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A STRATEGY FOR PROTECTION AND RESTORATION OF THE ENGLISHMAN RIVER MAINSTEM

***Prepared for*:**

Englishman River Watershed Recovery Plan Community Roundtable

and

Pacific Salmon Endowment Fund Society

October 2005

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INTRODUCTION

As a means to properly implement protection measures and restoration works leading to the recovery of the Englishman River watershed, a detailed strategy that prioritizes activities along the Englishman River mainstem corridor was considered necessary by the Englishman River Watershed Recovery team. Therefore, the goal of this project was to provide a detailed strategy for the Englishman River that identifies those priority activities that will protect and/or restore, over the long term, those processes of the watershed and elements of the ecosystem that salmon and other native fishes require for survival.

This strategy builds on the Englishman River Recovery Plan (Bocking and Gaboury 2001), focusing on specific projects and activities that will lead to the achievement of the recovery objectives outlined in the Plan. Development of the strategy was based on a scientific analysis and interpretation of historical and current conditions in the lower mainstem anadromous section and the influence of upper watershed conditions on current and future channel morphology and watershed processes in the lower river. Specifically, channel width and pattern were assessed using a time series of aerial photographs that ranged from 1949 to 2002. Conditions that are causing perturbations to watershed processes and channel characteristics were identified. Potential stability of the channel under its current condition was also assessed. The report outlines a strategy that logically prioritises and sequences protection and restoration measures to achieve restoration objectives and provides first order cost estimates to implement these measures.

Background Information

Based on DFO snorkel survey observations, all five pacific salmon species are found within Reaches E1 through E5 in the Englishman River (S. Baillie, DFO, unpubl. data; Table 1; Figure 1). Pink and chum are the most abundant salmon species that spawn in the river, followed by coho and chinook with only incidental occurrences of sockeye. Snorkel surveys by staff of BC Conservation Foundation (BCCF) have documented the distribution of adult steelhead from Englishman River falls (Reach E7) to Big Tent Run (located at most downstream bridge crossing; Reach E1), with the highest concentrations typically occurring in Reaches 3 and 4 (H. Wright, BCCF, pers. comm.).

Table 1. Summary of snorkel survey observations conducted between September 17 and November 2, 2001 from the Englishman River mouth to 13 km above the mouth (S. Baillie DFO, unpubl. data). The data are actual observations (not expanded for observer efficiency) of live, adult (non-jack) salmon and trout. Number of fish in each Reach was calculated to nearest 500 m section break from DFO survey.

Species	Reach E1	Reach E2	Reach E3	Reach E4	Reach E5
Chinook	417	2600	1366	12	224
Chum	1107	2907	3969	485	673
Coho	614	5125	1527	9	189
Pink	109	4828	4396	224	2390
Sockeye	0	9	12	0	5
Rainbow Trout	0	24	49	11	58
Cutthroat Trout	41	326	190	14	125

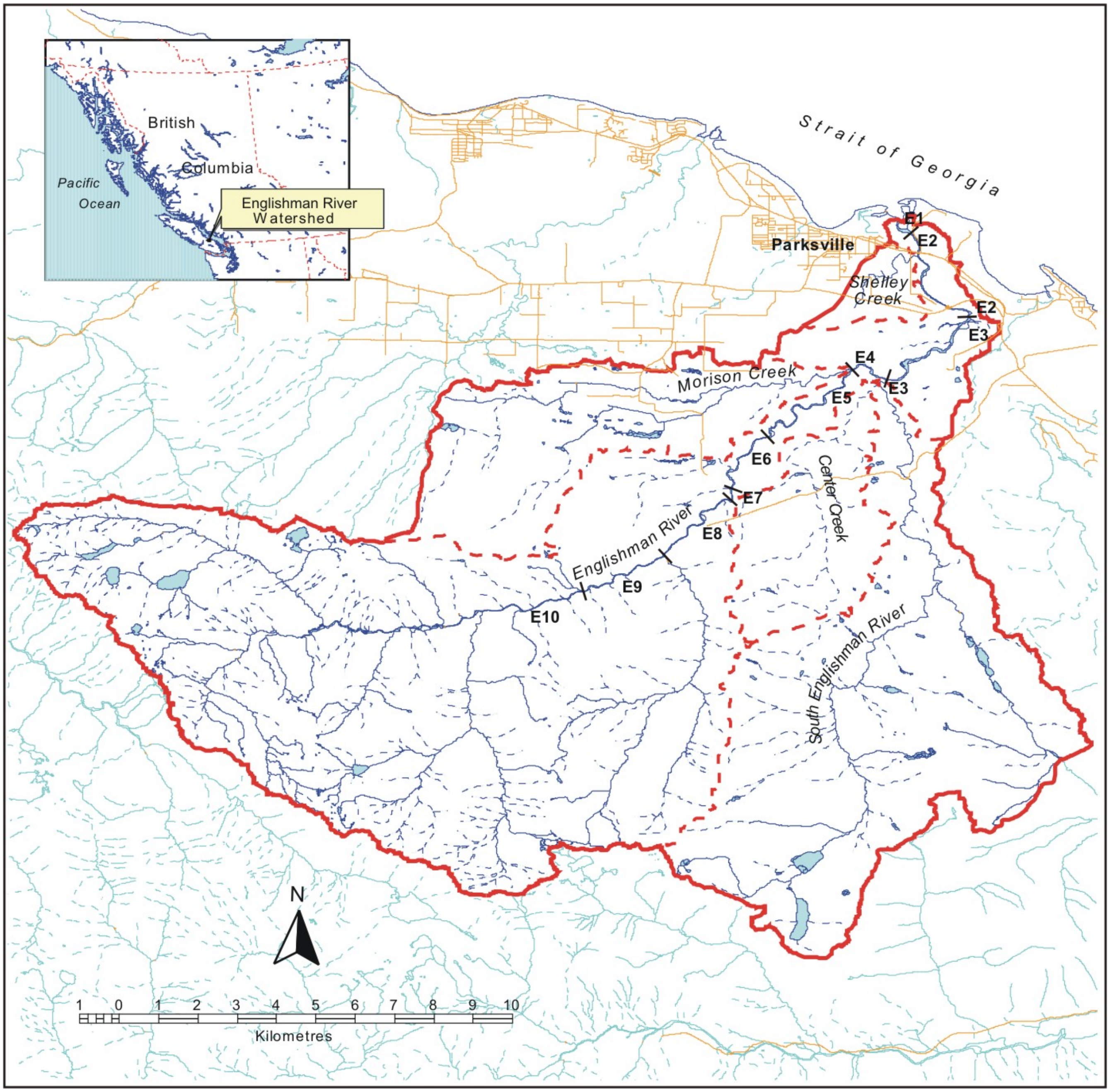

Figure 1. Index map of Englishman River watershed. Reaches for mainstem from nhc (2002). Note: The anadromous section extends up to Englishman River falls, at the head of Reach E7.

Coho and rainbow trout rearing in Reaches E2-E6 have been confirmed through electrofishing surveys by Lough and Morley (2002) (Table 2). From the brief surveys, Reach E3 tended to have higher abundances of coho fry while rainbow trout fry were fairly evenly distributed throughout the five reaches.

Table 2. Catch data from open site electrofishing (100 m sections) in Reaches E2-E6 of the Englishman River (raw data from Lough and Morley 2002).

Reach	Date (2001)	Species		
		Coho	Rainbow Trout	
			Fry	Parr
E2	Oct. 17	0	22	0
E2	Oct. 17	23	11	0
E3	Oct. 15	36	21	2
E3	Oct. 16	84	14	3
E3	Oct. 17	24	14	0
E4	Oct. 15	8	14	0
E4	Oct. 15	31	17	0
E5	Oct. 28	2	19	0
E5	Oct. 14	21	33	1
E5	Oct. 14	57	20	0
E6	Oct. 13	5	20	2
E6	Oct. 13	21	24	1
Total		312	229	9

Recently, three assessments have been completed that pertain to the mainstem. Overview assessments of channel condition by nhc (2002) and fish and fish habitat by Lough and Morley (2002) were conducted. In addition, Weyerhaeuser conducted a watershed assessment to identify impacts of past forest development activities on the condition of the streams and to provide guidance for a Prescription Team to develop management strategies for Weyerhaeuser's future forest operations in the Englishman River watershed (Higman et al. 2003). Lough and Morley (2002) and nhc (2002) concluded that the mainstem channel is considered to be overwidened with a limited number of high quality rearing pools, particularly in Reaches E3 and E4 (Lough and Morley 2002). The current status of the anadromous section of the Englishman River is regarded as being in a relatively poor condition. The authors indicated that although the river is showing signs of recovery in some reaches (i.e., evidenced by re-vegetation of the gravel bars), excessive bank erosion and lateral channel migration along with poor pool-riffle development continues to plague the river. These factors lower fresh water survival of salmonids and the quality of their rearing and spawning habitats.

From the watershed assessment of the Englishman River, Higman et al. (2003) found:

- major landowners are: 69% (22,488 ha) of Englishman River watershed (32,462 ha) owned by Weyerhaeuser, 18% owned by TimberWest, and 3% owned by the Crown;
- potential for peak flow increases from clearcut are low for most of Weyerhaeuser's land, with the exception of some headwater sub-basins;
- greatest concentration of sediment sources are in the upper (western) part of the watershed, partly due to its location in a wetter biogeoclimatic zone;
- 19% (23.4 km) of channel length within the basin is classified as alluvial Type A1. This type of channel is most sensitive to disturbance, with effects such as channel widening, sediment aggradation and loss of channel structure commonly found;

- increases in the amount of sediment deposited in the lower reaches and loss of bank stability as a result of logging in the riparian zones have likely aggravated channel instability in the anadromous reaches of the lower Englishman River;
- a significant component of the increase in sediment loading has been due to increased erosion of logged channel banks;
- riparian zone in virtually all of the areas checked during the assessment were second growth;
- natural levels of erosion resistance requires mature coniferous forest (~80 yr old);
- from the confluence of Morison Creek downstream to the mouth (Reaches E4 to E1- reach delineations as per this project), the alluvial mainstem shows continuous channel instability throughout the period of air photo record. Disturbances appear to stem from or have been greatly aggravated by;
  - historic logging of the banks in the reaches more than 50 yrs ago,
  - logging of alluvial reaches in upper Englishman (near Arrowsmith Creek confluence). The riparian forest along these reaches has not reached a natural condition of erosion resistance, and sediment yield from this reach continues to be much higher than natural levels,
  - sediment delivery in the mainstem from the upper basins (Basins 4, 0-A, 3),
- Large Woody Debris (LWD) is found in low gradient, low energy reaches but is scarce or absent throughout much of the stream system;
- LWD is an important component of streams, and functions by trapping sediments, protecting banks and channel beds from scour, and providing structure for fish habitat; and
- potential enhancement and restoration opportunities included;
  - remediate important point sources of sediment, such as slope failures, ineffective culverts, and unstable channels that aggravate problems identified in the downstream anadromous zone,
  - cooperate with restoration efforts underway as part of the Englishman River Recovery Plan, as identified in Bocking and Gaboury (2001),
  - speed the recovery of riparian zones, and
  - protect riparian zones when harvesting second growth to provide bank protection, overhead cover, and a LWD recruitment source to increase habitat diversity in stream channels.

Weyerhaeuser's Englishman River watershed assessment (Higman et al. 2003) states that the majority of headwater reaches lack LWD that would normally retain sediment and that this will likely be a long-term problem as the riparian forest is too young for new LWD recruitment. They confirm that as a result of logging, accelerated transport of sediment from upstream reaches has increased deposition below the anadromous barrier. A brief comment was sought from Weyerhaeuser on the watershed's current state of recovery by the Mid-Vancouver Island Habitat Enhancement Society. The following was received from G. Horel of Ostapowich Engineering Ltd., (one of the report authors of Higman et al. 2003) concerning whether the anadromous reaches are "in recovery" or not (http://www.mvihes.bc.ca/ERWRP/Eman%20E3-E4%20Coord%20meeting%20notes%20June%2027,%202003.doc).

> "With respect to the overall watershed condition, the watershed is trending toward recovery. Riparian forest along the disturbed alluvial reaches is becoming well advanced and seasonal erosion from these channel banks and bars is diminishing. There are still numerous sediment sources from the upper watershed (Middle Fork, Moriarty Creek and the upper Englishman)

> that deliver sediment to the Englishman River mainstem. A significant number of these sources are natural, and [restorative] works in the lower Englishman should take into account that normal peak seasonal bedload transport in the mainstem will always be quite high. Because there are extensive bars and glaciofluvial deposits in the alluvial reaches, very high sediment loads can be mobilized during extreme storm events. One of the consequences of this is that channel switching in the lower alluvial reaches can occur during extreme storms, and this has happened historically. Old channels are visible in these reaches. Some of these take overflow during peak flow events. In summary, the lower Englishman mainstem will always be subject to high bedload transport -- it is a natural behaviour in this watershed. As well, the main thread of the river can switch locations on the wide alluvial reaches during extreme storms."

