

Stream Flow Monitoring in the Englishman River Watershed, 2003

as part of the

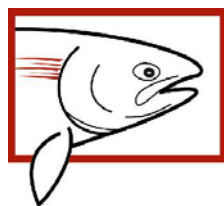
Englishman River Watershed Recovery Plan

Prepared for

Pacific Salmon Foundation
Vancouver, B.C.

By

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GREATER GEORGIA BASIN
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ACKNOWLEDGEMENTS

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1.0 Introduction

The Englishman River Watershed Recovery Plan, developed for and primarily funded by the Pacific Salmon Endowment Fund Society (PSEFS), is an initiative aimed at rebuilding wild salmon and steelhead stocks in the Englishman River. The Englishman River was selected for recovery by regional biologists from Department of Fisheries and Oceans (DFO) and Ministry of Water, Land and Air Protection (MWLAP) because it is a suitable size for habitat restoration activities and has a wide range of mostly wild anadromous fish species (Bocking and Gaboury 2001).

Following initial development of the Plan, Lough and Morley conducted a study to identify limiting factors to salmonid production and “identify opportunities to alleviate these constraints to fish production”. Their study found “reduced summer rearing habitat caused by low summer flows” to be a major limiting factor. Additionally, a channel assessment identified potential for loss of surface flow through groundwater seepage, compounding the effects of low flows (nhc 2002).

In 2002, the BC Conservation Foundation (BCCF) completed an extensive stream flow and water quality monitoring project. Results included four recommendations:

1. re-assess mainstem discharge to confirm if potential loss of flow resulting from groundwater seepage is significant (2002 results were inconclusive);
2. determine the cause of water losses in Morison Creek;
3. maintain summer flow near 20% of mean annual discharge ($2.76 \text{ m}^3/\text{s}$), with a short term minimum base flow no lower than 10% ($1.38 \text{ m}^3/\text{s}$); and
4. initiate stream enrichment in the mainstem to increase primary productivity (Wright 2003).

This monitoring study addresses the first two recommendations listed above. Loss of flow resulting from groundwater seepage was re-assessed in 2003 with a series of discharge transects. Using a semi-permanent hydrometric station, a second year of flow data was collected in Morison Creek to confirm if unusual water losses observed in 2002 were atypical.

2.0 Study Area

The Englishman River enters the Strait of Georgia on the central east coast of Vancouver Island near the city of Parksville (Figure 1). It supplies water to residents of Parksville and the Parksville East Water District. The watershed originates on Mount Arrowsmith and has a total area of approximately 325 km^2 (Bocking and Gaboury 2001). Mean annual discharge (MAD), based on 23 years of Water Survey of Canada (WSC) data from 1915 to 2000, is $13.8 \text{ m}^3/\text{s}$.

A dam on the outlet of Arrowsmith Lake, in the headwaters of the Englishman River, has been augmenting low summer flows for fisheries and domestic purposes since 1999. The reservoir has a live storage volume of $9,000,000 \text{ m}^3$ of water. Approximately 50% of the storage is allocated for fisheries purposes (Regional District of Nanaimo website). The current water license requires that $1.6 \text{ m}^3/\text{s}$, (11.6% MAD), be maintained in the

lower river (Provisional Operation Rule), as measured at the WSC gauge at the Highway 19A bridge in Parksville.

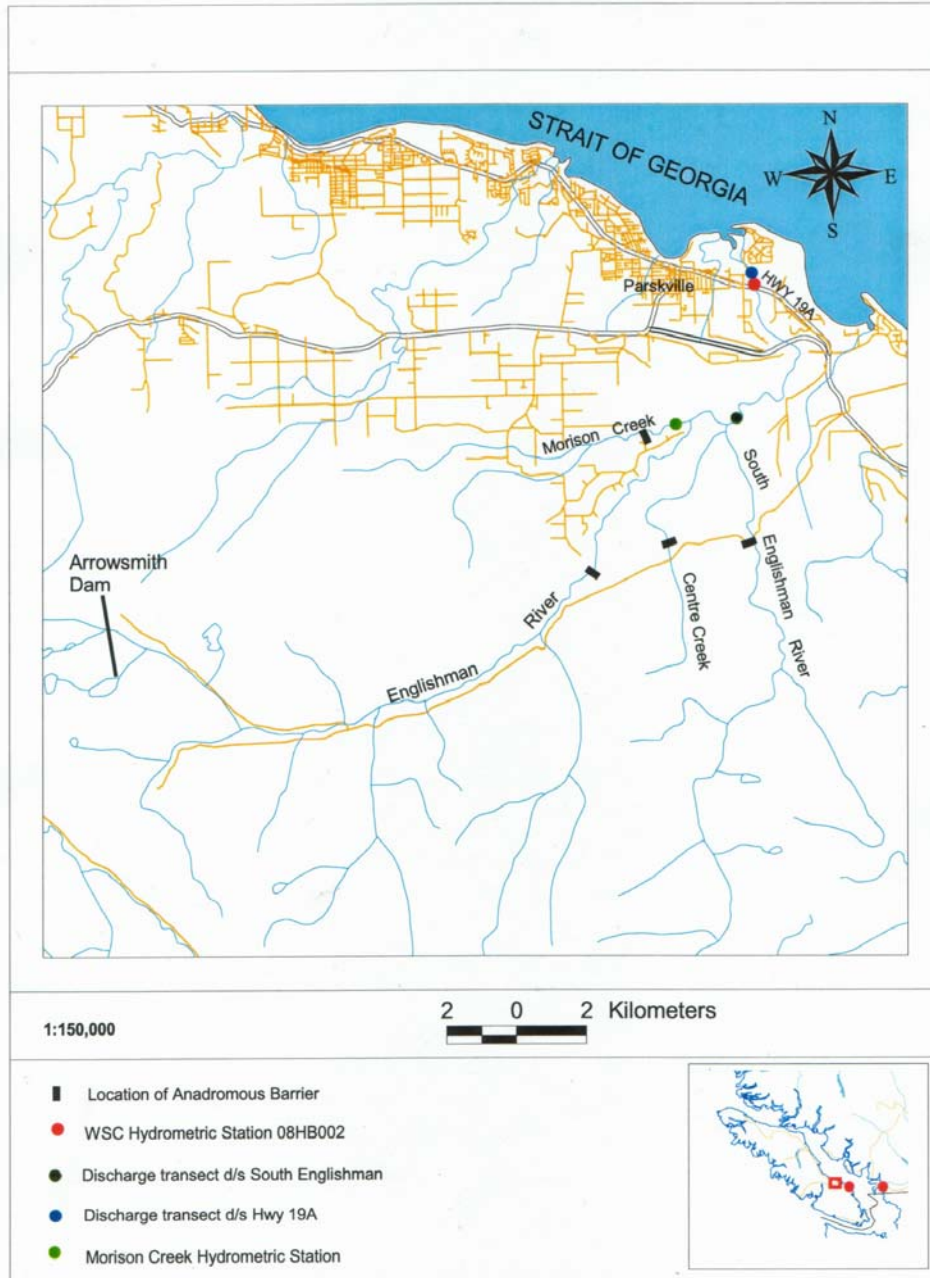


Figure 1. Englishman River watershed with stream flow measurement locations.

