0.8		With rootwads
41	6+332	LT-3	Left	3	0.5 x 8-10	6	0.8		With rootwads
42	6+405	LT-3	Right	3	0.5 x 8-10	6	0.8		With rootwads
43	7+049	Existing LWD	Left	0		0	0		Anchor to bedrock
0+000 m - starting at mouth of right bank overflow channel located at 5+341 m in Haslam Creek and progressing upstream									
44	0+020	LT-6	Right	6	0.5 x 8-10	12	0.8		With rootwads
45	0+062	LT-6	Left	6	0.5 x 8-10	12	0.8		With rootwads
46	0+095	LT-6	Right	6	0.5 x 8-10	12	0.8		With rootwads
47	0+189	LT-3	Left	3	0.5 x 8-10	6	0.8		With rootwads
48	0+226	Boulder Cluster	Right					0.6	4 boulders
49	0+267	LT-3	Left	3	0.5 x 8-10	6	0.8		With rootwads
0+000 m - starting at mouth of left bank overflow channel located at 5+515 m in Haslam Creek and progressing upstream									
50	0+046	LT-3	Left	3	0.5 x 8-10	6	0.8		With rootwads
51	0+150	LT-6	Right	6	0.5 x 8-10	12	0.8		With rootwads
Total				257		550			

Table 10. Ballast requirements and boulder size options for the LWD structures in Haslam Creek.
Buoyancy and sliding safety factors ≥ 1.5; ballast factor = 1; and specific gravity of LWD (S_L) = 0.5.
Modified after D'Aoust and Millar (1999).

					Log (m)			Rootwad	Alternative Quantities for Each Boulder Diameter (m)						
Site	Chainage (m)	Structure Type	No. of Logs	Average Submerged Length of Each Log (m)	0.5 @ 130 or 280 kg/m	0.8 @ 430kg/ m	0.9 @ 540kg/ m	660 kg/log (0.5x2x3 m)	Total Mass of Ballast Required (kg)	0.5 @ 190 kg	0.6 @ 300 kg	0.7 @ 480 kg	0.8 @ 700 kg	0.9 @ 1000 kg	1 @ 1400 kg
0+000 m - starting at mouth of Haslam Creek and progressing upstream															
1	0+183	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
2	0+250	LT-6	6	6	15600	0	0	3960	19560	103	65	41	28	20	14
3	0+278	LSP-5	5	6	3900	0	0	0	3900	21	13	8	6	4	3
4	0+324	LO-4	4	6	6720	0	0	2640	9360	49	31	20	13	9	7
5	0+438	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
6	0+575	Existing LWD	5	20	0	12900	0	2640	15540	82	52	32	22	16	11
7	0+600	LSP-5	5	6	3900	0	0	0	3900	21	13	8	6	4	3
8	0+686	LO-4	4	6	6720	0	0	2640	9360	49	31	20	13	9	7
9	0+768	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
10	0+830	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
11	1+049	LO-4-Sweeper	6	6	8280	0	0	3960	12240	64	41	26	17	12	9
12	1+125	LO-3	3	6	5040	0	0	1980	7020	37	23	15	10	7	5
12	1+125	Existing LWD	1	15	0	0	8100	660	8760	46	29	18	13	9	6
13	1+289	LO-4	4	6	6720	0	0	2640	9360	49	31	20	13	9	7
14	1+946	LSP-5	20	6	15600	0	0	0	15600	82	52	33	22	16	11
15	2+044	LO-1-Sweeper	2	6	2460	0	0	1320	3780	20	13	8	5	4	3
16	2+108	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
17	2+200	LSP-5	20	6	15600	0	0	0	15600	82	52	33	22	16	11
18	2+303	LT-3	3	6	2340	0	0	1980	4320	23	14	9	6	4	3
19	2+362	LO-1-Sweeper	4	6	4920	0	0	2640	7560	40	25	16	11	8	5
20	2+810	LO-4	4	6	6720	0	0	2640	9360	49	31	20	13	9	7
21	3+109	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
22	3+185	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
23	3+410	LO-1-Sweeper	4	6	4920	0	0	2640	7560	40	25	16	11	8	5
24	3+517	Sweeper	3	6	2340	0	0	1980	4320	23	14	9	6	4	3