Similar to the findings of Higman et al. (2003), nhc (2002) indicated that the main morphologic issues for the lower Englishman River within the anadromous section are lack of functioning LWD and sand and gravel deposition in pools and riffles. They surmised that "sediment transport would maintain the existing substrate condition for many years." Though not confirmed, their feeling was that most coarse sediment below the falls is coming from alluvial mainstem reaches in the upper watershed (as opposed to slopes and tributaries). They state that even if coarse sediment sources on slopes and tributaries are rehabilitated, decades would pass before stream substrate (i.e., steelhead overwintering habitat) improves due to the volume of sediment stored along the river and that is available for transport. They suggested bar stabilization in the mainstem reaches above the anadromous barrier, but made no suggestions for sediment management within the anadromous reach.

The initial position of various government personnel was documented through a field trip conducted in June 2003 (http://www.mvihes.bc.ca/ERWRP/Eman%20E3-E4%20Coord%20meeting%20notes%20June%2027,%202003.doc). Pertinent comments of the individuals attending the field trip are summarized as follows:

- Mel Sheng, Fisheries Biologist for the Department of Fisheries and Oceans (DFO), supports efforts to increase sediment trapping and gravel bar stabilization within the anadromous section. He suggested that this could be accomplished either through plantings or LWD "wind rowing" or both.
- Rick Guthrie, Professional Geomorphologist for the Ministry of Environment (MOE), suggested that such treatments should be done sparingly with an eye to ensure that flood flows continue to be accommodated within the channel and that gravel bar treatments do not put undue pressure on adjacent stream banks. Furthermore, he suggested that an overall stabilization strategy should be considered as a first step. For example, should restoration concentrate on unstable gravel bars or should it begin with upstream sediment sources and work downstream over several years.
- Craig Wightman, Fisheries Biologist for MOE, expressed urgent need for functioning LWD to increase parr rearing habitat (identified as limiting by Lough and Morley 2002). As steelhead are mainstem rearing, LWD offering cover in and adjacent to fast water habitats is ideal. There may be risk associated with installing LWD in this relatively unstable reach, but stock status warrants that some degree of risk should be acceptable. Site selection should be done to maximize success rate and longevity.

During the recent review process and in light of the status of Englishman steelhead, the ERWRP Steering Committee supported mainstem LWD projects to create fish habitat despite the associated risks of doing so in a relatively unstable channel. The group agreed that some sites would be more likely to erode behind installed LWD than others. In those cases, Russ Doucet (DFO) recommended rip rap groins being incorporated upstream of LWD to avoid the "end run" scenario as seen at the Parry's RV site.

Based on the opinions of the group as a whole, a number of objectives and tasks were suggested for the Englishman Restoration Strategy, including:

- A thorough, long term plan focused on restoring these reaches is required,
- Involve private forest companies and their plans for the upper watershed,
- Determine the watershed's current status and expected rate of recovery,
- Both fisheries agencies and PSEF/ERWRP need to work together to ensure the development of this strategy is funded, and
- The Restoration Strategy should include an implementation schedule and estimated costs for the protection and restoration activities.

Further discussion on the selection of appropriate reaches for concentrating restoration work activities occurred in January 2005 with Mel Sheng (DFO pers. comm.). Based on his interpretation of the aerial photo mosaics and apparent changes in channel alignments within the anadromous section of the Englishman River, Mel believed that Reaches E3 and E4 should be the primary and secondary reaches, respectively, targeted for restoration. He suggested that limited restoration works be undertaken in Reaches E1, E2 and E5-E6. He suggested that treatments within Reaches E3 and E4 potentially consider:

- bank stabilization and channel re-alignment for irregular meanders bends,
- LWD-boulder structures for instream cover in pools,
- intensive riparian or bio-engineering vegetation treatments along eroding streambanks (typically in conjunction with boulder and LWD bank stabilization spurs), and
- stabilization of the larger gravel bars that are chronic sources of sediment.

METHODOLOGY

Peak and mean monthly flow estimates were made using historical hydrometric data from Station 08HB002 for Englishman River near Parksville, as published by Water Survey of Canada (WSC) (2002). The analysis was based on mean daily flows recorded between 1913 and 2000. The estimates of the maximum daily peak discharges were computed using the Log Pearson III distribution. Discharges from seven other east Vancouver Island watersheds were computed for comparison to the Englishman River.

Air photos were obtained for six years; 1949, 1968, 1977, 1984, 1996 and 2002. Photo mosaics were prepared for each year for the Englishman River mainstem between the mouth and the anadromous fish barrier. The mosaics were printed at a 1:10,000 scale. The same reach breaks identified by nhc (2002) for Reaches E1 to E7 were used for this project. Channel boundaries were manually drawn onto the aerial photo mosaic for each year and then digitized. Channel boundaries included exposed or unvegetated gravel bars. Drainage areas, channel length and channel areas were calculated from the air photo mosaics using ArcView GIS. Average channel width was calculated for each Reach by dividing channel area by channel length.

Historic aerial photographs of the Englishman River watershed were compared to current aerial photography to assess changes in the condition, pattern and characteristics of the historical and existing channel, including the rate of channel migration at chronic bank erosion sites.

Topographical field surveys were conducted to obtain channel cross sections in Reach E3. Substrate size distributions at riffles and on gravel bars were determined using pebble counts (Wolman 1954).

RESULTS

Hydrology and Channel Characteristics

The drainage area of the Englishman River watershed is 325 km^2. Based on the period of hydrometric record, large floods occurred in 1979, 1980, 1981, 1983, 1986 and 1990 (Table 3). From the flood frequency analysis, peak and mean monthly flows were estimated for the downstream end of each of the seven anadromous reaches (Table 4). 2-year and 50-year maximum daily flows were estimated at 164 and 480 m^3/s, respectively for the Englishman River watershed at its mouth. The unit flood discharge with a return period of 50 years was calculated at 1478 $l/s/km^2$, which was quite similar to the estimate for Chemainus River (1426 $l/s/km^2$), Jump Creek (1590 $l/s/km^2$) and Nanaimo River near Cassidy (1329 $l/s/km^2$).

Historical Changes in Channel Characteristics

A comparison of channel length was made using the historic series of aerial photos (Table 5; Maps 1 to 7). Based on an analysis of aerial photos for the anadromous portion of the mainstem, Reach E3 showed the greatest change in channel length, having a length today (2002) about 20% shorter than it was in 1949. Most of the shortening in Reach E3 occurred by 1968 (Table 5). The loss of two large and two small meanders accounts for much of the shortening that occurred within Reach E3. Shortening of the channel decreased sinuosity (Table 6) and increased channel gradient (Table 7) in Reach E3 and appears to have contributed to increased streambed and bank erosion within this reach. Changes in sinuosity and gradient have been less dramatic in the other reaches downstream of the anadromous barrier.

The greatest change in average channel width was evident in Reaches E1 and E3 (Tables 8 and 9). For the other reaches, the average channel widths have not varied greatly for the six years of comparison. Differences in Reach E1 are attributed primarily to interpretation and mapping of the channel pattern through the estuary. In 1949, the channel was confined to a relatively narrow configuration with, it appears, a limited number of active distributaries. In later years, the photos show a similar main channel width through the estuary but with a higher number of active distributaries. This would suggest that increased sediment loads and deposition in the lower portion of Reach E1 after 1949 may have resulted in a wider delta and zone of active channels.

Reach E3 has shown the greatest change in average channel width since 1949, with an increase in width of 37 m in 1968 and even today (2002) is 28 m greater than the width in 1949. As average width measurements include gravel bars, the increase in average width in Reach E3 is primarily due to lateral migration of the channel. For example, erosion at primarily three meander bends caused the channel to shift laterally from 60 to 80 m between 1984 and 1996 (Maps 4 and 5). The cause of the channel instability is likely due to the increased gradient as a result of the channel being shortened by 727 m between 1949 and 1968. The instability evident in Reach E3 is of concern as this reach is the primary spawning and rearing area for anadromous fish within the Englishman River. As such, Reach E3 was the zone where much of the field work effort in this project was concentrated.

Table 3. Maximum instantaneous, and average daily maximum and minimum discharges for Englishman River at station 08HB002. Data from Water Survey of Canada (2002). Peak flood discharges for period of record shown in bold.

Year	Maximum Instantaneous (cms)	Month--Day	Average Daily Maximum (cms)	Month--Day	Average Daily Minimum (cms)	Month--Day
1979			387	12--17		
1980			**393**	12--26	0.633	9--19
1981			310	12--5	0.464	8--23
1982			197	12--3	0.494	9--3
1983			392	11--15	0.476	10--12
1984			269	1--4	0.418	8--31
1985			62.7	10--22	0.269	8--28
1986	426	2--24	259	1--18	0.292	9--19
1987	200	1--12	160	1--12	0.265	10--19
1988	228	1--14	109	1--14	0.268	9--14
1989	231	12--4	119	12--4	0.31	10--3
1990	**454**	11--23	310	11--23	0.216	8--29
1991	341	2--2	244	2--2	0.29	8--5
1992			241	1--30	0.252	8--16
1993	269	12--10	169	12--10	0.144	9--30
1994	324	3--2	234	3--2	0.338	9--2
1995	241	11--18	142	11--8	0.249	9--25
1996	182	2--18	111	2--18	0.208	8--28
1997	343	3--18	263	3--18	0.831	8--19
1998	351	12--13	215	12--13	0.17	9--7
1999	273	1--14	194	1--14	0.891	10--12
2000	125	10--20	73.9	10--20	0.665	9--28
2001	258	12--16	174	12--16	1.12	7--24
2002	313	1--7	226	1--7	0.973	11--5
2003	312	3--13	256	3--13	1.02	7--21
2004	251	12--10	114	12--10	1.15	9--7

Table 4. Summary of return period maximum daily and mean monthly discharges for the Englishman River. Data from Water Survey of Canada (2002).