3.0 Methods

3.1 Mainstem

Discharge was measured in the Englishman River mainstem at a glide adjacent to the claybank 700 m downstream of the South Englishman River confluence, and at a glide 500 m downstream of the Highway 19A bridge (Figure 1). Sites were thus located upstream and downstream of reach E3 (Lough and Morely 2002) where loss of flow stemming from groundwater seepage is suspected. Though the upstream site excludes flow diverted into the TimberWest side-channel⁵ that enters the bottom of reach E3, locating the site downstream of the South Englishman confluence was seen to be more important.

Site selection and metering methodology was consistent with Resources Information Committee standards. Depth and velocity measurements were taken at a minimum of 20 stations equally spaced across the wetted width. Discharge was calculated by entering transect data into a standardized depth/velocity spreadsheet (Appendix A). Flows were measured at both sites every two weeks between mid-July and the end of September. On each day, the two sites were measured in succession to avoid significant time lapse.

3.2 Morison Creek

For continuous monitoring, a semi-permanent pressure transducer device was installed on Morison Creek approximately 200 m upstream of its mouth. Equipment was purchased from Edutech Technologies Corp. (Gibson's, B.C.) for the 2002 study. The instruments recorded hourly stage measurements while discharge at the site was manually measured bi-weekly to develop a rating curve (Appendix B). A staff gauge referenced to a benchmark was set to allow for correction and confirm the pressure transducer did not shift during the study period.

4.0 Results

4.1 Mainstem

Flow metering results indicate that discharge downstream of the Hwy 19A bridge was typically higher than downstream of the South Englishman confluence. On four of six dates, discharge was greater at the lower site by approximately 0.1 m³/s. On July 14, the metered discharge was 0.4 m³/s greater at the upper site, though rain showers through the day account for some of this change. On August 11, during a stable hydrograph, discharge was 0.03 m³/s higher at the upper site, a difference of less than 2.5%.

⁵ Flow in the side-channel is consistently in the range of 0.1 m³/s during the summer.

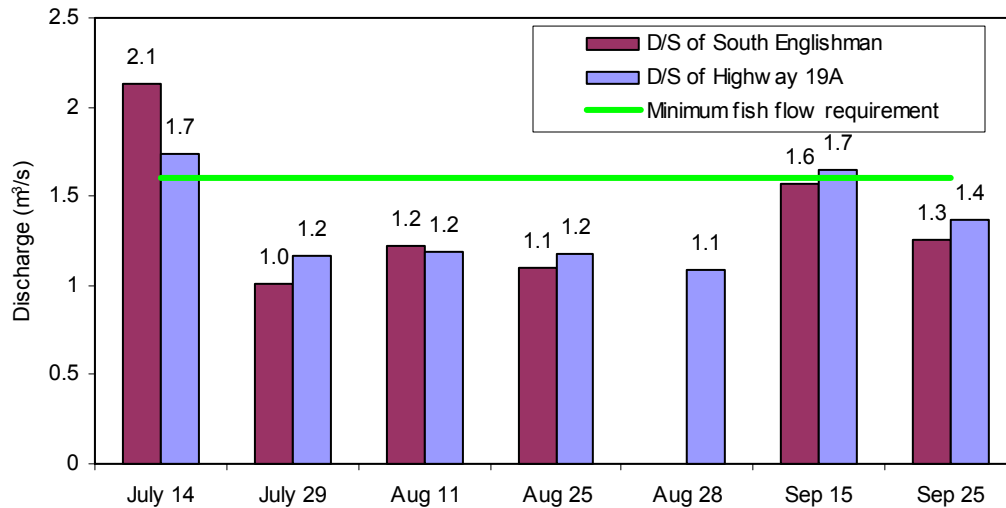


Figure 2. Comparison of Englishman River discharge values at locations above and below reaches suspected of groundwater loss, July 14 to September 25, 2003.

Results also suggest that minimum fish flow required under the current Provisional Operation Rule was not maintained (Figure 2). On August 28, test measurements were conducted with WSC staff to confirm metering results. Flows measured by WSC and BCCF personnel were 1.10 m³/s and 1.093 m³/s, respectively, confirming that flows were well below the required minimum of 1.6 m³/s.

4.2 Morison Creek

Mean daily discharge derived from Morison Creek flow station data is displayed in Figure 3. Following installation on June 4, discharge decreased rapidly from 38 L/s to 15 L/s on June 10. After mid-June, flow decreased steadily until September 4, when the season's lowest measurement of 6.6 L/s was recorded.

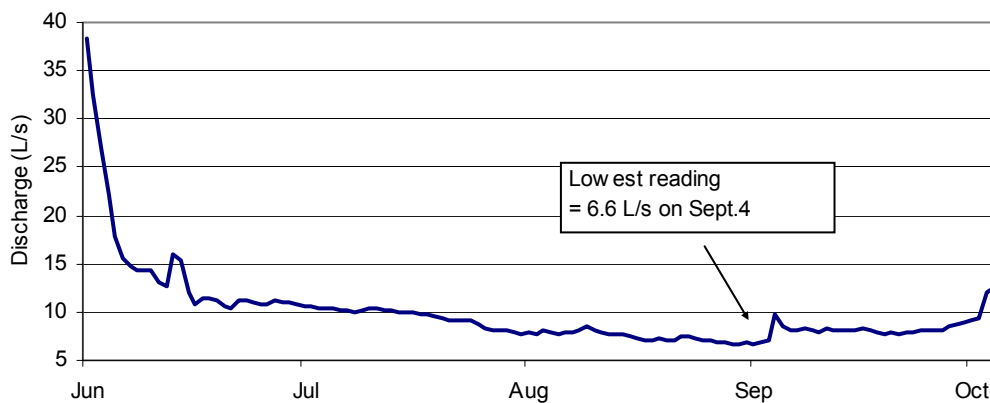


Figure 3. Mean daily discharge in Morison Creek, June 4 to October 2, 2003.