					Log (m)			Rootwad	Alternative Quantities for Each Boulder Diameter (m)						
Site	Chainage (m)	Structure Type	No. of Logs	Average Submerged Length of Each Log (m)	0.5 @ 130 or 280 kg/m	0.8 @ 430kg/m	0.9 @ 540kg/m	660 kg/log (0.5x2x3 m)	Total Mass of Ballast Required (kg)	0.5 @ 190 kg	0.6 @ 300 kg	0.7 @ 480 kg	0.8 @ 700 kg	0.9 @ 1000 kg	1 @ 1400 kg
25	3+746	DJ-5	5	6	3900	0	0	1320	5220	27	17	11	7	5	4
26	3+892	LT-6	12	6	9360	0	0	7920	17280	91	58	36	25	17	12
27	3+989	Existing LWD	0	0	0	0	0	0	0	0	0	0	0	0	0
28	4+116	LO-1-Sweeper	4	6	4920	0	0	2640	7560	40	25	16	11	8	5
29	4+210	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
31	4+290	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
30	4+279	LSP-5	5	6	3900	0	0	0	3900	21	13	8	6	4	3
32	4+373	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
33	4+504	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
34	4+596	Sweeper	1	6	780	0	0	660	1440	8	5	3	2	1	1
36	4+929	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
35	4+900	LSP-5	5	6	3900	0	0	0	3900	21	13	8	6	4	3
37	5+015	DJ-5	5	6	3900	0	0	1320	5220	27	17	11	7	5	4
39	6+059	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
39	6+059	Existing Sweeper	1	10	1300	0	0	660	1960	10	7	4	3	2	1
40	6+299	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
41	6+332	LT-3	3	6	2340	0	0	1980	4320	23	14	9	6	4	3
42	6+405	LT-3	3	6	2340	0	0	1980	4320	23	14	9	6	4	3
43	7+049	Existing LWD	0	0	0	0	0	0	0	0	0	0	0	0	0
0+000 m - starting at mouth of right bank overflow channel located at 5+341 m in Haslam Creek and progressing upstream															
44	0+020	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
45	0+062	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
46	0+095	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6
47	0+189	LT-3	3	6	2340	0	0	1980	4320	23	14	9	6	4	3
48	0+226	Boulder Cluster	0	0	0	0	0	0	0	0	0	0	0	0	0
49	0+267	LT-3	3	6	2340	0	0	1980	4320	23	14	9	6	4	3
0+000 m - starting at mouth of left bank overflow channel located at 5+515 m in Haslam Creek and progressing upstream															
50	0+046	LT-3	3	6	2340	0	0	1980	4320	23	14	9	6	4	3
51	0+150	LT-6	6	6	4680	0	0	3960	8640	45	29	18	12	9	6

Page 2 of 2

Appendix 9. Figure 2. Haslam Creek Restoration Cost Estimate (Gaboury and McCulloch, 2002)

Table 32. Cost estimate (2002) for restoration projects in selected East Vancouver Island watersheds.