Gauge	Station Name	Years	No. of Years	Area (km^2)	Unit Discharge ($l/s/km^2$) Mean Annual	2 yr	10 yr	25 yr	50 yr	Max	Average Monthly Discharge ($l/s/km^2$) January	February	March	April	May	June	July	August	September	October	November	December
08HA001	Chemainus River near Westholme	1914-17, 1952-99	52	355	54	642	1088	1287	1426	1513	101	90	72	63	42	20	8	3	5	35	97	116
08HB041	Jump Creek at the Mouth	1970-94	25	62.2	75	951	1431	1540	1590	1752	119	129	95	64	64	39	21	19	19	56	135	143
08HB003	Haslam Creek near Cassidy	1914-15, 1949-62, 1993-98	22	95.6	44	325	633	717	758	681	75	76	51	62	39	15	5	3	5	35	75	85
08HB005	Nanaimo River near Extension	1913-27, 1948-64	32	645	63	693	1281	1634	1921	1938	101	99	60	71	61	37	15	7	15	58	102	125
08HB034	Nanaimo River near Cassidy	1965-1999	35	684	58	618	1041	1215	1329	1146	104	95	79	58	49	29	13	9	12	44	98	113
08HB029	Little Qualicum River near Qualicum Beach	1960-1986	27	237	51	379	732	911	1043	1084	87	77	60	47	49	35	18	9	12	40	78	94
08HD011	Oyster River below Woodhus Creek	1973-1999	27	298	47	409	693	787	841	872	59	52	44	52	71	64	32	14	11	36	73	60
08HD005	Quinsam River near Campbell River	1956-1999	44	280	31	217	408	513	595	779	53	50	42	28	22	16	10	8	11	24	49	61
08HB002	Englishman River near Parksville	1913-2000	29	324	42	504	1082	1323	1478	1213	76	77	53	42	34	22	10	4	5	27	75	85
	Mean of All Gauges Above				52	526	932	1103	1220	1220	86	83	62	54	48	31	15	9	11	39	87	98
Gauge	Station Name	Years	No. of Years	Area (km^2)	Discharge (m^3/s) Mean Annual	2 yr	10 yr	25 yr	50 yr	Max	Average Monthly Discharge (m^3/s) January	February	March	April	May	June	July	August	September	October	November	December
08HA001	Chemainus River near Westholme	1914-17, 1952-99	52	355	19.3	228	386	457	506	537	35.7	32.1	25.4	22.4	15.0	7.1	2.7	1.2	1.8	12.5	34.3	41.1
08HB041	Jump Creek at the Mouth	1970-94	25	62.2	4.7	59	89	96	99	109	7.4	8.0	5.9	4.0	4.0	2.4	1.3	1.2	1.2	3.5	8.4	8.9
08HB003	Haslam Creek near Cassidy	1914-15, 1949-62, 1993-98	22	95.6	4.2	31	60	69	73	65	7.2	7.3	4.9	5.9	3.7	1.4	0.5	0.3	0.5	3.3	7.2	8.1
08HB005	Nanaimo River near Extension	1913-27, 1948-64	32	645	40.4	447	827	1054	1239	1250	64.9	63.9	39.0	46.0	39.5	24.0	9.4	4.2	9.6	37.7	65.9	80.8
08HB034	Nanaimo River near Cassidy	1965-1999	35	684	40.0	422	712	831	909	784	70.9	65.2	54.1	39.5	33.4	19.5	8.9	6.0	8.3	29.8	67.2	77.0
08HB029	Little Qualicum River near Qualicum Beach	1960-1986	27	237	12.0	90	174	216	247	257	20.6	18.2	14.3	11.2	11.7	8.4	4.3	2.1	2.9	9.4	18.4	22.2
08HD011	Oyster River below Woodhus Creek	1973-1999	27	298	14.1	122	207	235	251	260	17.5	15.4	13.2	15.4	21.1	19.0	9.6	4.3	3.4	10.6	21.8	17.8
08HD005	Quinsam River near Campbell River	1956-1999	44	280	8.7	61	114	144	167	218	14.8	14.0	11.7	7.8	6.1	4.4	2.8	2.3	3.2	6.6	13.6	17.0
08HB002	Englishman River near Parksville	1913-2000	29	324	13.7	163	351	429	479	393	24.6	24.9	17.3	13.5	11.1	7.0	3.1	1.3	1.5	8.8	24.4	27.4
Estimate for Englishman River Reaches (based on Gauge 08HB002 only)		Reach E1		325	13.8	164	352	430	480	394	24.7	25.0	17.4	13.5	11.1	7.0	3.1	1.3	1.5	8.8	24.5	27.5
		Reach E2		324	13.7	163	351	429	479	393	24.6	24.9	17.3	13.5	11.1	7.0	3.1	1.3	1.5	8.8	24.4	27.4
		Reach E3		317	13.4	160	343	420	468	385	24.1	24.4	16.9	13.2	10.9	6.8	3.0	1.3	1.5	8.6	23.9	26.8
		Reach E4		308	13.1	155	333	408	455	374	23.4	23.7	16.4	12.8	10.6	6.7	2.9	1.2	1.4	8.4	23.2	26.0
		Reach E5		166	7.0	84	180	220	245	201	12.6	12.8	8.9	6.9	5.7	3.6	1.6	0.7	0.8	4.5	12.5	14.0
		Reach E6		163	6.9	82	176	216	241	198	12.4	12.5	8.7	6.8	5.6	3.5	1.6	0.7	0.8	4.4	12.3	13.8
		Reach E7		150	6.4	76	162	199	222	182	11.4	11.5	8.0	6.3	5.1	3.2	1.4	0.6	0.7	4.1	11.3	12.7

Table 5. Comparison of historic trends over six years: 1949, 1968, 1977, 1984, 1996 and 2002 in overall channel length for Englishman River mainstem between Reaches E1 (mouth) and E7 (anadromous barrier).

Year	E1	E2	E3	E4	E5	E6	E7	Total Channel Length (m)
1949	669	3537	4275	1254	4177	2374	452	16738
1968	709	3521	3544	1291	4077	2359	433	15934
1977	728	3535	3585	1270	4220	2347	436	16121
1984	759	3553	3418	1263	4132	2348	423	15896
1996	749	3484	3479	1246	4214	2353	469	15993
2002	751	3495	3505	1233	4187	2358	460	15989

Table 6. Historic trend in sinuosity for Englishman River mainstem between 1949 and 2002.

Year	E1	E2	E3	E4	E5	E6	E7
1949	1.12	1.22	1.45	1.52	1.39	1.22	1.13
1968	1.18	1.21	1.20	1.56	1.35	1.21	1.08
1977	1.21	1.22	1.22	1.54	1.40	1.20	1.09
1984	1.27	1.23	1.16	1.53	1.37	1.20	1.06
1996	1.25	1.20	1.18	1.51	1.40	1.21	1.17
2002	1.25	1.21	1.19	1.49	1.39	1.21	1.15

Table 7. Historic trend in gradient (%) for Englishman River mainstem between 1949 and 2002.

Year	E1	E2	E3	E4	E5	E6	E7
1949	0.30	0.45	0.49	0.64	0.79	1.18	1.13
1968	0.28	0.45	0.59	0.62	0.81	1.19	1.08
1977	0.27	0.45	0.59	0.63	0.78	1.19	1.09
1984	0.26	0.45	0.61	0.63	0.80	1.19	1.06
1996	0.27	0.46	0.60	0.64	0.78	1.19	1.17
2002	0.27	0.46	0.60	0.65	0.79	1.19	1.15

Table 8. Trend in average channel width of the Englishman River mainstem between 1949 and 2002. Channel width includes exposed gravel bars. Bold indicates maximum width in each reach.

Year	E1	E2	E3	E4	E5	E6	E7
1949	37	23	44	26	27	22	25
1968	61	32	**82**	28	**35**	26	24
1977	**75**	31	59	22	26	28	28
1984	60	30	55	23	29	**29**	25
1996	55	31	66	28	23	25	**31**
2002	53	**35**	72	**37**	29	28	29

Table 9. Maximum change in average channel width for Englishman River mainstem Reaches E1 to E7 over the six years of air photo analysis. Channel width includes exposed gravel bars.

Reach	Average Width (m)		Difference (Max-Min)
	Minimum	Maximum	
E1	37	75	38
E2	23	35	12
E3	44	82	38
E4	22	37	15
E5	23	35	12
E6	22	29	7
E7	24	31	7

The following provides a general overview of channel characteristics of Reach E3 based on field survey data and describes some potential causes of channel instability in this reach. Several cross sections were surveyed in the Reach E3 (Appendices 1-4). Existing bankfull width measurements ranged from 31.9 to 49.5 m with an average of 38.3 m (Table 10). This measured bankfull width is significantly smaller that the average channel width of 72 m based on air photo interpretation (Table 8). The reason for this difference was that channel width from the air photos was calculated from the total channel area divided by channel length. The margins delineating the channel area included the active or frequently inundated channel which encompassed gravel bars with little or no vegetation apparent on the air photos.

Existing mean bankfull depth ranged from 0.69 to 1.51 m with an overall average of 1.06 m. Expected bankfull width and depth, based on relationships between these variables and drainage area, are about 35-45 and 1.6-1.8 m, respectively (Newbury et al. 1997). Therefore, the bankfull widths from the surveyed cross sections indicate that the active channel is not over-widened, but the bankfull depths indicate the Reach is shallower than is found in natural streams. As a consequence, the width to depth ratios within Reach E3 range from 26 to 61:1. Width to depth ratios of natural channels are typically 10:1 to 15:1 (Newbury and Gaboury 1993). However, it is important to note that the cross section dataset in Table 10 is biased to cross section surveys of riffle crests, which would tend to lower the mean bankfull depth. As noted by nhc (2002) and Lough and Morley

(2002), the mainstem suffers from a lack of deeper pools, attributed to the high sediment loads in-filling pool habitats. Consequently, the shallow water depth appears to be the factor that has caused the high width to depth ratio in Reach E3.

Entrenchment ratio (Doll et al. 2003) provides a measure of channel incision. Entrenchment ratio is the width of flood prone area (i.e., channel + floodplain to an elevation of 2 x D_{max}) divided by bankfull width. An entrenchment ratio of <1.4 indicates an incised channel. Streams with a well developed floodplain (entrenchment ratio > 2.2) should have flows greater than bankfull conveyed on the floodplain (Bohn 1998). The entrenchment ratio for the two surveyed cross sections in Reach E3 adjacent to large gravel bars was calculated at >4.4 indicating that the channel is not incised.

Table 10. Summary of wetted (30 September 2002; 18 August 2005) and bankfull channel measurements for each surveyed cross section in Reach E3. Site chainages measured from downstream end of Reach E3.

Site (m)	Date	Wetted		Bankfull				Depth to Top of Bank	Bank Height Ratio (D_{TOB}/D_{max})
		Width (m)	Depth (m)	Width (m)	Mean Depth (m)	Maximum Depth (m)	Width to Depth Ratio		
1+558	18-08-2005	21.5	0.28	35.9	0.69	1.16	52.0	1.24	1.07
1+575	18-08-2005	26.9	0.25	32.0	0.75	1.19	42.9	1.86	1.56
2+250	30-09-2002	30.7	0.31	37.0	1.24	1.58	29.9	1.73	1.09
2+325	18-08-2005	25.4	0.42	31.9	0.85	1.43	37.4	2.16	1.51
2+433	18-08-2005	37.7	0.24	45.7	0.75	0.99	60.8	1.65	1.67
2+490	30-09-2002	13.3	0.60	35.4	1.38	1.94	25.7	2.64	1.36
2+525	30-09-2002	23.8	0.61	38.7	1.29	2.03	30.1	2.14	1.05
3+380	30-09-2002	25.1	0.30	49.5	1.51	1.98	32.7	3.48	1.76
Mean		**25.6**	**0.38**	**38.3**	**1.06**	**1.54**	**39.0**	**2.11**	**1.38**

Note: Discharge on 30 September 2002 was 1.38 cms and on 18 August 2005 was 1.85 cms.

Bank height ratio is the depth of the channel to the top of the bank divided by the maximum bankfull depth. Bank height ratios of >1.0 indicates increasing channel incision. As bank height ratio increases above 1.0, the channel becomes more incised. For Reach E3, BHR ranged from 1.05 to 1.76 with an average of 1.38. Although some sections of the Reach are incised, overall it appears the river morphology provides ample opportunity for floodwaters to access the floodplain.

Bed paving materials were measured at chainages 1+558, 2+250 and 2+433 m (Appendices 5 and 6). Measurements were taken on the downstream face of three riffles, between the water surface and bankfull elevation, and on the gravel bars. Median (50%) diameter (D_{50}) for the existing bed material on the riffles varied between 13 and 21 cm, and D_{50} on the gravel bars ranged from 10 to 11 cm. At a bankfull discharge of 160 m^3/s, bankfull channel width of 35.9 (1+558 m cross section), estimated mean depth of flow of 1.38 m and an average gradient of 0.6%, the tractive force was calculated at 8.3 kg/m^2. At this depth of flow, the shear stress in the channel will dislodge substrate <8.3 cm in diameter. This analysis suggests that about 80-100% of the substrate paving the downstream face of riffles would be stable at bankfull discharge. Appendices 5 and 6 show that the size of paving substrate on riffles increases from 13 cm at 1+558 m to 20-21 cm further upstream at 2+250 and 2+433 m, respectively, in Reach E3 and then to 32 cm in Reach E4 (Gaboury 2003). This suggests that the riffles in the upper section of Reach E3 and E4 are more stable than those in the lower section of Reach E3. Estimation of the tractive force in those cross sections where flood flows would be contained within the main channel indicates that for a 10 yr recurrence interval flood of about 343 m^3/s, where the depth of flow would be approximately 2.2 m, the substrate size in incipient motion (i.e., the point at which the shear stress exerted by the flow causes the individual particle to begin moving) would be 13 cm. Similarly, for a 50 yr flood of about 468 m^3/s (Table 4) with a flow depth of 2.6 m, substrate size in incipient motion would be 16 cm. For $\geq$10 yr floods, it is evident that the riffles in the upper section of Reach E3 would be relatively stable but >50% of the paving substrate on the riffles in the lower section downstream could be dislodged.

Soil survey mapping indicates that most of the reaches of the lower Englishman River are dominated by soils classified as ‘Qgls’ representing brown podzolic soils comprised of loamy sand and gravelly loamy sand that ranges from few stones to excessively cobbly and stony (Figure 2). Based on the aerial photo history, it appears that this soil type of coarser materials with a higher cobble and stone composition has provided relatively stable streambanks and reduced the rate of lateral migration for most of the mainstem reaches. However, the left bank of Reach E3, into which most of the lateral migration has occurred, is composed of alluvial material classified as ‘Cagls’ and representing alluvial soils comprised of gravelly loamy sand that is stone free to moderately stony.