5.0 DISCUSSION/RECOMMENDATIONS

5.1 Mainstem

Loss of discharge through groundwater seepage in the lower Englishman was confirmed to be insignificant. As would be expected, discharge was typically higher at the lower transect site than it was downstream of the South Englishman confluence (Figure 2). The July 14th data point suggests otherwise (0.4 m³/s loss of flow), but rain caused flow to increase throughout the day,⁶ and the upper transect was completed approximately 1.5 hours later than the lower transect.

The upper transect site, downstream of the South Englishman, excludes water that is diverted into the TimberWest side-channel. Flow in the side-channel re-enters the mainstem upstream of the lower transect site. This diversion likely accounts for most if not all of the 0.1 m³/s higher flow typically measured below Highway 19A.

Five of seven transects completed below the Highway 19A bridge indicate discharge values well below the 1.6 m³/s minimum required under the current operation rule (Figure 2). Riffle hydraulic suitability and wetted width analysis in 2002 indicated significant habitat loss occurs when flows drop below 10% MAD, or 1.4 m³/s (Wright 2003).

Releases from Arrowsmith Dam are managed by the City of Parksville to achieve 1.6 m³/s or greater, based on discharge data emailed daily by WSC. Discharge data is preliminary and calculated using the most recent approved stage/discharge curve, which, in this case, was finalized in February 2003 (R. Gregory, WSC, pers. comm.).

The discrepancy between calculated and measured flows suggests that channel conveyance at the WSC station changed significantly by the summer of 2003. This is an inherent complication with hydrometric stations, as real-time stage data must be translated to discharge using curves that quickly become outdated due to channel dynamics. Operationally, WSC is not currently resourced to modify staff/discharge relationships continuously, despite the fact that changes are regularly monitored and noted, and that their mandate is to determine flows within +/- 5% (R. Gregory, WSC, pers. comm.).

WSC has suggested that an alternative to the present system that would alleviate some of the potential error from year to year. If necessary and adequately funded, preliminary shifts in the Englishman rating curve could be provided to Arrowsmith Water Service (City of Parksville) following each field measurement. The shift could be uploaded to the WSC database immediately and applied to obtain a preliminary corrected flow for Arrowsmith Water Service to better manage water releases from Arrowsmith Dam.

5.2 Morison Creek

Results from the Morison Creek hydrometric station show a steady hydrograph in 2003 (Figure 3). There were no sudden water withdrawals in the headwaters to cause drastic

⁶ WSC data from the Englishman River hydrometric station indicate that flow steadily increased by 58% over the day.

loss of water. In 2002, there was a significant drop from 17 L/s to 4 L/s on August 4, likely due to agricultural withdrawals, though this was not confirmed. Low water in summer 2002 was exacerbated by an extremely dry fall, causing discharge to drop to 2 L/s in late October.

REFERENCES

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Personal Communication

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Appendix A

Depth/velocity spreadsheets used to derive discharge.

**DEPTH/VELOCITY TRANSECT DATA ANALYSIS SPREADSHEET
(CALCULATES W.U.A. & DISCHARGE)**

STREAM:	Englishman River
DATE:	14-Jul-03
TIME:	13:15
SAMPLE TYPE:	discharge
SITE NAME:	d/s Hwy 19A

MAIN/SIDE CHANNEL:	m
METERED/EST.:	m
MEAN/SURFACE:	m
TRANSECT WIDTH:	32.7 m
METER TYPE:	swoffer
SENSOR DEPTH (from bottom):	40 %
METERED DISCHARGE:	1.7421 m ³ s ⁻¹

HYDRAULIC TYPE:	glide
WIDTH : DEPTH RATIO :	100.41
TRANSECT TYPE:	total
STREAM WIDTH:	32.7 m
NO. OF STATIONS:	25

SITE WEIGHTED MEANS	
MEAN DEPTH:	0.326 m
MEAN VELOCITY:	0.164 ms ⁻¹
CROSS-SECT. AREA:	10.649 m ²

ADJUSTED USABLE AREAS	
% USABLE BY RBT FRY	63 %
% USABLE BY RBT PARR	65 %
% USABLE BY CT FRY	72 %
% USABLE BY CT PARR	87 %
% USABLE BY CHINOOK	72 %
% USABLE BY COHO	73 %