			Chemainus River		Haslam Creek		Deadwood Creek		Nanaimo River (spawning gravel)		Little Qualicum River		Oyster River		Little Oyster River		Quinsam River		Cold Creek	
Description	Unit	Unit Cost	Approx. Quantity	Cost	Approx. Quantity	Cost	Approx. Quantity	Cost	Approx. Quantity	Cost	Approx. Quantity	Cost	Approx. Quantity	Cost	Approx. Quantity	Cost	Approx. Quantity	Cost	Approx. Quantity	Cost
Major Equipment:																				
1 Excavator, all found	hour	$125	250	$31,250	245	$30,625	0	$0	0	$0	351	$43,875	279	$34,875	0	$0	202	$25,250	72	$9,000
2 Excavators mob/demob	km	$1	80	$112	50	$70	100	$140	100	$140	112	$157	89	$125	29	$41	65	$91	23	$32
3 Excavator, Spyder	hour	$165		$0	0	$0	288	$47,520	40	$6,600	0	$0	0	$0	91	$15,015	0	$0	0	$0
3 Forwarder/small excavator	hour	$100	100	$10,000	98	$9,800	115	$11,500	40	$4,000	140	$14,000	112	$11,200	37	$3,700	81	$8,100	29	$2,900
4 Dump Truck, all found	hour	$70	100	$7,000	98	$6,860	115	$8,050	40	$2,800	140	$9,800	112	$7,840	37	$2,590	81	$5,670	29	$2,030
5 Self-loading Logging Truck, all found	hour	$80	100	$8,000	98	$7,840	115	$9,200	0	$0	140	$11,200	112	$8,960	37	$2,960	81	$6,480	29	$2,320
Sub-total major equipment				**$56,362**		**$55,195**		**$70,410**		**$13,540**		**$79,032**		**$63,000**		**$24,306**		**$45,591**		**$16,282**
Manpower:																				
1 Project Coordinator (1)	pers-day	$500	25	$12,500	25	$12,500	30	$15,000	5	$2,500	35	$17,500	28	$14,000	9	$4,500	20	$10,000	7	$3,500
2 Restoration Specialist (1)	pers-day	$730	4	$2,920	4	$2,920	4	$2,920	2	$1,460	4	$2,920	4	$2,920	1	$730	20	$14,600	1	$730
3 Semi-skilled Labour (2)	pers-day	$250	40	$10,000	39	$9,750	50	$12,500	8	$2,000	56	$14,000	45	$11,250	15	$3,750	20	$5,000	12	$3,000
Sub-total manpower				**$25,420**		**$25,170**		**$30,420**		**$5,960**		**$34,420**		**$28,170**		**$8,980**		**$29,600**		**$7,230**
Light Equipment:																				
1 Drilling Equipment Rental	week	$500	4	$2,000	4	$2,000	4	$2,000	0	$0	6	$3,000	4	$2,000	1	$500	20	$10,000	1	$500
Sub-total light equipment				**$2,000**		**$2,000**		**$2,000**		**$0**		**$3,000**		**$2,000**		**$500**		**$10,000**		**$500**
Materials:																				
1 LWD With and Without Rootwads	log	$200	212	$42,400	257	$51,400	269	$53,800	0	$0	339	$67,800	196	$39,200	97	$19,400	201	$40,200	47	$9,400
*2 Ballast Rock (0.8 m) for LWD Structures	m^3	$10	191	$1,910	281	$2,810	258	$2,580	0	$0	311	$3,110	195	$1,950	101	$1,010	202	$2,020	47	$470
3 Boulders for Clusters / Riffles	m^3	$10	5	$50	2	$20	0	$0	40	$400	150	$1,500	70	$700	0	$0	0	$0	0	$0
4 Spawning gravel	m^3	$8	0	$0	0	$0	0	$0	70	$560	0	$0	0	$0	0	$0	0	$0	0	$0
5 Miscellaneous (epoxy, clamps, cable, etc)		$1,000	3	$3,000	3	$3,000	3	$3,000	0.5	$500	4	$4,212	3	$3,346	1	$1,096	20	$20,000	1	$865
Sub-total materials				**$47,360**		**$57,230**		**$59,380**		**$1,460**		**$76,622**		**$45,196**		**$21,506**		**$62,220**		**$10,735**
Total Cost				**$131,142**		**$139,595**		**$168,210**		**$20,960**		**$193,073**		**$138,366**		**$55,292**		**$147,411**		**$34,748**
Total of 371 restoration sites; by watershed:			**62**		**51**		**60**		**1**		**73**		**58**		**19**		**42**		**16**	
Total estimated cost for all projects:	**$1,007,836**																			

Note: *Assume 0.8 m diameter boulder has a volume of 0.51 m^3

Appendix 10.
Figure 1. Status of Fish Habitat in Small East Vancouver Island Streams (Michalski and Sala, 2007).

Table 1. Biostandards and ratings for instream fish habitat parameters (from Johnston and Slaney 1996; Michalski et al., 1998).

Habitat Parameter	Biostandard (of reach except where noted)	Classification
Pools	>55%	Good
	40 – 50%	Fair
	<40%	Poor
Instream Cover	>20%	Good
	6 – 20%	Fair
	0 – 5%	Poor
Large Woody Debris	>2 pieces/Bankfull channel width	Good
	1 – 2 pieces/Bankfull channel width	Fair
	<1piece/Bankfull channel width	Poor
Fines	<10%	Good
	10 – 20%	Fair
	>20%	Poor
Wetted Area	>90%	Good
	70 – 90%	Fair
	<70%	Poor
Land Use	Exposed, industrial, roads, commercial, livestock/farm, golf course	Poor
	Residential, lawns, farm/grass	Fair
	Natural	Good
Altered Sites	Any alteration to the natural riparian habitat – total length in meters.	