The elevation where the alluvial material in Reach E3 occurs coincides with an ‘old shoreline terrace’ at the 100 ft level on the east coast of Vancouver Island (Figure 3). This suggests that, historically, during the period when the glaciers were receding, a delta of the Englishman River was present in Reach E3 and alluvium was deposited for some time in this location. The predominance of sands and silts that comprise these alluvial materials offers limited protection from the erosive power of flood flows and these soil materials appears to have contributed to the instability of the left bank in Reach E3. The extent of channel instability and lateral migration that is evident in Reach E3 from the time series of aerial photomosaics appears similar to that observed in channels on alluvial fans that have been extensively logged. It is likely that the greater degree of channel instability observed in Reach E3, in comparison to the other reaches, is due primarily to the finer alluvial substrates present and the re-working of these substrates during extreme floods. Furthermore, it is believed that channel instability was initiated after logging of the riparian zones and further exacerbated from hydrological changes (i.e., larger peak discharges) from upstream logging and sediment inputs to this reach from upstream sources. It should be noted, however, that the presence of these alluvial sediments is likely responsible for the observed concentrations of salmon and trout in Reach E3, as these sediments constitute excellent spawning substrates.

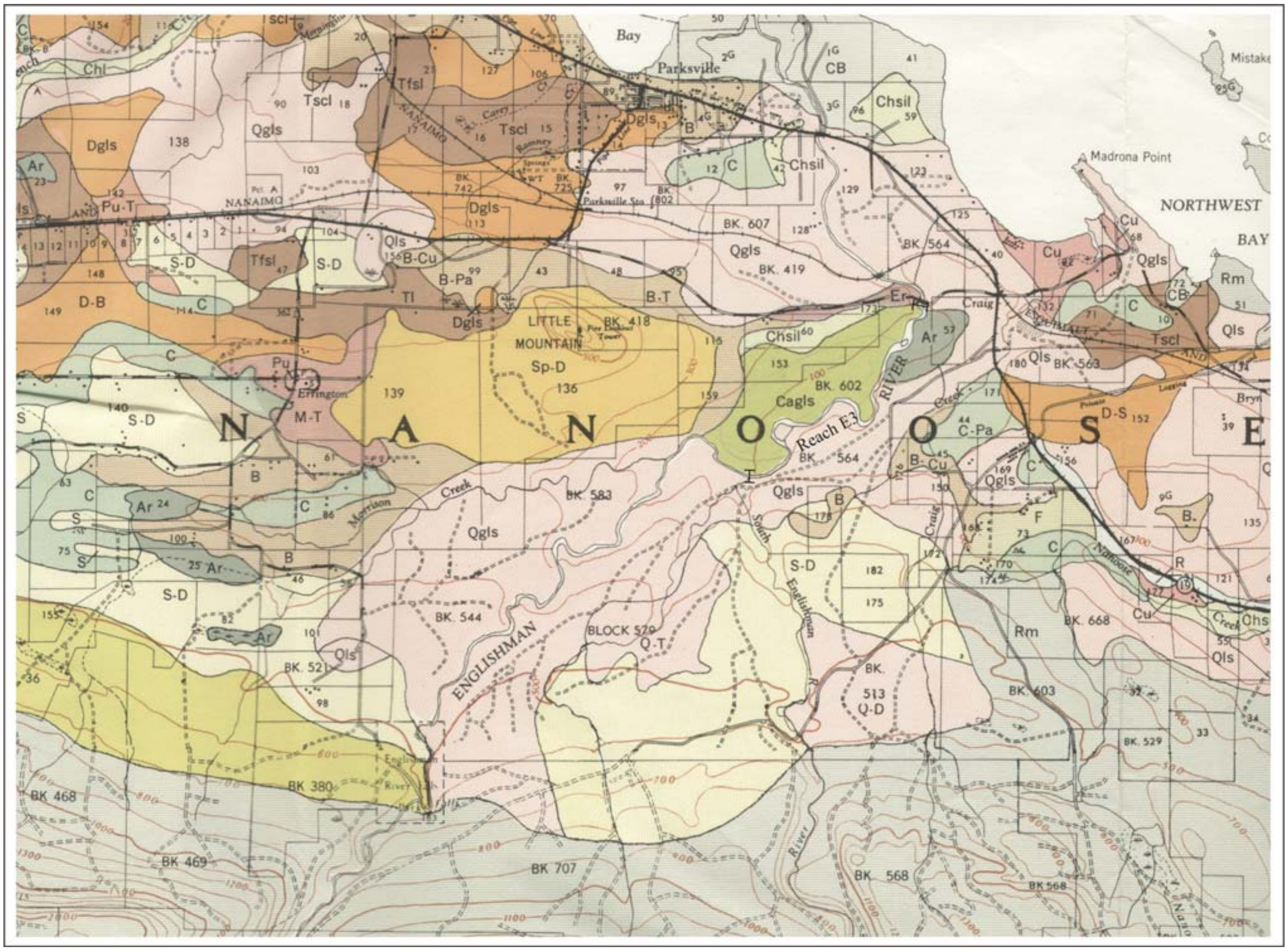

Figure 2. Soil map of lower Englishman River. Classification ‘Cagls’on left bank of Reach E3 (Block 602) represents alluvial soils comprised of gravelly loamy sand that is stone free to moderately stony. Classification ‘Qgls’ on right bank of Reach E3 (Block 564) represents brown podzolic soils comprised of loamy sand and gravelly loamy sand that ranges from few stones to excessively cobbly and stony. Modified from Soil Survey of Southeast Vancouver Island and Gulf Islands, British Columbia (Day et al. 1959).

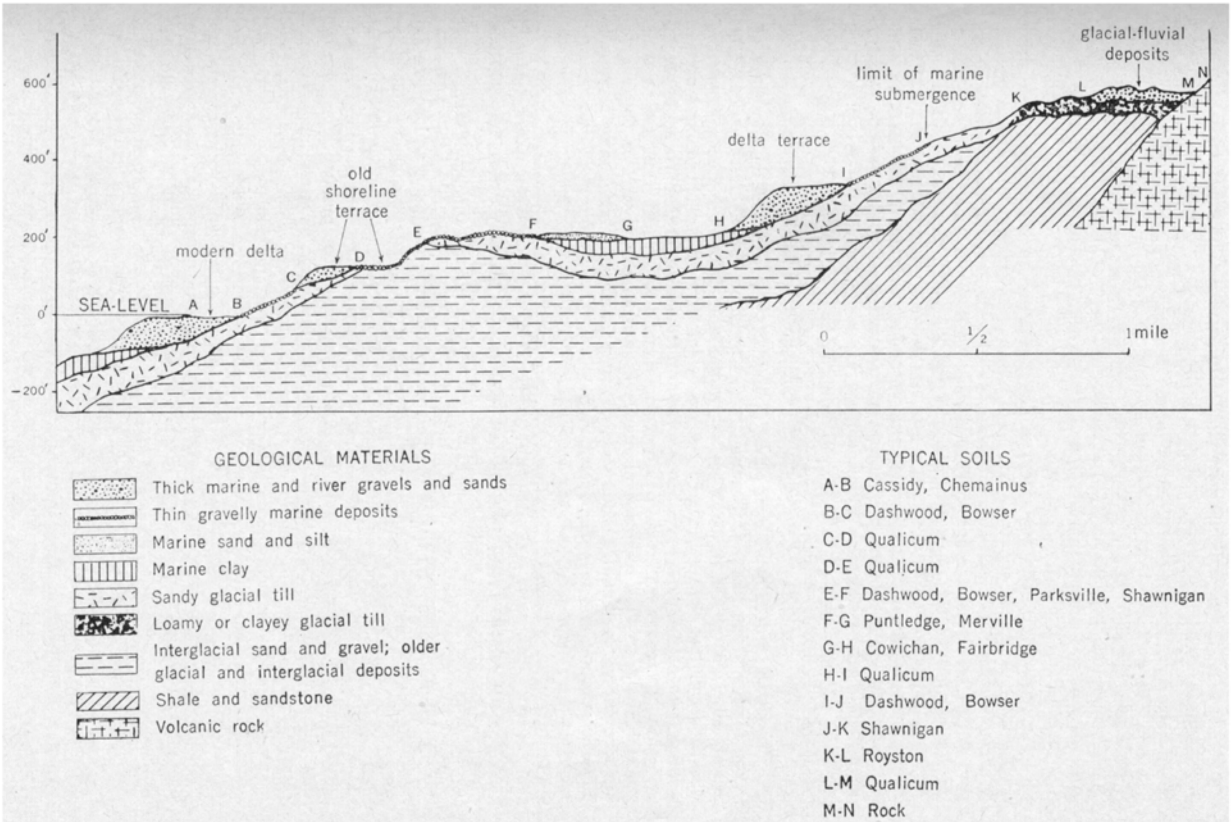

Figure 3. Diagrammatic vertical section showing materials beneath the eastern coastal lowland of Vancouver Island. Geological relations are typical of the country between Campbell River and Lantzville. Limit of marine submergence for Englishman River estimated at 475 ft. Reproduced from Soil Survey of Southeast Vancouver Island and Gulf Islands, British Columbia (Day et al. 1959).

PROTECTION AND RESTORATION STRATEGY

Priorities

The primary goal for the implementation of this strategy is to first protect the current integrity and productivity of the existing habitat into the future by identifying sensitive ecosystem components and sensitive areas, and by recommending or implementing measures to ensure that land and water use activities do not have detrimental effects on these components and sensitive areas. The secondary goal is to implement measures that will hasten the restoration of ecosystem components and processes to a condition that maintains high quality instream and riparian habitats.

Some of the identified projects require additional focused assessments, followed by topographical surveys and the preparation of restoration designs prior to implementation. Other projects have conceptual designs prepared but should undergo a final review and confirmation from key stakeholders prior to proceeding to the final survey and design stage. Many of the potential habitat actions will require cooperative working relationships with private landowners, particularly forest companies.

The following sections provide a brief description and rationale for the proposed protection and restoration actions, primarily relating to the Englishman River mainstem. This report does not specifically address the level of disturbances in the Englishman River tributaries or the downstream effects of these disturbances in the mainstem. Specific remedial measures for the tributaries should be identified based on intensive assessments in an approach similar to that taken for Centre Creek by Warttig and Clough (2004). The EWRP Technical Committee should then prioritize and dovetail the tributary priorities into the protection and restoration priorities for the mainstem, as described below.

The protection and restoration measures, in order of priority, identified for the Englishmen River mainstem are as follows:

1. Improved flow management from Arrowsmith Dam;
2. Securement of riparian corridor;
3. Bank stabilization in Reach E3;
4. Riparian treatments in Reach E3;
5. Stabilization of chronic sediment sources in upper watershed affecting mainstem and tributaries;
6. Off-channel development in Reach E3;
7. Assessment of ‘clay bank’ in Reach E3;
8. Riparian treatments in Reaches E4, E2, E5 and E6;
9. Construction of instream habitat structures in Reach E5; and
10. Biophysical assessment of estuary and development of management plan to protect and improve function and effective area.

<u>Improved Flow Management</u>

The Englishman River basin is subject to chronic low discharges during the summer which limits the quality and quantity of functional rearing habitat for salmonids (Lough and Morley 2002). Low discharges in the lower mainstem were believed to have been exacerbated by a loss of discharge through percolation into the streambed (nhc 2002). In a study evaluating streamflow measurements along the length of the mainstem downstream of the anadromous barrier, these losses were confirmed to be insignificant (Wright 2003).

Flow supplementation to the Englishman River mainstem from Arrowsmith Lake reservoir has occurred since 1999. The water licence for the reservoir stipulates that releases from Arrowsmith Dam should maintain a minimum discharge of 1.6 cms or about 10% of mean annual discharge (MAD) at the 19A Highway bridge between 1 June and 31 October. Assessments by BCCF staff suggested that refinements to the operational rules for Arrowsmith Dam releases are required. As recommended by Rosenau and Angelo (2003), a more appropriate “rule curve” (i.e., guidelines for releasing water) has been developed recently by representatives from DFO, the provincial government and Arrowsmith Dam licensees that improves flow management, including both discharge rates from the Dam and the timing of those releases. The most significant change under the revised rule curve is that water is not released from Arrowsmith Lake reservoir beginning June 1 unless a minimum discharge of 1.6 cms is reached at the 19A Highway bridge. Continued monitoring and refinement of these flow management guidelines are recommended. Furthermore, the water supply intake currently located downstream of the Highway 19A bridge ensures that a minimum discharge is maintained in the river essentially up to tidal influence. It is recommended that this intake location not be moved further upstream unless a minimum discharge of 1.6 cms up to the present intake location can be maintained and is stipulated as a condition in a new water licence agreement.

Opportunities to provide more water storage within the watershed should be investigated. Two potential candidate waterbodies, located in the upper South Englishman River, are Shelton Lake and Healy Lake, which have surface areas of 36 and 29 ha, respectively. If suitable sites are found, a collaborative funding arrangement should be pursued with all interested parties for the construction of a storage dam. Entrenched into the water licence agreement should be conditions which ensure preferred flows to maintain aquatic habitat in South Englishman River and Englishman River mainstem.