DEPTH/ VELOCITY DATA FOR WEIGHTED USABLE AREA (WUA) CALCULATIONS

Transect Data				cell	cell	cell	cell	usable	cell	usable	cell	usable	cell	usable	cell	usable	cell	cell		
station length	depth	velocity	substrate	width	mean	mean	prob.	width	prob.	width	prob.	width	prob.	width	prob.	width	area	discharge		
(m)	(m)	(m/s)		(m)	depth	velocity	RBT	Fry	RBT	RBT	CT	CT	CT	CT	CT	CH	CH	CO	CO	
					(m)	(m/s)		(m)	Parr	Parr	fry	fry	parr	parr		(m)	(m)	(sq. m)	(cu. m/sec)	
1.00	0.28	0.00		0.75	0.23	0	0.2	0.2	0.00	0	0.98	0.735	0.98	0.7	0.00	0.00	0.98	0.74	0.1725	0
2.50	0.64	0.00		1.5	0.64	0	0.022	0.033	0.00	0	0.15	0.225	1.00	1.5	0.00	0.00	1.00	1.50	0.96	0
4.00	0.53	0.16		1.5	0.53	0.16	0.22	0.33	0.78	1.17	0.29	0.435	1.00	1.5	0.84	1.26	0.88	1.32	0.795	0.1272
5.50	0.40	0.230		1.5	0.4	0.23	0.478	0.718	0.96	1.44	0.594	0.891	1.00	1.5	0.97	1.46	0.60	0.90	0.6	0.138
7.00	0.38	0.19		1.5	0.38	0.19	0.58	0.87	0.87	1.305	0.66	0.99	1.00	1.5	0.92	1.38	0.76	1.14	0.57	0.1083
8.50	0.44	0.19		1.5	0.44	0.19	0.4	0.6	0.87	1.305	0.5	0.75	1.00	1.5	0.92	1.38	0.76	1.14	0.66	0.1254
10.00	0.50	0.16		1.5	0.5	0.16	0.27	0.405	0.78	1.17	0.4	0.6	1.00	1.5	0.84	1.26	0.88	1.32	0.75	0.12
11.50	0.47	0.17		1.5	0.47	0.17	0.34	0.51	0.81	1.215	0.4	0.6	1.00	1.5	0.87	1.31	0.84	1.26	0.705	0.11985
13.00	0.52	0.21		1.5	0.52	0.21	0.223	0.335	0.92	1.38	0.261	0.3915	1.00	1.5	0.95	1.43	0.68	1.02	0.78	0.1638
14.50	0.46	0.20		1.5	0.46	0.2	0.36	0.54	0.90	1.35	0.4	0.6	1.00	1.5	0.94	1.41	0.72	1.08	0.69	0.138
16.00	0.36	0.18		1.5	0.36	0.18	0.65	0.975	0.84	1.26	0.66	0.99	1.00	1.5	0.89	1.34	0.80	1.20	0.54	0.0972
17.50	0.30	0.14		1.5	0.3	0.14	0.85	1.275	0.70	1.044	0.98	1.47	1.00	1.5	0.78	1.17	0.94	1.41	0.45	0.063
19.00	0.22	0.19		1.5	0.22	0.19	1	1.5	0.70	1.057	0.98	1.47	0.98	1.5	0.92	1.38	0.74	1.11	0.33	0.0627
20.50	0.20	0.22		1.5	0.2	0.22	0.94	1.41	0.71	1.058	0.882	1.323	0.85	1.3	0.92	1.38	0.60	0.90	0.3	0.066
22.00	0.25	0.24		1.5	0.25	0.24	0.89	1.335	0.89	1.338	0.882	1.323	1.00	1.5	0.98	1.47	0.56	0.84	0.375	0.09
23.50	0.30	0.18		1.5	0.3	0.18	0.85	1.275	0.82	1.235	0.98	1.47	1.00	1.5	0.89	1.34	0.80	1.20	0.45	0.081
25.00	0.31	0.19		1.5	0.31	0.19	0.82	1.23	0.85	1.279	0.85	1.275	1.00	1.5	0.92	1.38	0.76	1.14	0.465	0.08835
26.50	0.22	0.20		1.5	0.22	0.2	1	1.5	0.73	1.094	0.98	1.47	0.98	1.5	0.94	1.41	0.70	1.05	0.33	0.066
28.00	0.19	0.19		1.5	0.19	0.19	1	1.5	0.62	0.927	0.98	1.47	0.85	1.3	0.84	1.26	0.70	1.05	0.285	0.05415
29.50	0.12	0.08		1	0.12	0.08	1	1	0.19	0.189	1	1	0.36	0.4	0.22	0.22	0.70	0.70	0.12	0.0096
30.00	0.08	0.12		0.75	0.08	0.12	1	0.75	0.16	0.118	1	0.75	0.22	0.2	0.16	0.12	0.51	0.38	0.06	0.0072
31.00	0.10	0.10		1	0.1	0.1	1	1	0.18	0.182	1	1	0.27	0.3	0.19	0.19	0.61	0.61	0.1	0.01
32.00	0.09	0.07		1	0.09	0.07	1	1	0.12	0.116	1	1	0.27	0.3	0.12	0.12	0.56	0.56	0.09	0.0063
33.00	0.07	0.00		0.85	0.07	0	0.2	0.17	0.00	0	1	0.85	0.22	0.2	0.00	0.00	0.45	0.38	0.0595	0
33.70	0.00	0.00		0.35	0.035	0	0.12	0.042	0.00	0	1	0.35	0.03	0	0.00	0.00	0.20	0.07	0.0123	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0

This spread sheet is brought to you by Poul Bech, Ron Ptolemy, and Rob Knight, B.C. Environment, Fisheries Section, May 1994.
(Modified by Harlan Wright, British Columbia Conservation Foundation, July 2002).

DEPTH/VELOCITY TRANSECT DATA ANALYSIS SPREADSHEET (CALCULATES W.U.A. & DISCHARGE)

STREAM:	Englishman River
DATE:	14-Jul-03
TIME:	15:00
SAMPLE TYPE:	Discharge Transect
SITE NAME:	d/s South Englishman

MAIN/SIDE CHANNEL:	m
METERED/EST.:	m
MEAN/SURFACE:	m
TRANSECT WIDTH:	22.5 m
METER TYPE:	swiffer
SENSOR DEPTH (from bottom):	40 %

METERED DISCHARGE:	2.1254 m ³ s ⁻¹
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SITE WEIGHTED MEANS	
MEAN DEPTH:	0.392 m
MEAN VELOCITY:	0.241 ms ⁻¹
CROSS-SECT. AREA:	8.816 m ²

HYDRAULIC TYPE:	glide
WIDTH : DEPTH RATIO :	57.43
TRANSECT TYPE:	full
STREAM WIDTH:	22.5 m
NO. OF STATIONS:	24

ADJUSTED USABLE AREAS	
% USABLE BY RBT FRY	41 %
% USABLE BY RBT PARR	71 %
% USABLE BY CT FRY	49 %
% USABLE BY CT PARR	87 %
% USABLE BY CHINOOK	72 %
% USABLE BY COHO	57 %