Appendix10.Figure 2. Amounts and classifications for individual instream and riparian habitat parameters for east coast Vancouver Island streams.
(Michalski and Sala, 2007)

Regional District and Stream	% Pool Area	Rating	Class	LWD/BFW	Rating	Class	% Instream Cover	Rating	Class	% Fines	Rating	Class	% Wetted Area	Rating	Class	Total Ratings	Instream Class	Landuse Value	Riparian Class	Overall Classification
Campbell River (n=16)																				
Kingfisher East	-	-		-	-		-	-		-	-		-	-		-	-	24	Poor	-
Kingfisher West	54.3	1	Good	0.3	5	Poor	53.0	1	Good	55.0	5	Poor	49.1	5	Poor	17	Fair	13	Fair	Fair
Lamalchi Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	Fair	-
Larwood Crek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	Fair	-
Menzies 1999	49.9	3	Fair	0.3	5	Poor	40.2	1	Good	12.3	3	Fair	60.6	1	Good	13	Fair	17	Fair	Fair
Menzies Creek 1998	83.1	1	Good	0.3	5	Poor	12.8	3	Fair	43.8	5	Poor	34.4	5	Poor	19	Poor	9	Good	Fair
Newman Creek	47.6	3	Fair	0.2	5	Poor	19.2	3	Fair	57.3	5	Poor	45.2	5	Poor	21	Poor	8	Good	Fair
Nunns Creek 1998	64.0	1	Good	0.1	5	Poor	57.2	1	Good	42.5	5	Poor	57.3	5	Poor	17	Fair	13	Fair	Fair
Nunns Creek 1999	66.5	1	Good	0.2	5	Poor	66.2	1	Good	68.3	5	Poor	47.4	5	Poor	17	Fair	12	Fair	Fair
Oyster Bay Stream 5 1997	32.5	5	Poor	0.2	5	Poor	26.5	1	Good	64.5	5	Poor	80.2	3	Fair	19	Poor	5	Good	Fair
Oyster Bay Stream 6 1997	68.5	1	Good	0.3	5	Poor	25.8	1	Good	44.2	5	Poor	92.0	5	Poor	17	Fair	9	Good	Fair
Oyster Bay Stream 1999	14.6	5	Poor	0.0	5	Poor	36.2	1	Good	81.3	5	Poor	36.8	5	Poor	21	Poor	18	Fair	Poor-Fair
Oyster River	61.1	1	Good	1.2	3	Fair	35.3	1	Good	94.5	5	Poor	42.3	5	Poor	15	Fair	6	Good	Fair
Simms Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	Poor	-
Willow Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	Poor	-
Woods Creek	80.0	1	Good	0.2	5	Poor	25.3	1	Good	53.0	5	Poor	60.2	5	Poor	17	Fair	7	Good	Fair-Good
Averages	56.6	2.1	Good	0.3	4.8	Poor	36.2	1.4	Good	56.0	4.8	Poor	55.0	4.5	Poor	17.5	Fair	14	Fair	Fair
Total Ratings Ranges: 13-15; 16-18; 19-21																				
Courtney/Comox (n=29)																				