Securement of Riparian Corridor

Protection of critical riparian habitats should be pursued within the Englishman River mainstem. Protection initiatives, particularly the securement of the riparian corridor, should be spearheaded for Reaches E1 to E7. Significant portions of riparian corridors in the Englishman River mainstem and its tributaries have been secured into the public trust through purchase or conservation agreements, which offers long-term protection of the riparian vegetation. For example, the estuary, the left and right banks of Reach E3, the left bank of Reaches E4-E7, and the lower Morrison are owned and/or managed by BC Nature Trust, RDN or the provincial government (Map 8). More riparian land should be secured between the mouth and the anadromous barrier through either purchase or conservation agreements. The priorities for land securement, in order of priority, include: right bank of Reaches E4, E5 and E6, left bank of E1 and the left and right banks of Reach E2. The securement of the left bank in Reach E1 is associated with potential development of rearing habitats within the estuary (Mel Sheng, DFO pers. comm.).

In cooperation with private land owners, land parcels along either side of the river could be opportunistically purchased or secured through conservation agreements to provide protection for the riparian corridor and channel over the long term. Working with private land owners and forest managers to protect small pockets of riparian habitats is a start toward ensuring that watershed integrity will be preserved.

Bank Stabilization in Reach E3

The priority for restoration works will be to stabilize streambanks vulnerable to continued erosion in Reach E3. Bar vegetation within Reach E3 has become well established which may result in greater flow resistance at high flood discharges, potentially increasing water levels in the main channel and, therefore, increasing erosion of the vulnerable left bank. Two banks are of most concern, labelled as Site A and Site C on Map 9. Each bend is approximately 250 m long, for a total of 500 m. LWD structures that primarily provide instream cover have been constructed over the past three years at these two meander bends. Structure spacing and high porosity prevents these LWD structures from providing substantial bank protection. The LWD structures function only partially as bank protection structures because of the short projection length (note: projection length measured from bankfull elevation on the streambank to instream tip of non-porous portion of the structure) and current structure spacing of 3-6 times their projection lengths. Additional rock groins, LWD structures or rock deflector vanes could be installed at a spacing of 2-3 times the projection length between the structures on two meander bends. Also, additional riprap could be placed on the upstream leading edge of the LWD structures, where needed, to decrease porosity and increase the functional projection length for bank protection. The recommended restoration treatments to stabilize these two meander bend streambanks are:

1. Increase the functional projection length of the existing structures to about 8-9 m by adding more riprap to the upstream leading edge and core of each LWD structure, and
2. Where current spacing of the LWD structures is >20, construct another LWD structure in between, thereby maintaining a projection length of 8-9 m.

Nine additional LWD structures could be added to Sites A and C by placing one structure between each of the existing structures where the current spacing is >20 m. Five additional structures should be placed at Site A and four at Site C. For each LWD structure, rock should be placed within the core to decrease porosity and ensure a projection length of 8-9 m. The resultant spacing of the structures would be approximately 2-3 times the projection length, ensuring a higher level of bank protection. The riprap should be placed to a bankfull height and could include a launching apron at the toe to protect to the depth of scour.

At Site B, the projection length of the existing structures should be increased to at least 7 m using riprap. Two additional LWD structures would be required to maintain a spacing of <4 times projection length between structures. Site B appears to migrating laterally at a slower rate than sites A and C and therefore a spacing of 4 times projection length would be appropriate. In addition, it is recommended that logs be placed vertically, extending well above the downstream end and highest point in the structure, to enhance the trapping and retention of woody debris on these structures during extreme flood events.

An additional option to further enhance bank protection would be to provide riprap toe protection between each of the LWD structures along with soil wraps. Riprap would be placed from the toe of the bank up to the bankfull elevation and would include a launching apron in the thalweg. Prior to placing the riprap, the bank below bankfull elevation would be re-sloped to a 2 to 1 slope using river cobbles and gravels. The 1-1.5 m high soil wrap treatment would be constructed above the riprap toe protection up to the 1 in 50 year flood level or the top of the banks, whichever is less.

Riffle structures are often applied as a remedial measure in channelized streams where gradients have increased as a result of channel shortening. The riffle structures help to stabilize the channel by providing gradient control and, thus, reducing bed and bank erosion. Four existing rapids in the section of channel between Sites A and C should be covered with larger boulders to provide some backwatering of the meander bends. A higher crest for the rapids and larger boulders placed on the downstream face will help to reduce scour of the rapids during floods, especially the rapids with relatively small substrate size in the lower sections of Reach E3. These measures on the existing rapids will concentrate some the fall within this shortened reach on more stable rapids and locally raise water surface elevations during floods resulting in a shallower average depth over a wider cross section of flow and also a higher frequency of gravel bar / floodplain inundation. These hydrological effects from riffle enhancement will help to reduce bank erosion. In addition, riffles would raise the water table locally, benefiting the proposed willow plantings along the base of eroding banks.

Riparian Treatments in Reach E3

Poulin (2005) has recommended riparian treatments for Reach E3 (see Poulin 2005 for location of polygons). The treatments that would hasten the recovery and stabilization of the streambanks and gravel bars should be undertaken, in order of priority, as follows:

Polygon	Left or Right Bank	Treatable Area (ha)	Treatment
13c	Left	1.5	Cottonwood release/collection
13d	Right	0.8	Cottonwood release/collection
8	Right	1.5	Cottonwood release/collection
13b	Left	3.8	Uniform thinning/conifer release

Revegetation of eroding banks, particularly in Reach E3, should occur at existing and proposed instream LWD structure sites. Willow and alder are beginning to colonize the streambank area between the existing structures at Sites A and C. Additional willow should be planted between the top of the bank and low water surface at LWD structure sites. Poulin (2005) recommended three techniques to establish vegetative cover around the LWD structures using cottonwood and shrubs. The techniques included palisades, live stakes and brush layering. Specifications and methods of these revegetation techniques are outlined in Poulin (2005), Polster (2002) and Muhlberg and Moore (2005).

Off-channel Development in Reach E3

The lack of over-winter refuge in the Englishman River mainstem appears to be a major factor that undermines total survival and smolt production (Lough and Morley 2002). Considering the loss of channel length and apparent instability in Reach E3, it is appropriate to expand on the amount of stable spawning, summer rearing and overwintering habitat. To date, two existing off-channel habitats within Reach E3 have been effective at providing stable and productive rearing / spawning habitat for coho, chum and pink salmon and steelhead. A potential high quality off-channel habitat has been identified on the left bank of Reach E3 in Block 602, which would expand on the existing ‘TimberWest’ side channel by 3.5 km at a cost of about $300K. Preliminary conceptual designs for the side channel expansion have been prepared by DFO (Mel Sheng, DFO pers. comm.). Topographical surveys should be conducted and a side-channel design should be prepared for construction. Works should be constructed once final design drawings are prepared and approved.

Assessment of Clay Bank in Reach E3

The clay bank located 150 m downstream of the confluence with the South Englishman River was identified as a potentially significant source of sediment to the river. From the preliminary analysis of the aerial photo mosaics, it appears that migration of the channel into the clay bank has occurred at a rate of about 0.6 m per year. This rate suggests that it may not be a significant sediment source to the river. However, further assessment of the rate of erosion and an estimate of sediment contribution should be undertaken in a detailed study. The study should include:

1. An assessment of the clay bank site by a geotechnical engineer;
    a. to determine the composition and stability of the bank,
    b. to quantify the rate of channel migration and average annual volume of sediment generated, and

   c. to provide predictions on the future stability of the clay bank site,
2. An environmental assessment to quantify impacts on fish and aquatic fauna from the current rate of bank sloughing;
3. Field investigations by a river engineer specializing in bank protection to assess the feasibility of stabilization / flow realignment options;
4. If stabilization is deemed feasible, topographic surveys of the clay bank site and the development of a detailed bank stabilization design; and
5. If restoration works are constructed, a monitoring program should be initiated to determine the effectiveness of prescribed treatments.

<u>Riparian Treatments in Reaches E4, E2, E5 and E6</u>

Poulin (2005) has recommended riparian treatments for Reach E4 (see Poulin 2005 for location of polygons). The treatments that would hasten the recovery and stabilization of the streambanks and gravel bars should be undertaken, in order of priority, as follows:

Reach	Polygon	Left or Right Bank	Treatable Area (ha)	Treatment
E4	13a	Left	3.2	Uniform thinning (No treatment of Mature Forest conifer /mixed edge)
E4	15	Left	2.6	Conifer release/cottonwood release & thinning
E4	14	Right	1.2	Conifer release (girdle DrMb)

Riparian assessments and prescriptions should be undertaken on Reaches E2, E5 and E6. Treatments should be prioritized for implementation based primarily on potential improvements to bank integrity and secondarily in providing a source of functional LWD to mainstem habitats.

<u>Stabilization of Chronic Sediment Sources in Upper Watershed</u>

Historical land use activities, in particular riparian logging, that occurred in the upper portion of the Englishman River watershed are believed to have negatively affected downstream fish habitat (Higman et al. 2003; Lough and Morley 2002). Critical areas in the upper portions of each basin that are (or have the potential) to contribute coarse sediments to the lower river sections need to be protected and/or managed to ensure that such transport does not happen. This would include areas that are prone to sliding and/or severe bank erosion.

Higman et al. (2003) identified three basins in the upper watershed that because of their sediment loads had caused disturbances in the mainstem. The tributaries included: Basin 4, Basin 0-A, and Basin 3. Stabilization of chronic sediment sources in these tributaries would reduce sediment loads to the mainstem and provide greater channel stability in the alluvial reaches. It is likely that additional restoration work should be undertaken in other tributaries and the upper mainstem. It is recommended that chronic sediment generation sites within Island Timberlands, TimberWest and other private lands be assessed and treated. As the majority of the land within the tributary watersheds is primarily owned by forest companies, it is mandatory that the implementation of the assessments and potential restoration measures be undertaken in consultation and cooperation with private landowners.

Construction of Instream Habitat Structures in Reach E5

Reach E5 has remained relatively stable with little evidence of lateral channel migration evident in aerial photo mosaics between 1949 and 2002 (Maps 1 to 7). The apparent stability provides a potential opportunity to improve rearing and holding habitat in a reach where historic logging of the riparian zone has limited LWD recruitment to mainstem habitats. Consequently, pool scour and instream cover is limited within Reach E5 (Lough and Morley 2002). It is recommended that a habitat assessment be undertaken to identify the opportunities to improve mainstem rearing and holding habitat for salmon and trout in Reach E5. Where suitable opportunities are found, site-specific restoration prescriptions to improve instream habitat should be developed. As access may limit the feasibility of implementing construction in a cost-efficient manner, it may be preferable to opportunistically secure deadfalls that have entered the channel to other live trees on the bank using cables until an adequate number of LWD are present at priority sites to warrant the transport of rock ballast and positioning / anchoring of LWD using machinery.

Estuary Management Plan

A biophysical assessment of the estuary and development of an estuary management plan should be undertaken. The plan should provide clear direction regarding development and restoration and should address issues such as:

- Characterization of existing and historic conditions within the estuary including: areal extent, hydrology, biological habitats, and alterations that have affected its functional condition,
- Identification of and means to achieving the protection and restoration of critical salmon habitats,
- Detailed designs to restore estuarine hydrology and processes that will maintain functional habitats,
- Reduction in pollution discharges to the estuary,
- Maintenance and restoration of sloughs and smaller estuarine channels with adequate fresh and saltwater exchange, and
- Recommended guidelines and controls on further development.

STRATEGY IMPLEMENTATION

Coordination and Schedule

The success of this plan will depend on strong coordination by the ERWRP Technical Committee and cooperation among all parties with an interest in the protection and restoration of the Englishman River watershed. Implementing the strategy will require considerable annual effort on the part of key individuals. The first step should be to identify a Coordinator from the ERWRP Technical Committee who will guide the strategy, ensure coordination with all parties and coordinate funding initiatives.

The scheduling for implementation of the various protection and restoration measures is quite open-ended and many of the initiatives could be implemented opportunistically. Activities such as securement of the riparian corridor and evaluation of the revised operational rules for flow releases from Arrowsmith Dam should be initiated as soon as possible but will likely continue over a number of years. Other activities, such as bank stabilization in Reach E3, are more finite and could be completed in a relatively short time period.

Funding Requirements

The total cost of the protection and restoration initiative over the next five year period is estimated at around $1.8 Million with the contribution from the Pacific Salmon Endowment Fund estimated at about $450K or about $80-100K per year (Table 11). The annual cost estimates to implement the strategy assumes:

- a significant commitment of PSEF annual funding to ERWRP over the next five years to the protection and restoration priorities,
- PSEF would provide core funding for the project, typically not exceeding 50% of the project's costs, and
- government and non-government partners would work together to provide the bulk of the funds and technical expertise to implement the protection and restoration activities.