DEPTH/ VELOCITY DATA FOR WEIGHTED USABLE AREA (WUA) CALCULATIONS

Transect Data				cell	cell	cell	cell	usable	cell	usable	cell	usable	cell	isab	cell	usable	cell	usable	cell	cell	
station length	depth	velocity	substrate	width	mean	mean	prob.	width	prob.	width	prob.	width	prob.	width	prob.	width	prob.	width	prob.	width	discharge
(m)	(m)	(m/s)		(m)	depth	velocity	RBT	Fry	RBT	RBT	CT	CT	CT	CT	CH	CH	CO	CO		(sq. m)	(cu. m/sec)
23.10	0.00	0.00		0.55	0.025	0.035	0.32	0.2	0.00	0	1	0.55	0.03	0	0.01	0.01	0.12	0.07	0.0138	0.000481	
22.00	0.10	0.07		1.05	0.1	0.07	1	1.05	0.13	0.139	1	1.05	0.27	0.3	0.14	0.14	0.61	0.64	0.105	0.00735	
21.00	0.17	0.05		1	0.17	0.05	0.9	0.9	0.19	0.189	1	1	0.71	0.7	0.27	0.27	0.87	0.87	0.17	0.0085	
20.00	0.25	0.03		1	0.25	0.03	0.8	0.8	0.16	0.164	0.98	0.98	1.00	1	0.22	0.22	1.00	1.00	0.25	0.0075	
19.00	0.35	0.05		1	0.35	0.05	0.612	0.612	0.30	0.3	0.85	0.85	1.00	1	0.35	0.35	1.00	1.00	0.35	0.0175	
18.00	0.36	0.10		1	0.36	0.1	0.65	0.65	0.55	0.55	0.66	0.66	1.00	1	0.63	0.63	1.00	1.00	0.36	0.036	
17.00	0.40	0.09		1	0.4	0.09	0.52	0.52	0.50	0.5	0.66	0.66	1.00	1	0.57	0.57	1.00	1.00	0.4	0.036	
16.00	0.48	0.25		1	0.48	0.25	0.267	0.267	1.00	1	0.3	0.3	1.00	1	0.99	0.99	0.52	0.52	0.48	0.12	
15.00	0.55	0.27		1	0.55	0.27	0.142	0.142	1.00	1	0.16	0.1595	1.00	1	1.00	1.00	0.44	0.44	0.55	0.1485	
14.00	0.50	0.24		1	0.5	0.24	0.24	0.24	0.98	0.98	0.36	0.36	1.00	1	0.98	0.98	0.56	0.56	0.5	0.12	
13.00	0.53	0.26		1	0.53	0.26	0.18	0.18	1.00	1	0.218	0.2175	1.00	1	1.00	1.00	0.48	0.48	0.53	0.1378	
12.00	0.55	0.25		1	0.55	0.25	0.155	0.155	1.00	1	0.218	0.2175	1.00	1	0.99	0.99	0.52	0.52	0.55	0.1375	
11.00	0.53	0.30		1	0.53	0.3	0.15	0.15	1.00	1	0.102	0.1015	0.99	1	1.00	1.00	0.33	0.33	0.53	0.159	
10.00	0.45	0.34		1	0.45	0.34	0.209	0.209	1.00	1	0.09	0.09	0.95	1	0.99	0.99	0.20	0.20	0.45	0.153	
9.00	0.44	0.25		1	0.44	0.25	0.344	0.344	1.00	1	0.375	0.375	1.00	1	0.99	0.99	0.52	0.52	0.44	0.11	
8.00	0.53	0.20		1	0.53	0.2	0.22	0.22	0.90	0.9	0.29	0.29	1.00	1	0.94	0.94	0.72	0.72	0.53	0.106	
7.00	0.60	0.36		1	0.6	0.36	0.064	0.064	1.00	1	0.027	0.0273	0.92	0.9	0.97	0.97	0.14	0.14	0.6	0.216	
6.00	0.58	0.39		1	0.58	0.39	0.057	0.057	1.00	1	0.013	0.0126	0.80	0.8	0.94	0.94	0.08	0.08	0.58	0.2262	
5.00	0.42	0.48		1	0.42	0.48	0.083	0.083	1.00	1	0.005	0.005	0.40	0.4	0.80	0.80	0.00	0.00	0.42	0.2016	
4.00	0.33	0.30		1	0.33	0.3	0.51	0.51	0.99	0.99	0.298	0.2975	0.99	1	1.00	1.00	0.33	0.33	0.33	0.099	
3.00	0.30	0.21		1	0.3	0.21	0.825	0.825	0.90	0.902	0.882	0.882	1.00	1	0.95	0.95	0.68	0.68	0.3	0.063	
2.00	0.23	0.07		0.9	0.23	0.07	1	0.9	0.34	0.306	0.98	0.882	0.98	0.9	0.46	0.41	0.98	0.88	0.207	0.01449	
1.20	0.20	0.00		0.7	0.2	0	0.2	0.14	0.00	0	0.98	0.686	0.85	0.6	0.00	0.00	0.94	0.66	0.14	0	
0.60	0.00	0.00		0.3	0.1	0	0.2	0.06	0.00	0	1	0.3	0.27	0.1	0.00	0.00	0.61	0.18	0.03	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	

This spread sheet is brought to you by Poul Bech, Ron Ptolemy, and Rob Knight, B.C. Environment, Fisheries Section, May 1994.
(Modified by Harlan Wright, British Columbia Conservation Foundation, July 2002).

**DEPTH/VELOCITY TRANSECT DATA ANALYSIS SPREADSHEET
(CALCULATES W.U.A. & DISCHARGE)**

STREAM:	Englishman River
DATE:	11-Aug-03
TIME:	13:30
SAMPLE TYPE:	discharge
SITE NAME:	d/s Hwy 19A

MAIN/SIDE CHANNEL:	m
METERED/EST.:	m
MEAN/SURFACE:	m
TRANSECT WIDTH:	32.1 m
METER TYPE:	swoffer
SENSOR DEPTH (from bottom):	40 %
METERED DISCHARGE:	1.1896 m ³ s ⁻¹

HYDRAULIC TYPE:	glide
WIDTH : DEPTH RATIO :	111.01
TRANSECT TYPE:	
STREAM WIDTH:	32.1 m
NO. OF STATIONS:	24

SITE WEIGHTED MEANS	
MEAN DEPTH:	0.289 m
MEAN VELOCITY:	0.128 ms ⁻¹
CROSS-SECT. AREA:	9.283 m ²

ADJUSTED USABLE AREAS	
% USABLE BY RBT FRY	66 %
% USABLE BY RBT PARR	53 %
% USABLE BY CT FRY	82 %
% USABLE BY CT PARR	87 %
% USABLE BY CHINOOK	63 %
% USABLE BY COHO	85 %