Ackinclose Creek	42.2	3	Fair	0.1	5	Poor	28.4	1	Good	38.1	5	Poor	48.8	5	Poor	19	Poor	8	Good	Fair
Apple Creek	29.1	5	Poor	5.1	1	Good	42.8	1	Good	31.2	5	Poor	30.8	5	Poor	17	Fair	8	Good	Fair-Good
Black Brook	59.0	1	Good	0.7	5	Poor	11.0	3	Fair	61.5	5	Poor	66.4	5	Poor	19	Poor	9	Good	Fair
Chef Creek	35.0	3	Fair	1.0	3	Fair	27.4	5	Poor	36.8	5	Poor	81.3	5	Poor	21	Poor	30	Poor	Poor
Courtenay No Name Creek	55.2	1	Good	0.1	5	Poor	20.0	1	Good	44.4	5	Poor	29.4	5	Poor	17	Fair	8	Good	Fair-Good
Deep Bay Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28	Poor	-
Happy Creek	70.1	1	Good	3.3	1	Good	78.3	1	Good	2.9	1	Good	48.0	5	Poor	9	Good	16	Fair	Fair-Good
Hart Creek	44.0	3	Fair	0.3	5	Poor	1.9	5	Poor	15.2	3	Fair	55.4	5	Poor	21	Poor	18	Fair	Poor-Fair
Jamison Creek	35.9	5	Poor	1.2	3	Fair	19.8	3	Fair	36.8	5	Poor	57.2	5	Poor	21	Poor	12	Fair	Poor-Fair
Jenkins Creek	11.2	5	Poor	0.9	5	Poor	35.0	1	Good	65.0	5	Poor	82.3	5	Poor	21	Poor	6	Good	Fair
Kitty Coleman Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	Poor	-
Little River	12.1	5	Poor	7.7	1	Good	40.4	1	Good	59.7	5	Poor	42.8	5	Poor	17	Fair	4	Good	Fair-Good
Millard Creek Lower	74.5	1	Good	0.1	5	Poor	70.2	1	Good	77.4	5	Poor	38.7	5	Poor	17	Fair	19	Fair	Fair
Millard Creek Upper	56.3	1	Good	0.2	5	Poor	32.3	1	Good	53.3	5	Poor	52.2	5	Poor	17	Fair	12	Fair	Fair
Piercy Creek Lower	62.5	1	Good	0.4	5	Poor	40.0	1	Good	95.0	5	Poor	60.4	5	Poor	17	Fair	22	Poor	Poor-Fair
Piercy Creek Upper	49.1	3	Fair	2.8	1	Good	48.1	1	Good	55.5	5	Poor	32.2	5	Poor	15	Fair	26	Poor	Poor-Fair
Piercy Creek Tributary #7 1997	12.5	5	Poor	1.3	3	Fair	7.2	3	Fair	36.8	5	Poor	81.3	3	Fair	19	Poor	10	Fair	Poor-Fair
Piercy Creek Tributary #8 1997	47.0	3	Fair	0.1	5	Poor	53.3	1	Good	45.0	5	Poor	72.4	3	Fair	17	Fair	5	Good	Fair
Portugese Creek	57.8	1	Good	0.1	5	Poor	17.8	3	Fair	94.2	5	Poor	63.7	5	Poor	19	Poor	32	Poor	Poor
Riverbend Creek	22.4	5	Poor	0.0	5	Poor	40.0	1	Good	32.5	5	Poor	61.7	5	Poor	21	Poor	11	Fair	Poor-Fair
Roy Creek	65.2	1	Good	0.1	5	Poor	21.7	1	Good	50.3	5	Poor	66.6	5	Poor	17	Fair	37	Poor	Poor-Fair