Cost estimates should be considered at a Class D level as more accurate costs will require site-specific assessments and designs. Other costs associated with inter- and intra-governmental discussions on broader initiatives (i.e., riparian corridor securement or flow management) would be considered as in-kind costs as the initiatives will likely be led by public civil servants with input from ERWRP committee members. The timeframe for expenditures is consistent with the priorities and has been scheduled over the next five year period. However, it is expected that implementation of the proposed activities will extend beyond the five year period and additional funding will be required beyond 2010 to fully complete the proposed activities under the strategy.

Funding Strategy

The protection and restoration strategy will need to be implemented using various funding sources. Currently, numerous parties are contributing their labour and/or funds to the implementation of the Englishman River Watershed Recovery Plan by, for example, preparing and disseminating public information, and by implementing stewardship, fisheries assessments, and habitat restoration projects. These parties include the Mid-Vancouver Island Habitat Enhancement Society, DFO, MOE, Pacific Salmon Endowment Fund Society and Pacific Salmon Foundation, to name a few.

Potential funding sources in the immediate future include:

- Canadian Government – DFO, Environment Canada, Agriculture Canada, Indian and Northern Affairs
- British Columbia Government – Ministry of Environment, Habitat Conservation Trust Fund
- Municipal and Regional Governments – Regional District of Nanaimo, Town of Parksville
- International Arrangements – Pacific Salmon Commission Southern Endowment Fund
- Non-Government Organizations – The Land Conservancy, BC Nature Trust, Ducks Unlimited, Pacific Salmon Foundation, BC Wildlife Federation
- Industry – Island Timberlands, TimberWest, other smaller industries
- Englishman River Basin Land Owners and Business Community

Evaluation of Watershed Recovery

The overall success of implementing the various activities in the strategy should be evaluated in terms of attaining coho and steelhead population targets, and rehabilitating watershed processes in concert with addressing the habitat limitations to fish production. The evaluation will answer questions relating to the rate of recovery of watershed processes, and the combined effectiveness of river, hillslope and estuary protection activities and restoration treatments on the recovery of limiting fish habitats and fish populations. The framework for this evaluation should be established coincident with the design of each protection or restoration initiative and the costs included as part of each project.

Table 11. Summary of projected costs to implement all components of this habitat protection and restoration strategy over the next five year period.

Project Activity	Sub-Activity	2006		2007		2008		2009		2010		Total Cost
		Core PSEF Funding	Total	Core PSEF Funding	Total	Core PSEF Funding	Total	Core PSEF Funding	Total	Core PSEF Funding	Total	
Improved Flow Management	Monitoring	$1,250	$2,000	$1,250	$2,000							$4,000.00
	Exploration	$12,500	$40,000									$40,000.00
	Design & Construction (if feasible)			$20,000	$250,000							$250,000.00
Securement of Riparian Corridor		$15,000	$50,000	$15,000	$50,000	$25,000	$50,000	$15,000	$50,000	$25,000	$50,000	$250,000.00
Bank Stabilization in Reach E3		$25,000	$50,000	$25,000	$50,000							$100,000.00
Riparian Treatments in Reach E3		$10,000	$20,000	$10,000	$20,000							$40,000.00
Stabilization of Chronic Sediment Sources		$10,000	$50,000	$10,000	$50,000	$10,000	$50,000					$150,000.00
Off-channel Development in Reach E3		$10,000	$50,000	$15,000	$100,000	$15,000	$100,000	$15,000	$100,000			$350,000.00
Assessment of Clay Bank in Reach E3	Assessment					$25,000	$50,000					$50,000.00
	Design & Construction (if feasible)							$25,000	$250,000			$250,000.00
Riparian Treatments in Reaches E4, E2, E5 and E6	Assessment					$10,000	$20,000					$20,000.00
	Implementation									$10,000	$20,000	$20,000.00
Construction of Instream Structures in Reach E5	Assessment					$10,000	$20,000					$20,000.00
	Design & Construction (if feasible)									$20,000	$40,000	$40,000.00
Estuary Management Plan and Restoration	Assessment							$25,000	$50,000			$50,000.00
	Design & Construction (if feasible)							$15,000	$100,000	$50,000	$100,000	$200,000.00
TOTAL		$83,750.00	$262,000.00	$96,250.00	$522,000.00	$95,000.00	$290,000.00	$95,000.00	$545,000.00	$80,000.00	$245,000.00	$1,834,000.00

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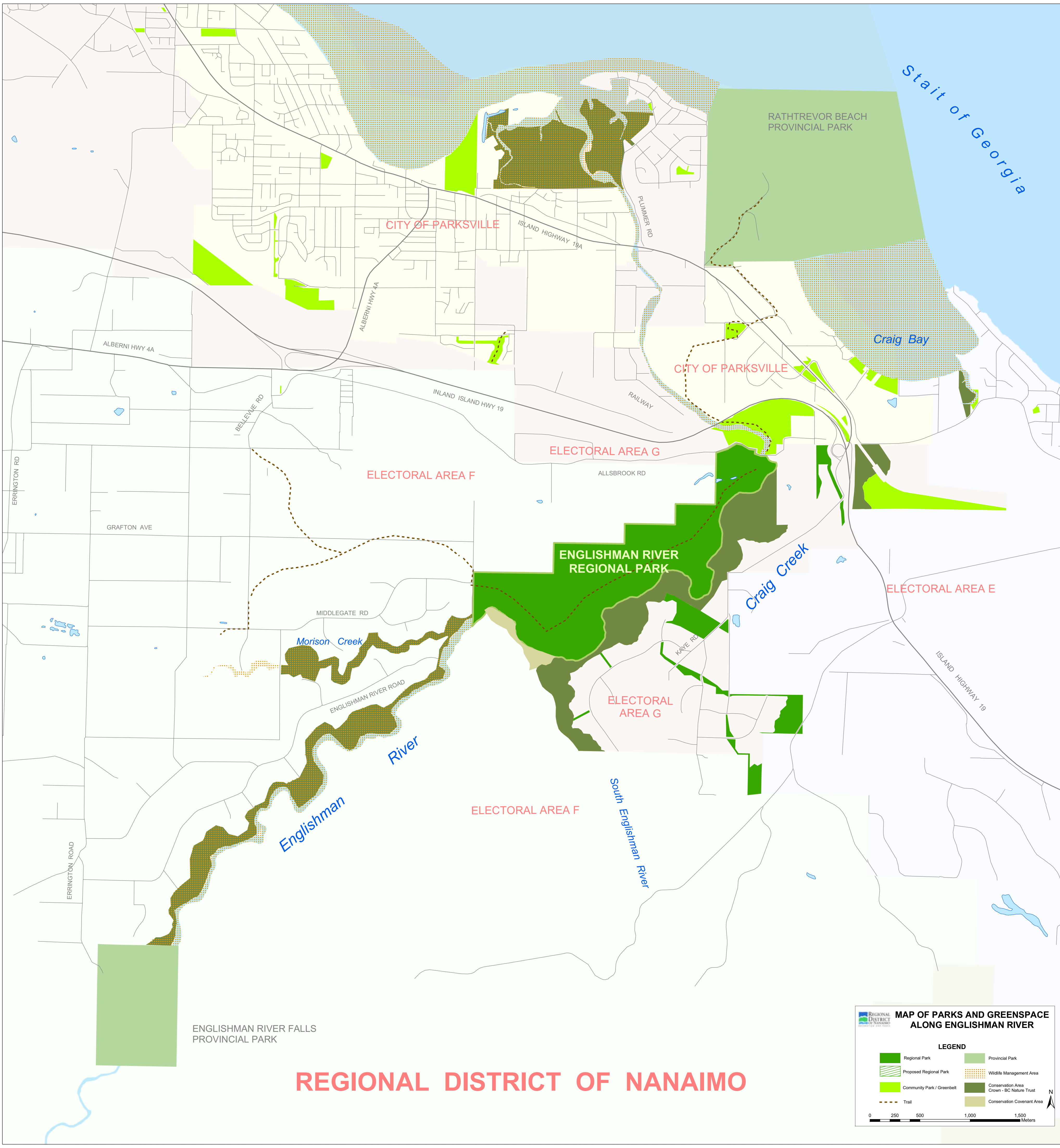
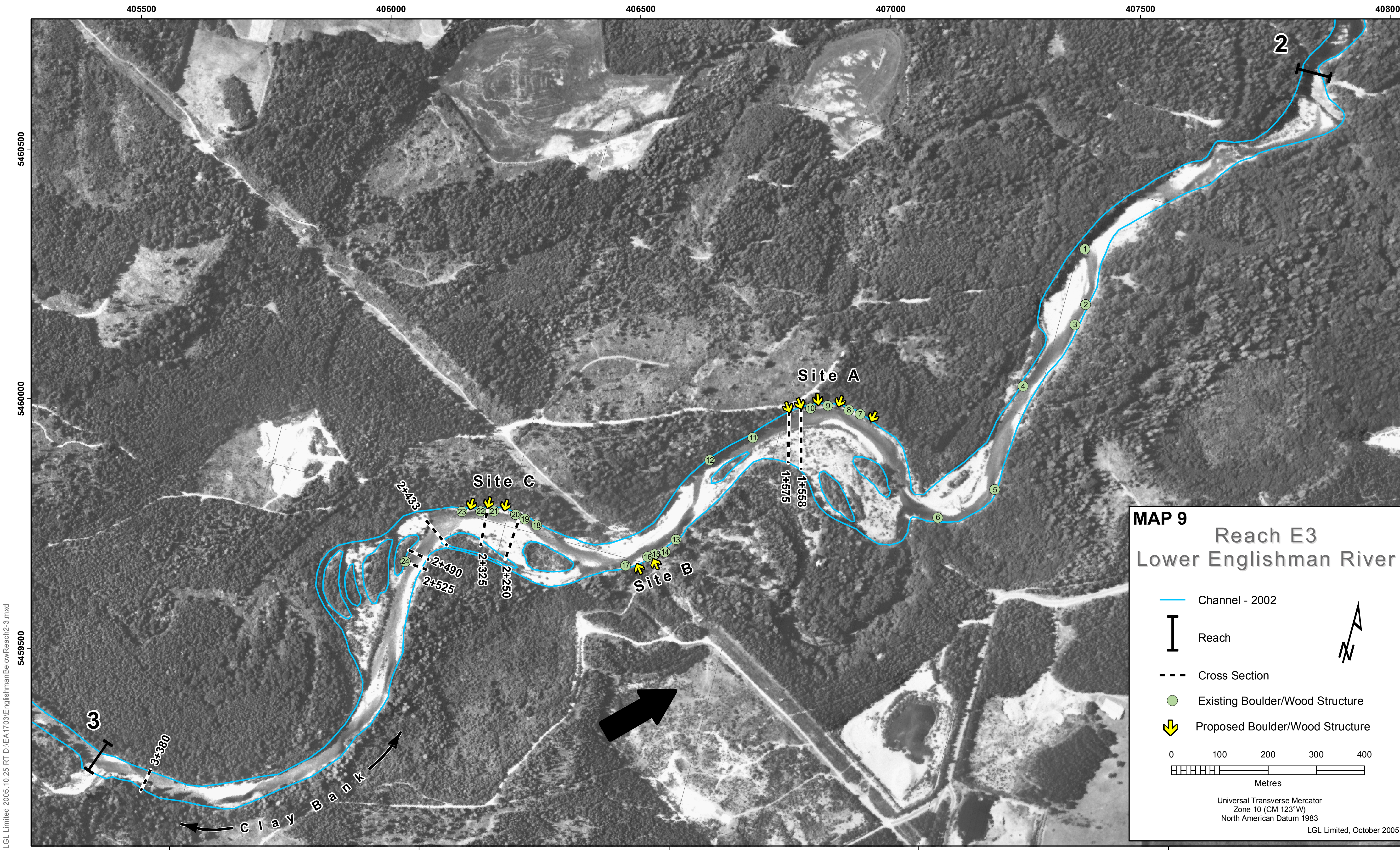
MAPS
(see large format sheets under separate cover)