DEPTH/ VELOCITY DATA FOR WEIGHTED USABLE AREA (WUA) CALCULATIONS

Transect Data				cell	cell	cell	cell	usable	cell	usable	cell	usable	cell	isabl	cell	usable	cell	usable	cell	cell	cell
station length	depth	velocity	substrate	width	mean	mean	prob.	width	prob.	width	prob.	width	prob.	width	prob.	width	prob.	width	area	discharge	
(m)	(m)	(m/s)		(m)	depth	velocity	RBT	Fry	RBT	RBT	CT	CT	CT	CT	CT	CH	CH	CO	CO	(sq. m)	(cu. m/sec)
0.90	0.30	0.00		0.55	0.2	0	0.2	0.1	0.00	0	0.98	0.539	0.85	0.5	0.00	0.00	0.94	0.52	0.11	0	
2.00	0.50	0.00		1.05	0.5	0	0.054	0.057	0.00	0	0.4	0.42	1.00	1.1	0.00	0.00	1.00	1.05	0.525	0	
3.00	0.53	0.09		1.25	0.53	0.09	0.22	0.275	0.50	0.625	0.29	0.3625	1.00	1.3	0.57	0.71	1.00	1.25	0.6625	0.059625	
4.50	0.44	0.160		1.5	0.44	0.16	0.4	0.6	0.78	1.17	0.5	0.75	1.00	1.5	0.84	1.26	0.88	1.32	0.66	0.1056	
6.00	0.33	0.14		1.5	0.33	0.14	0.75	1.125	0.70	1.054	0.85	1.275	1.00	1.5	0.78	1.17	0.94	1.41	0.495	0.0693	
7.50	0.34	0.14		1.5	0.34	0.14	0.71	1.065	0.71	1.065	0.85	1.275	1.00	1.5	0.78	1.17	0.94	1.41	0.51	0.0714	
9.00	0.35	0.18		1.5	0.35	0.18	0.68	1.02	0.84	1.26	0.85	1.275	1.00	1.5	0.89	1.34	0.80	1.20	0.525	0.0945	
10.50	0.35	0.17		1.5	0.35	0.17	0.68	1.02	0.81	1.215	0.85	1.275	1.00	1.5	0.87	1.31	0.84	1.26	0.525	0.08925	
12.00	0.52	0.14		1.5	0.52	0.14	0.23	0.345	0.71	1.065	0.29	0.435	1.00	1.5	0.78	1.17	0.94	1.41	0.78	0.1092	
13.50	0.45	0.15		1.5	0.45	0.15	0.38	0.57	0.75	1.125	0.5	0.75	1.00	1.5	0.82	1.23	0.91	1.37	0.675	0.10125	
15.00	0.38	0.17		1.5	0.38	0.17	0.58	0.87	0.81	1.215	0.66	0.99	1.00	1.5	0.87	1.31	0.84	1.26	0.57	0.0969	
16.50	0.30	0.13		1.5	0.3	0.13	0.85	1.275	0.66	0.985	0.98	1.47	1.00	1.5	0.74	1.11	0.96	1.44	0.45	0.0585	
18.00	0.22	0.15		1.5	0.22	0.15	1	1.5	0.61	0.911	0.98	1.47	0.98	1.5	0.82	1.23	0.88	1.32	0.33	0.0495	
19.50	0.21	0.12		1.5	0.21	0.12	1	1.5	0.49	0.737	0.98	1.47	0.98	1.5	0.70	1.05	0.95	1.43	0.315	0.0378	
21.00	0.23	0.10		1.5	0.23	0.1	1	1.5	0.47	0.701	0.98	1.47	0.98	1.5	0.63	0.95	0.98	1.47	0.345	0.0345	
22.50	0.21	0.17		1.5	0.21	0.17	1	1.5	0.63	0.948	0.98	1.47	0.98	1.5	0.86	1.29	0.80	1.20	0.315	0.05355	
24.00	0.30	0.13		1.5	0.3	0.13	0.85	1.275	0.66	0.985	0.98	1.47	1.00	1.5	0.74	1.11	0.96	1.44	0.45	0.0585	
25.50	0.20	0.11		1.5	0.2	0.11	1	1.5	0.44	0.664	0.98	1.47	0.85	1.3	0.64	0.96	0.94	1.41	0.3	0.033	
27.00	0.18	0.12		1.5	0.18	0.12	1	1.5	0.42	0.633	1	1.5	0.85	1.3	0.60	0.91	0.89	1.34	0.27	0.0324	
28.50	0.16	0.14		1.5	0.16	0.14	1	1.5	0.42	0.628	1	1.5	0.71	1.1	0.56	0.84	0.79	1.18	0.24	0.0336	
30.00	0.06	0.00		1.5	0.06	0	0.2	0.3	0.00	0	1	1.5	0.13	0.2	0.00	0.00	0.40	0.60	0.09	0	
31.50	0.06	0.02		1	0.06	0.02	0.7	0.7	0.02	0.019	1	1	0.13	0.1	0.02	0.02	0.40	0.40	0.06	0.0012	
32.00	0.08	0.00		0.75	0.08	0	0.2	0.15	0.00	0	1	0.75	0.22	0.2	0.00	0.00	0.51	0.38	0.06	0	
33.00	0.00	0.00		0.5	0.04	0	0.16	0.08	0.00	0	1	0.5	0.03	0	0.00	0.00	0.27	0.14	0.02	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0	

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**DEPTH/VELOCITY TRANSECT DATA ANALYSIS SPREADSHEET
(CALCULATES W.U.A. & DISCHARGE)**

STREAM:	Englishman River
DATE:	11-Aug-03
TIME:	15:00
SAMPLE TYPE:	discharge
SITE NAME:	d/s South Englishman

MAIN/SIDE CHANNEL:	m
METERED/EST.:	m
MEAN/SURFACE:	m
TRANSECT WIDTH:	21.9 m
METER TYPE:	swoffler
SENSOR DEPTH (from bottom):	40 %
METERED DISCHARGE:	1.2223 m ³ s ⁻¹

HYDRAULIC TYPE:	glide
WIDTH : DEPTH RATIO :	70.06
TRANSECT TYPE:	full
STREAM WIDTH:	21.9 m
NO. OF STATIONS:	24

SITE WEIGHTED MEANS	
MEAN DEPTH:	0.313 m
MEAN VELOCITY:	0.179 ms ⁻¹
CROSS-SECT. AREA:	6.846 m ²

ADJUSTED USABLE AREAS	
% USABLE BY RBT FRY	49 %
% USABLE BY RBT PARR	60 %
% USABLE BY CT FRY	71 %
% USABLE BY CT PARR	84 %
% USABLE BY CHINOOK	64 %
% USABLE BY COHO	70 %