Appendix10.Figure 2. Amounts and classifications for individual instream and riparian habitat parameters for east coast Vancouver Island streams.
(Michalski and Sala, 2007)

Regional District and Stream	% Pool Area	Rating	Class	LWD/BFW	Rating	Class	% Instream Cover	Rating	Class	% Fines	Rating	Class	% Wetted Area	Rating	Class	Total Ratings	Instream Class	Landuse Value	Riparian Class	Overall Classification
Scales Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	Good	-
South Nash Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	Fair	-
Spence Creek	48.4	3	Fair	2.8	1	Good	48.6	1	Good	68.4	5	Poor	69.0	5	Poor	15	Fair	28	Poor	Poor-Fair
Sully Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	Good	-
Thames Creek	44.6	3	Fair	1.7	1	Good	41.6	1	Good	53.1	5	Poor	50.3	5	Poor	15	Fair	28	Poor	Poor-Fair
Tweedy Creek	26.3	5	Poor	0.2	5	Poor	10.5	3	Fair	26.5	5	Poor	34.8	5	Poor	23	Poor	16	Fair	Poor-Fair
Valens Brook	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	Good	-
Winter Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	Poor	-
Averages	44.6	2.9	Fair	0.8	3.6	Poor	35.9	1.8	Good	57.3	4.7	Poor	56.9	4.8	Poor	17.9	Fair	14	Fair	Fair
Total Ratings Ranges: 9.0-13.0; 13.1-18.0; 18.1-23.0																				
Nanaimo (n=12)																				
Beach Creek	58.3	1	Good	0.4	5	Poor	18.3	3	Fair	47.6	5	Poor	57.8	5	Poor	19	Poor	97	Poor	Poor
Benson Creek	43.1	1	Good	1.1	3	Fair	26.8	1	Good	46.7	5	Poor	100.0	1	Good	11	Good	21	Poor	Fair
Bloods Creek	19.0	5	Poor	0.1	5	Poor	21.0	1	Good	83.9	5	Poor	13.9	5	Poor	21	Poor	6	Good	Fair
Chase River	61.6	1	Good	4.0	1	Good	18.1	3	Fair	3.0	1	Good	34.9	5	Poor	11	Good	198	Poor	Poor
Departure Bay Creek	36.6	5	Poor	0.1	5	Poor	74.5	1	Good	69.4	5	Poor	68.6	5	Poor	21	Poor	7	Good	Good
Grandon Creek	21.4	5	Poor	1.2	3	Fair	28.0	1	Good	60.6	5	Poor	91.6	5	Poor	19	Poor	12	Fair	Poor-Fair
Haslam Creek Lower	68.6	5	Poor	1.3	3	Fair	19.5	3	Fair	11.7	3	Fair	70.8	5	Poor	19	Poor	78	Poor	Poor
Haslam Creek Upper	20.6	1	Good	0.2	5	Poor	18.2	3	Fair	47.4	5	Poor	35.9	5	Poor	19	Poor	76	Poor	Poor
Shelly Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	Good	-
Stray Creek	36.6	5	Poor	1.1	3	Fair	16.8	3	Fair	26.0	5	Poor	35.7	5	Poor	21	Poor	15	Fair	Poor-Fair
Thatcher Creek	87.9	1	Good	0.9	5	Poor	47.0	1	Good	32.9	5	Poor	46.3	5	Poor	17	Fair	46	Poor	Poor
Westglade Brook	65.5	1	Good	1.8	3	Fair	49.9	1	Good	37.2	5	Poor	78.4	5	Poor	15	Fair	17	Fair	Fair
Averages	47.2	2.8	Fair	1.1	3.7	Poor	30.7	1.9	Good	42.4	4.5	Poor	57.6	4.6	Poor	17.5	Fair	49	Poor	Poor-Fair
Total Ratings Ranges: 11-14; 14.1-17.9; 18-21																				
Cowichan (n=9)																				
Beaver Creek 1	77.3	3	Fair	0.5	5	Poor	25.5	3	Fair	55.7	5	Poor	24.1	3	Fair	19	Poor	11	Fair	Poor-Fair
Beaver Creek 2	43.5	3	Fair	0.9	5	Poor	13.3	3	Fair	65.5	5	Poor	75.2	3	Fair	19	Poor	14	Fair	Poor-Fair
Bings Creek	91.7	1	Good	0.1	5	Poor	74.0	1	Good	68.3	5	Poor	62.8	5	Poor	17	Fair	6	Good	Fair-Good
Bonsall Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	53	Poor	-
Money's Wetland	87.4	1	Good	0.0	5	Poor	1.3	5		61.7	5	Poor	50.4	5	Poor	21	Poor	3	Good	Fair
Porter Creek	43.4	3	Fair	0.3	5	Poor	11.9	3	Fair	14.3	5	Poor	33.3	5	Poor	21	Poor	60	Poor	Poor
Somenos Creek	50.0	3	Fair	0.2	5	Poor	47.5	1	Good	100.0	5	Poor	87.6	5	Poor	19	Poor	10	Fair	Poor-Fair
Treffery Creek	34.5	5	Poor	0.1	5	Poor	2.5	5		47.6	5	Poor	41.3	5	Poor	25	Poor	6	Good	Fair
Whitehouse Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	Fair	-
Averages	61.1	2.7	Fair	0.3	5.0	Poor	25.2	3.0	Fair	59.0	5.0	Poor	53.8	4.4	Poor	20.1	Poor	20	Poor	Poor
Total Ratings Ranges: 17-19.0; 19.1-20.9; 21-25																				
Victoria/Gulf Islands (n=18)																				
Ayum Creek	28.2	5	Poor	6.9	1	Good	22.2	1	Good	12.9	3	Fair	100.0	1	Good	11	Good	16	Fair	Fair-Good
Blackburn Creek	69.0	1	Good	0.9	5	Poor	26.0	1	Good	58.0	5	Poor	72.7	5	Poor	17	Fair	10	Fair	Fair
Bullocks Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	Fair	-

Appendix10.Figure 2. Amounts and classifications for individual instream and riparian habitat parameters for east coast Vancouver Island streams.
(Michalski and Sala, 2007)