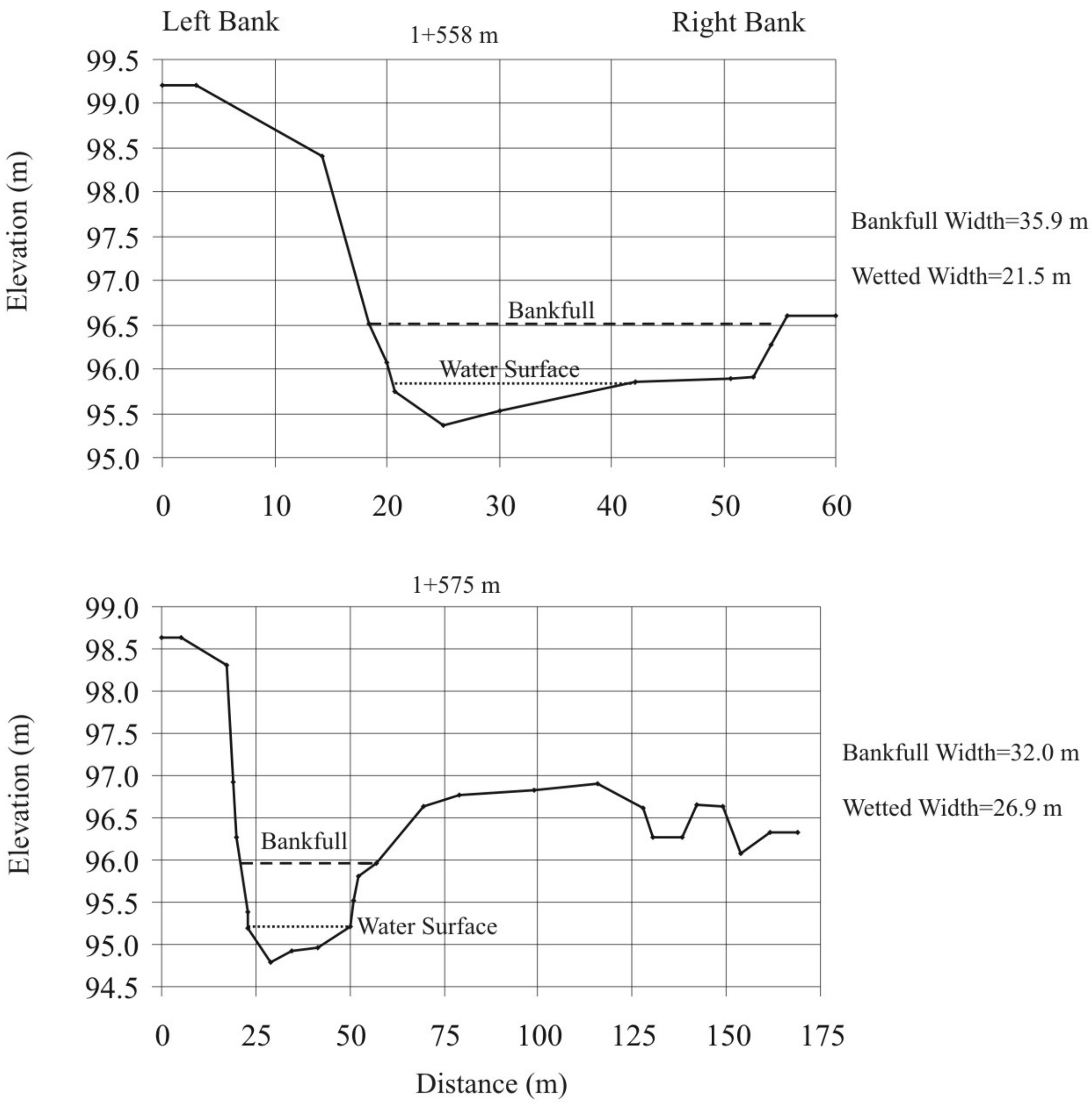


Stait of Georgia
RATHTREVOR BEACH
PROVINCIAL PARK
CITY OF PARKSVILLE
ISLAND HIGHWAY 19A
PLUMMER RD
ALBERNI HWY 4A
ALBERNI HWY 4A
INLAND ISLAND HWY 19
RAILWAY
Craig Bay
CITY OF PARKSVILLE
ELECTORAL AREA G
ELECTORAL AREA F
ALLSBROOK RD
BELLEVUE RD
ERRINGTON RD
GRAFTON AVE
ENGLISHMAN RIVER
REGIONAL PARK
Craig Creek
ELECTORAL AREA E
MIDDLEGATE RD
Morison Creek
KAYE RD
ISLAND HIGHWAY 19
ENGLISHMAN RIVER ROAD
ELECTORAL
AREA G
River
Englishman
ELECTORAL AREA F
South Englishman River
ERRINGTON ROAD
ENGLISHMAN RIVER FALLS
PROVINCIAL PARK
REGIONAL DISTRICT OF NANAIMO
MAP OF PARKS AND GREENSPACE
ALONG ENGLISHMAN RIVER
LEGEND
Regional Park
Provincial Park
Proposed Regional Park
Wildlife Management Area
Community Park / Greenbelt
Conservation Area
Crown - BC Nature Trust
Trail
Conservation Covenant Area
N
0
250
500
1,000
1,500
Meters

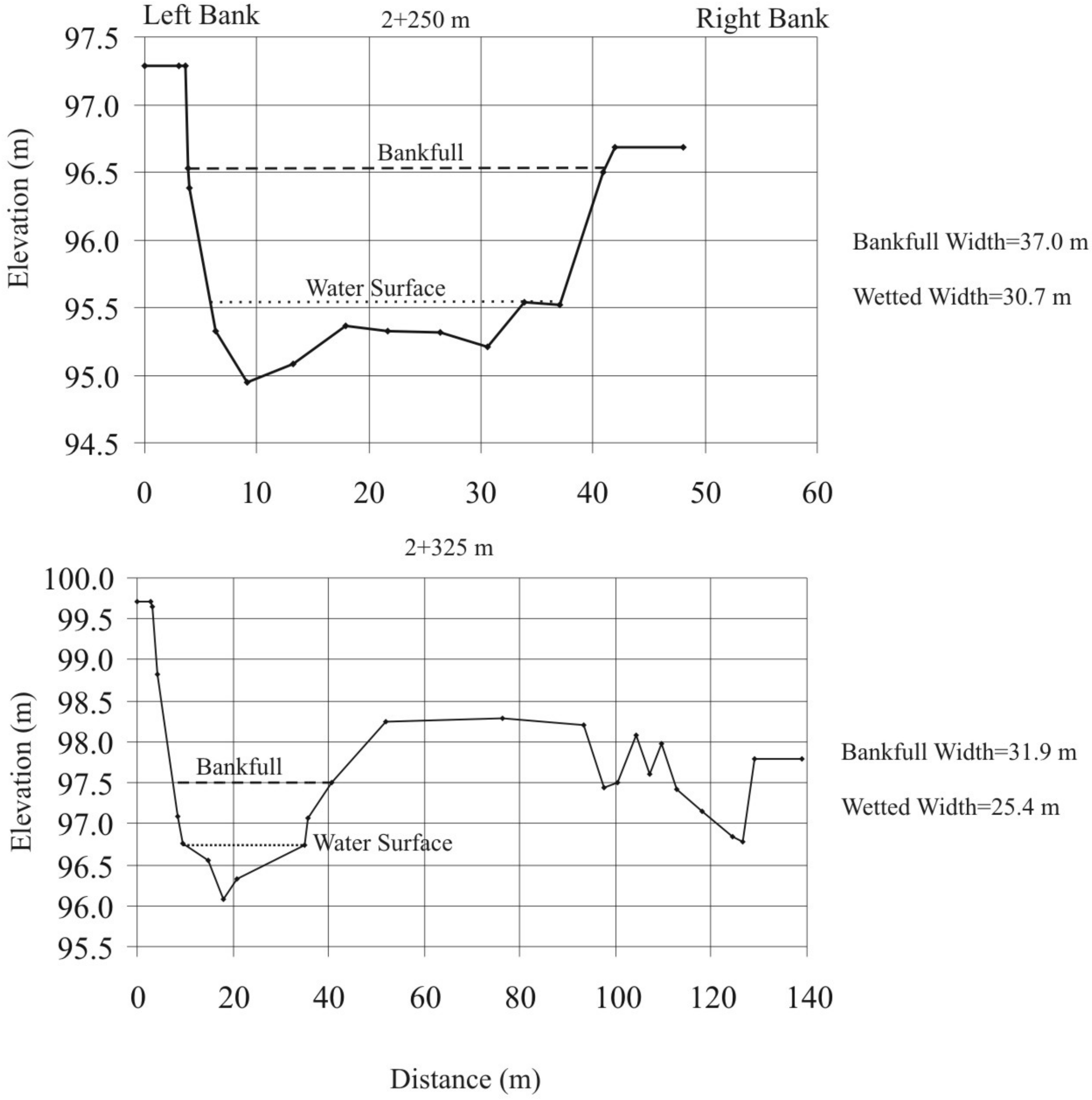


MAP 9
Reach E3
Lower Englishman River
Channel - 2002
Reach
Cross Section
Existing Boulder/Wood Structure
Proposed Boulder/Wood Structure
0 100 200 300 400
Metres
Universal Transverse Mercator
Zone 10 (CM 123°W)
North American Datum 1983
LGL Limited, October 2005
Site A
Site B
Site C
Clay Bank
2
3
1+575
1+558
2+433
2+490
2+525
2+325
2+250
3+380
405500
406000
406500
407000
407500
408000
5460500
5460000
5459500
5461000
LGL Limited 2005.10.25 RT D:\EA1703\EnglishmanBelowReach2-3.mxd