DEPTH/ VELOCITY DATA FOR WEIGHTED USABLE AREA (WUA) CALCULATIONS

Transect Data																				
station length (m)	depth (m)	velocity (m/s)	substrate	cell width	cell mean depth (m)	cell mean velocity (m/s)	cell usable RBT	cell usable Fry	cell usable RBT Parr	cell usable RBT Fry	cell usable CT Fry	cell usable CT Parr	cell usable CT Fry	cell usable CT Parr	cell usable CH	cell usable CH	cell usable CO	cell usable CO	cell area (sq. m)	cell discharge (cu. m/sec)
2.00	0.00	0.00		0.5	0.018	0	0.04	0.0	0.00	0	1	0.5	0.03	0	0.00	0.00	0.05	0.03	0.0088	0
3.00	0.07	0.00		1	0.07	0	0.2	0.2	0.00	0	1	1	0.22	0.2	0.00	0.00	0.45	0.45	0.07	0
4.00	0.08	0.05		1	0.08	0.05	0.9	0.9	0.08	0.075	1	1	0.22	0.2	0.08	0.08	0.51	0.51	0.08	0.004
5.00	0.17	0.10		1	0.17	0.1	1	1	0.35	0.347	1	1	0.71	0.7	0.49	0.49	0.87	0.87	0.17	0.017
6.00	0.29	0.00		0.75	0.29	0	0.176	0.132	0.00	0	0.98	0.735	1.00	0.8	0.00	0.00	1.00	0.75	0.2175	0
6.50	0.25	0.07		0.5	0.25	0.07	1	0.5	0.36	0.182	0.98	0.49	1.00	0.5	0.46	0.23	1.00	0.50	0.125	0.00875
7.00	0.28	0.21		0.75	0.28	0.21	0.883	0.662	0.87	0.656	0.882	0.6615	1.00	0.8	0.95	0.71	0.68	0.51	0.21	0.0441
8.00	0.31	0.17		1	0.31	0.17	0.82	0.82	0.79	0.794	0.85	0.85	1.00	1	0.87	0.87	0.84	0.84	0.31	0.0527
9.00	0.40	0.18		1	0.4	0.18	0.52	0.52	0.84	0.84	0.66	0.66	1.00	1	0.89	0.89	0.80	0.80	0.4	0.072
10.00	0.47	0.19		1	0.47	0.19	0.34	0.34	0.87	0.87	0.4	0.4	1.00	1	0.92	0.92	0.76	0.76	0.47	0.0893
11.00	0.45	0.23		1	0.45	0.23	0.35	0.35	0.96	0.96	0.45	0.45	1.00	1	0.97	0.97	0.60	0.60	0.45	0.1035
12.00	0.45	0.16		1	0.45	0.16	0.38	0.38	0.78	0.78	0.5	0.5	1.00	1	0.84	0.84	0.88	0.88	0.45	0.072
13.00	0.49	0.21		1	0.49	0.21	0.281	0.281	0.92	0.92	0.36	0.36	1.00	1	0.95	0.95	0.68	0.68	0.49	0.1029
14.00	0.38	0.27		1	0.38	0.27	0.458	0.458	1.00	1	0.363	0.363	1.00	1	1.00	1.00	0.44	0.44	0.38	0.1026
15.00	0.41	0.13		1	0.41	0.13	0.48	0.48	0.67	0.67	0.5	0.5	1.00	1	0.74	0.74	0.96	0.96	0.41	0.0533
16.00	0.40	0.20		1	0.4	0.2	0.52	0.52	0.90	0.9	0.66	0.66	1.00	1	0.94	0.94	0.72	0.72	0.4	0.08
17.00	0.45	0.27		1	0.45	0.27	0.3	0.3	1.00	1	0.275	0.275	1.00	1	1.00	1.00	0.44	0.44	0.45	0.1215
18.00	0.52	0.24		1	0.52	0.24	0.205	0.205	0.98	0.98	0.261	0.261	1.00	1	0.98	0.98	0.56	0.56	0.52	0.1248
19.00	0.43	0.24		1	0.43	0.24	0.383	0.383	0.98	0.98	0.45	0.45	1.00	1	0.98	0.98	0.56	0.56	0.43	0.1032
20.00	0.29	0.20		1	0.29	0.2	0.88	0.88	0.87	0.873	0.98	0.98	1.00	1	0.94	0.94	0.72	0.72	0.29	0.058
21.00	0.18	0.07		1	0.18	0.07	1	1	0.27	0.268	1	1	0.85	0.9	0.39	0.39	0.89	0.89	0.18	0.0126
22.00	0.17	0.00		1	0.17	0	0.2	0.2	0.00	0	1	1	0.71	0.7	0.00	0.00	0.87	0.87	0.17	0
23.00	0.14	0.00		0.95	0.14	0	0.2	0.19	0.00	0	1	0.95	0.50	0.5	0.00	0.00	0.78	0.74	0.133	0
23.90	0.00	0.00		0.45	0.07	0	0.2	0.09	0.00	0	1	0.45	0.22	0.1	0.00	0.00	0.45	0.20	0.0315	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0

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(Modified by Harlan Wright, British Columbia Conservation Foundation, July 2002).

DEPTH/VELOCITY TRANSECT DATA ANALYSIS SPREADSHEET (CALCULATES W.U.A. & DISCHARGE)

STREAM:	Englishman River
DATE:	25-Aug-03
TIME:	13:00
SAMPLE TYPE:	discharge
SITE NAME:	d/s Hwy 19A

MAIN/SIDE CHANNEL:	m
METERED/EST.:	m
MEAN/SURFACE:	m
TRANSECT WIDTH:	35.7 m
METER TYPE:	swoffer
SENSOR DEPTH (from bottom):	40 %
METERED DISCHARGE:	1.1797 m ³ s ⁻¹

HYDRAULIC TYPE:	glide
WIDTH : DEPTH RATIO :	146.82
TRANSECT TYPE:	
STREAM WIDTH:	35.7 m
NO. OF STATIONS:	27

SITE WEIGHTED MEANS	
MEAN DEPTH:	0.243 m
MEAN VELOCITY:	0.136 ms ⁻¹
CROSS-SECT. AREA:	8.681 m ²

ADJUSTED USABLE AREAS	
% USABLE BY RBT FRY	77 %
% USABLE BY RBT PARR	48 %
% USABLE BY CT FRY	85 %
% USABLE BY CT PARR	73 %
% USABLE BY CHINOOK	57 %
% USABLE BY COHO	77 %