Regional District and Stream	% Pool Area	Rating	Class	LWD/BFW	Rating	Class	% Instream Cover	Rating	Class	% Fines	Rating	Class	% Wetted Area	Rating	Class	Total Ratings	Instream Class	Landuse Value	Riparian Class	Overall Classificati
Cusheon Creek	70.0	1	Good	0.9	5	Poor	11.6	3	Fair	72.9	5	Poor	39.0	5	Poor	19	Poor	34	Poor	Poor
Descanzo Bay Creek	1.1	5	Poor	0.0	5	Poor	12.0	3	Fair	20.0	3	Fair	68.4	5	Poor	21	Poor	68	Poor	Poor
Duck Creek	83.9	1	Good	0.4	5	Poor	19.4	3	Fair	25.0	5	Poor	29.5	5	Poor	19	Poor	14	Fair	Poor-Fair
Fulford Creek	60.7	1	Good	0.8	5	Poor	13.3	3	Fair	56.8	5	Poor	32.3	5	Poor	19	Poor	49	Poor	Poor
Ganner Creek	51.2	3	Fair	0.9	5	Poor	14.0	3	Fair	68.3	5	Poor	34.1	5	Poor	21	Poor	14	Fair	Poor-Fair
Georgeson Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	Fair	-
Greig Creek	29.0	5	Poor	1.4	3	Fair	20.0	1	Good	21.5	5	Poor	57.3	5	Poor	19	Poor	8	Good	Fair
Jack Creek	30.6	5	Poor	0.5	5	Poor	23.6	1	Good	45.3	5	Poor	53.1	5	Poor	21	Poor	15	Fair	Poor-Fair
Madrona Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	Good	-
Maple Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	Good	-
McAfee Creek	36.3	5	Poor	0.6	5	Poor	10.0	3	Fair	91.7	5	Poor	44.6	5	Poor	23	Poor	10	Fair	Poor-Fair
Murchison Creek	18.5	5	Poor	0.7	5	Poor	26.7	1	Good	49.2	5	Poor	23.0	5	Poor	21	Poor	17	Fair	Poor-Fair
Stowe Creek	17.2	5	Poor	1.1	3	Fair	0.0	5	Poor	41.7	5	Poor	100.0	1	Good	19	Poor	10	Fair	Poor-Fair
Walker Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	Fair	-
Weston Creek	68.0	1	Good	1.3	3	Fair	21.0	1	Good	9.5	1	Good	30.4	5	Poor	11	Good	11	Fair	Fair-Good
Averages	43.4	3.3	Fair	1.3	4.2	Poor	16.9	2.2	Good	44.1	4.4	Poor	52.7	4.4	Poor	18.5	Poor	18	Fair	Poor-Fair

Appendix I0. KWRP S.O.P.

KWRP S.O.P. - Monitoring Methodology during In-Stream Work

- Monitor environmental conditions (temperature, suspended sediment) at work sites.
- If fish are present and work-site stream temperature exceeds 20 degrees C either:
  1. Limit substrate disturbance to prevent release of trapped gases and sediment.
  2. Move to an alternate site where the water temperature is cooler or work can proceed without harmful disturbance.
- Monitor and control sediment through:
  1.) Careful work procedures
  2.) Sediment control structures to isolate generation.
- In sites where work operations could generate sediment, ensure sediment control is in place and operating efficiently. If harmful sediment generation is apparent during work;
  1.) Stop work until sediment clears and proceed in a more cautious manner.
  2.) Move to an alternate site until the sediment clears.
  3.) Shut down in-stream operations.
- If fish are present, visually monitor for stress (racing, gulping or dying) at all times.
- Consider isolating site for fry removal before work.
- If fish stress occurs from operations;
  1. Proceed with restoration work in a more cautious manner, or
  2. Move to an alternate site, or
  3. Shut down in-stream operations.

If problems persist, stop work at the problem site, and contact the Project Biologist.

KWRP S.O.P. - LWD Placement Standard Operating Procedures

This Standard Operating Procedure (S.O.P.) is a general description based on the Kennedy Watershed Restoration Program operating since 1995. The activities were developed under FRBC and the BC Environment- Watershed Restoration Program and the Department of Fisheries and Oceans. The objective is to provide guiding principles and procedures for Large Woody Debris (LWD) and Small Woody Debris (SWD) placement in damaged streams.

Permits

- Instream LWD/SWD prescriptions can only be written by a professional biologist/engineer or government agent (C.A.), have land owner and agency approval and an approved Section 9 Notification by DFO to BC Environment. Volunteers and Societies may then undertake the work with appropriate training and supervision depending on the scope of work and their skills.

Design Objectives

- Wood placement should address Cover, Scour and/or Erosion protection of fish habitat.
- Cover is a function that maximizes the shade and complexity of wetted areas. The LWD structure should be a stable and provide refuge for fry to adult size fish. It should also reduce solar radiation and predator observation. It will also be habitat for birds, mammals, amphibians and invertebrates.
- Scour is a function that creates pools and gravel bars when LWD is placed to constrict or deflect flow. These structures require more specific anchoring and placement to ensure they function and resist the forces of flood events.
- Erosion protection of banks with LWD can mimic the natural processes provided by old growth tree roots. It can provide the time for native trees to establish their own root complexes.