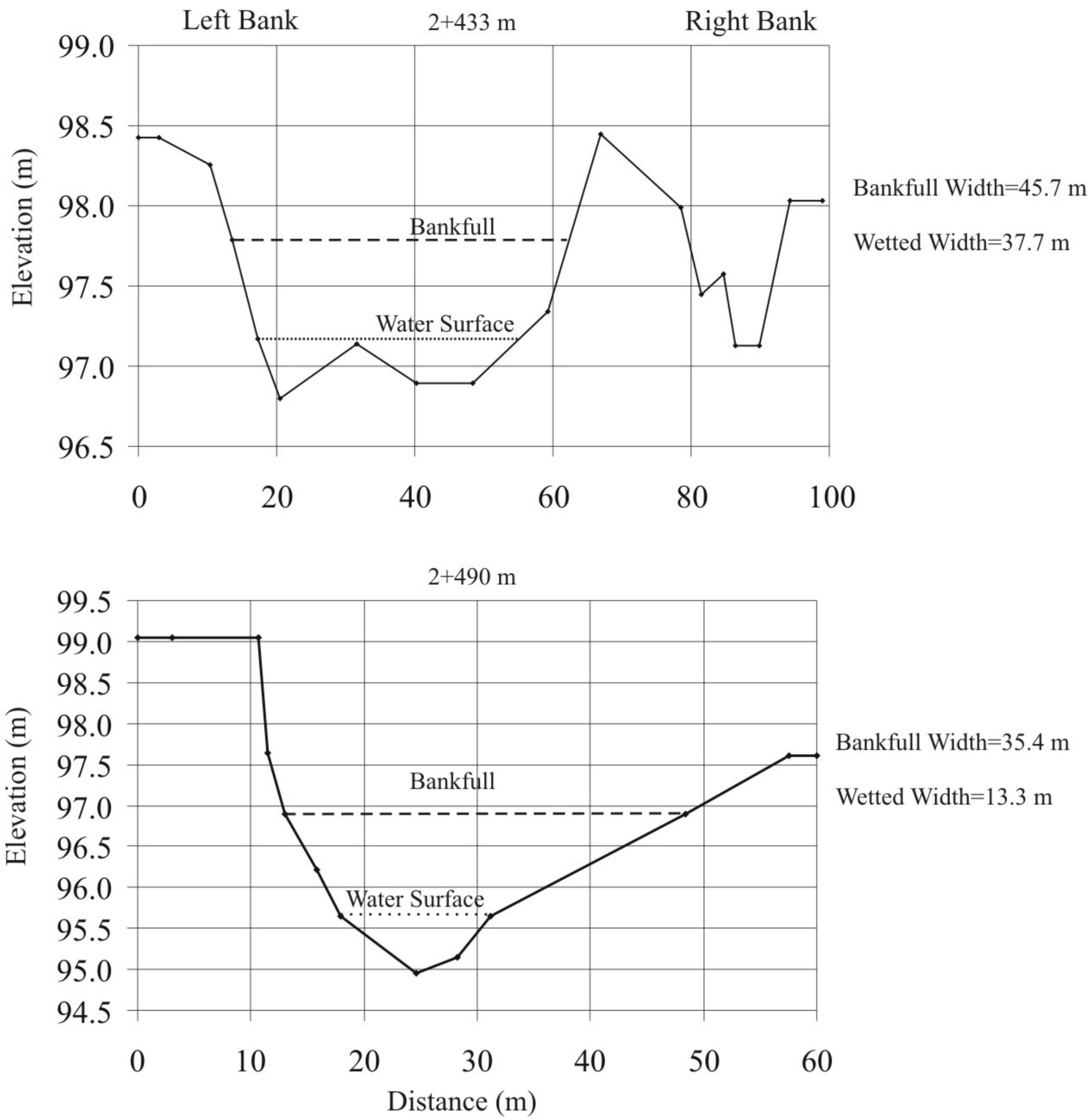
APPENDICES



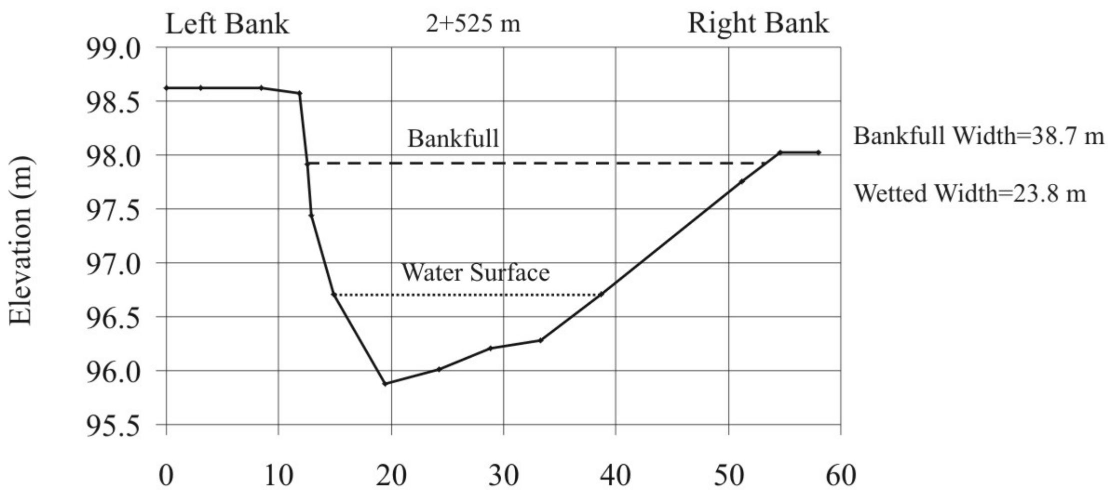
Appendix 1. Representative cross sections in Englishman River at 1+558 and 1+575 m of Reach E3.	LGL Limited

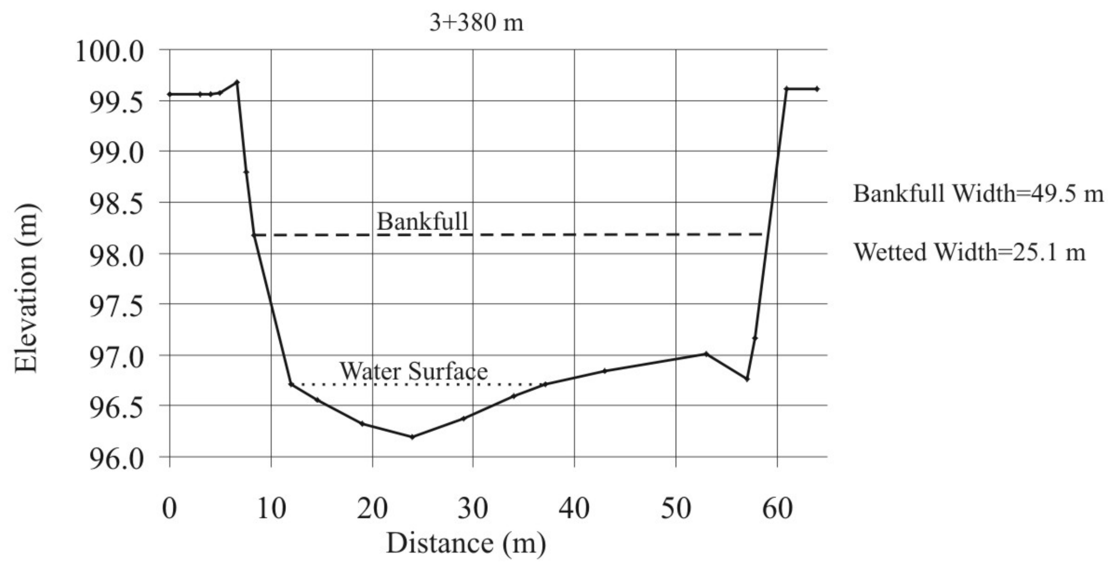


Appendix 2. Representative cross sections in Englishman River at 2+250 and 2+325 m of Reach E3.	LGL Limited

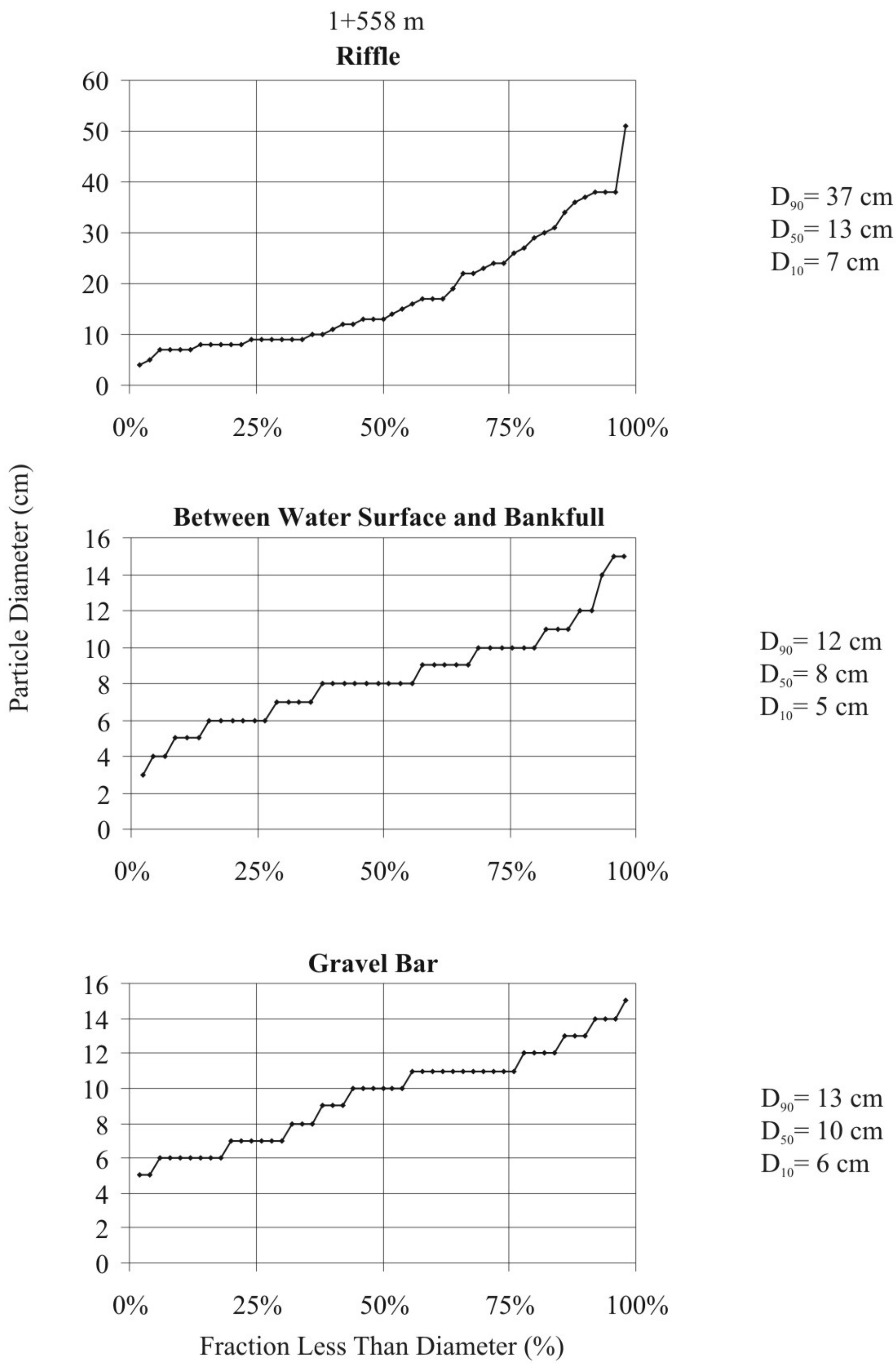


Appendix 3. Representative cross sections in Englishman River at 2+433 and 2+490 m of Reach E3.	LGL Limited



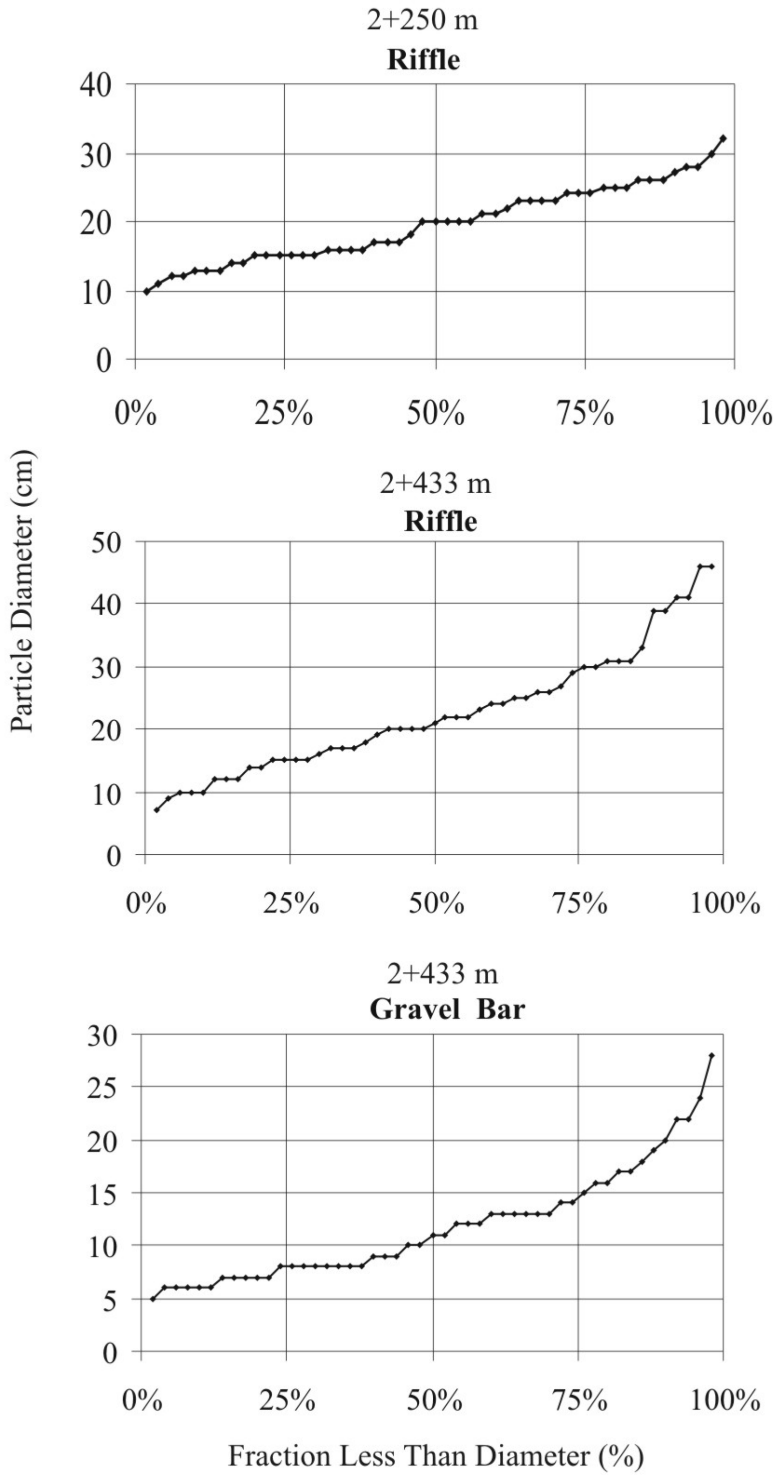


Appendix 4. Representative cross sections in Englishman River at 2+525 and 3+380 m of Reach E3.	LGL Limited



Appendix 5. Substrate characteristics from pebble counts in Englishman River at 1+558 m in Reach E3.

LGL Limited



2+250 m Riffle:
D_{90}= 27 cm
D_{50}= 20 cm
D_{10}= 13 cm

2+433 m Riffle:
D_{90}= 39 cm
D_{50}= 21 cm
D_{10}= 10 cm

2+433 m Gravel Bar:
D_{90}= 20 cm
D_{50}= 11 cm
D_{10}= 6 cm

Appendix 6. Substrate characteristics from pebble counts in Englishman River at 2+250 and 2+433 m in Reach E3.	LGL Limited