DEPTH/ VELOCITY DATA FOR WEIGHTED USABLE AREA (WUA) CALCULATIONS

Transect Data				cell	cell	cell	cell	usable	cell	usable	cell	usable	cell	usable	cell	usable	cell	usable	cell	usable			
station length	depth	velocity	substrate	width	mean	mean	prob.	width	prob.	width	prob.	width	prob.	width	prob.	width	prob.	width	prob.	width	prob.	area	discharge
(m)	(m)	(m/s)		(m)	depth	velocity	RBT	Fry	RBT	RBT	CT	CT	CT	CT	CH	CH	CO	CO			(sq. m)	(cu. m/sec)	
0.50	0.14	0.00		0.5	0.115	0.025	0.7	0.4	0.04	0.02	1	0.5	0.36	0.2	0.06	0.03	0.66	0.33	0.0575	0.001438			
1.50	0.32	0.05		1	0.32	0.05	0.702	0.702	0.30	0.297	0.85	0.85	1.00	1	0.35	0.35	1.00	1.00	0.32	0.016			
2.50	0.53	0.13		1	0.53	0.13	0.22	0.22	0.67	0.67	0.29	0.29	1.00	1	0.74	0.74	0.96	0.96	0.53	0.0689			
3.50	0.52	0.160		1.25	0.52	0.16	0.23	0.288	0.78	0.975	0.29	0.3625	1.00	1.3	0.84	1.05	0.88	1.10	0.65	0.104			
5.00	0.48	0.12		1.5	0.48	0.12	0.31	0.465	0.63	0.945	0.4	0.6	1.00	1.5	0.71	1.07	1.00	1.50	0.72	0.0864			
6.50	0.32	0.11		1.5	0.32	0.11	0.78	1.17	0.58	0.876	0.85	1.275	1.00	1.5	0.67	1.01	1.00	1.50	0.48	0.0528			
8.00	0.41	0.13		1.5	0.41	0.13	0.48	0.72	0.67	1.005	0.5	0.75	1.00	1.5	0.74	1.11	0.96	1.44	0.615	0.07995			
9.50	0.42	0.12		1.5	0.42	0.12	0.46	0.69	0.63	0.945	0.5	0.75	1.00	1.5	0.71	1.07	1.00	1.50	0.63	0.0756			
11.00	0.34	0.17		1.5	0.34	0.17	0.71	1.065	0.81	1.215	0.85	1.275	1.00	1.5	0.87	1.31	0.84	1.26	0.51	0.0867			
12.50	0.32	0.16		1.5	0.32	0.16	0.78	1.17	0.77	1.158	0.85	1.275	1.00	1.5	0.84	1.26	0.88	1.32	0.48	0.0768			
14.00	0.31	0.15		1.5	0.31	0.15	0.82	1.23	0.74	1.103	0.85	1.275	1.00	1.5	0.82	1.23	0.91	1.37	0.465	0.06975			
15.50	0.28	0.16		1.5	0.28	0.16	0.91	1.365	0.74	1.112	0.98	1.47	1.00	1.5	0.84	1.26	0.88	1.32	0.42	0.0672			
17.00	0.19	0.13		1.5	0.19	0.13	1	1.5	0.48	0.714	0.98	1.47	0.85	1.3	0.67	1.01	0.88	1.32	0.285	0.03705			
18.50	0.22	0.10		1.5	0.22	0.1	1	1.5	0.45	0.668	0.98	1.47	0.98	1.5	0.63	0.95	0.97	1.46	0.33	0.033			
20.00	0.21	0.18		1.5	0.21	0.18	1	1.5	0.66	0.983	0.98	1.47	0.98	1.5	0.88	1.32	0.76	1.14	0.315	0.0567			
21.50	0.24	0.14		1.5	0.24	0.14	1	1.5	0.62	0.937	0.98	1.47	1.00	1.5	0.78	1.17	0.93	1.40	0.36	0.0504			
23.00	0.17	0.23		1.5	0.17	0.23	0.92	1.38	0.60	0.907	0.9	1.35	0.71	1.1	0.76	1.13	0.52	0.78	0.255	0.05865			
24.50	0.17	0.12		1.5	0.17	0.12	1	1.5	0.40	0.595	1	1.5	0.71	1.1	0.55	0.83	0.87	1.31	0.255	0.0306			
26.00	0.13	0.19		1.5	0.13	0.19	1	1.5	0.40	0.6	1	1.5	0.36	0.5	0.46	0.69	0.56	0.84	0.195	0.03705			
27.50	0.11	0.18		1.5	0.11	0.18	1	1.5	0.31	0.466	1	1.5	0.27	0.4	0.33	0.49	0.53	0.79	0.165	0.0297			
29.00	0.09	0.10		1.5	0.09	0.1	1	1.5	0.16	0.239	1	1.5	0.27	0.4	0.16	0.25	0.56	0.84	0.135	0.0135			
30.50	0.06	0.19		1.5	0.06	0.19	1	1.5	0.15	0.222	1	1.5	0.13	0.2	0.14	0.21	0.30	0.46	0.09	0.0171			
32.00	0.04	0.11		1.5	0.04	0.11	0.8	1.2	0.05	0.08	1	1.5	0.03	0	0.07	0.10	0.27	0.41	0.06	0.0066			
33.50	0.07	0.01		1.5	0.07	0.01	0.5	0.75	0.01	0.016	1	1.5	0.22	0.3	0.01	0.02	0.45	0.68	0.105	0.00105			
35.00	0.14	0.13		1.25	0.14	0.13	1	1.25	0.34	0.427	1	1.25	0.50	0.6	0.43	0.54	0.75	0.94	0.175	0.02275			
36.00	0.12	0.00		0.6	0.12	0	0.2	0.12	0.00	0	1	0.6	0.36	0.2	0.00	0.00	0.70	0.42	0.072	0			
36.20	0.00	0.00		0.1	0.06	0	0.2	0.02	0.00	0	1	0.1	0.13	0	0.00	0.00	0.40	0.04	0.006	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			
				0	0	0	0	0	0.00	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0	0			

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Appendix B

Stage/discharge relationship for Morison Creek semi-permanent flow station.

Stage (m)	Discharge (m ³ /s)
0.242	0.0084
0.243	0.0101
0.255	0.0156
0.251	0.005
0.251	0.0075
0.246	0.0061
0.262	0.0066
0.268	0.0069
0.295	0.0075
0.436	0.3923
0.37	0.1406
0.307	0.0672
0.265	0.0188
0.248	0.0112