Work Guidelines

- Most damaged creeks have areas with too much wood or not enough. The objective should be to spread it out in more natural frequencies. Use the Fish Habitat Guidelines of 1-5 pieces per channel width.
- Generally avoid creating full spanning structures (unless they are above flood height) as they may catch debris and fail catastrophically.
- Conifers are the preferred structural wood for LWD placement. Smaller trees and deciduous material can be used as filler. Conifer wood rots at 1-3% volume per year.
- Direct excess SWD into the riparian areas for habitat biodiversity. Build piles for tree seedling protection and wildlife use. Place above the active floodplain or use appropriate anchoring. Avoid projecting structures more than 1/3 into the channel to reduce the potential for failure.
- Where there is a high degree of SWD and little LWD, make use of the SWD by bundling and tying with cable or import LWD to the site.
- SWD (branches, small trees) is often excessively loaded into creeks due to a homogeneous forest. Do concurrent Riparian Management practices to increase biodiversity and reduction of excess debris. If thinning the forest, use the felled trees for LWD.
- Avoid excessive working in wetted areas of the creek to protect fish habitat.
- Avoid or consult before moving substrate embedded pieces of LWD or SWD, as they may release sediment or poisonous gases.
- Hide anchor cable, clamps and cable ends. Use short cable ties, avoid elevated and open runs.
- Inspect sites after the first floods to ensure they remain anchored and functioning. Expect some maintenance for re-anchoring or tightening cables as necessary. Maintenance involves a short time period but is necessary.

KWRP S.O.P. - Spawning Gravel Placement SOP

Gravel:

- Washed (Clean) round rock,
- Rock size should be a mixture ranging from 1/4 to 2 $^{1/2}$ inch Gravel with 10 % Cobble and Boulders at larger sites.

Placement Sites:

- Areas of existing scour where there has been sufficient scour to remove organics and there is insufficient natural gravels,
- Tail out of pools,
- Areas of sufficient depth for water cover at low flows.

Placement Amounts:

- Depth 4" in 0.5 to 4.0 m wide channel width (take caution not to exceed winter low flow stream depths),
- Depth 6" in > 4.0 m wide channel width,
- Length equal to channel width.

Here are some of the guiding principles used for gravel placement in small, low gradient, streams.
Gravel Size: This depends on the gradient and peak flow of the creek. Sizes can be determined from observation of native gravel in the area. Species utilization is also a factor. Gravel should be suitably mixed and complex sizes similar to the historic condition for the stream reach. Typically small coho/cutthroat/chum streams require washed 1/4 to 2 1/2 inch round rock with a mix of 10 % cobble and a few boulders as well. The cobble acts to create aeration sites for the substrate, as well as invertebrate habitat. The boulders facilitate aeration, invertebrate and emergent fry habitat while helping to stabilize the entire bed.
Sites: Gravel sites are located in glides, riffles and pool tail outs. Do not place in pool bottoms. Select sites that offer 1-3 ft per second water velocity during spawning. This can be found natural or enhanced by creation of "quicks" through LWD and Boulder placement along the banks.
Small streams are easiest. Streams wider than 5 meters have complex thalwegs and placement can be more difficult to determine and should be done with site by site prescriptions.
Many glides can be made into spawning riffles by the addition of control structures at the downstream end. ie logs, boulder or cobble. This material must be sized large enough to hold the gravel in place and prevent washout, again use existing native substrate as a guide.
Substrate: The site substrate should be relatively impermeable and firm such as gravel, hardpan or clay. Avoid placement on soft substrates such as mud as the gravel will quickly become embedded. Some removal of sticks, mud, in-stream vegetation or dirty gravel is allowed, too much indicates a poor site selection.
Depth: Gravel depths of 1/10th of channel width are a good rule of thumb. This places the gravel in depths similar to the natural, healthy, stream sites. Too much gravel may wash out then fill pools or create dry areas at low flow. The material must be submerged during low winter flow.
Width & Length: Place gravel in square shaped deposits with lengths equal to the channel width. Most spawning areas in low gradient (0-2%) streams are one channel width long and wide. Exceptions are long riffles created by confined channels with less than the reach average width or areas of higher gradient. Do not spread it wider than the low flow margins along each bank and ensure a thalweg by spreading it in a shallow vee with a rake or with boots.