WATERSHED RESTORATION PROGRAM
INSTREAM ROUTINE EFFECTIVENESS EVALUATION 2001
KOBES AND COLT WATERSHEDS

Prepared for

Forest Renewal BC
Watershed Restoration Program
Ministry of Water, Land and Air Protection
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INTRODUCTION

West Kobes Creek watershed and Colt Creek watershed were both selected by the MWLAP and Canadian Forest Products Limited (Canfor) for restoration of fish habitat damaged by pre-code logging practices (Figure 1 and Figure 2, respectively). Both watersheds are located approximately 100 km WNW of Fort St. John, BC within the Omineca-Peace/Prince George region of MWLAP. West Kobes Creek is 21.1 km in length and drains a watershed area 79 km^2; while, Colt Creek is 37 km in length with a 155 km^2 watershed (Figure 1 and Figure 2).

Prior to this Routine Effectiveness Evaluation, Canadian Forest Products Ltd. in agreement with the former BC Ministry of Environment, Lands and Parks (now BC Ministry of Water, Land, and Air Protection) conducted Overview Assessments (LGL and CGL1999; LGL 2001), Level 1 Fish Habitat Assessments (Murray and Gaboury 2000, Klohn-Crippen 1997), Level 2 Fish Habitat Assessments or Prescriptions (Gaboury 2000, MacMahon 2000) and Constructed Works (Murray 2001, MacMahon 2001, Anderson and MacMahon 1999) within West Kobes and Colt watersheds.

Funding for these projects has been provided by Forest Renewal BC through the Ministry of Water, Land, and Air Protection and by Canadian Forest Products Ltd. through their Multi-Year Agreement with Forest Renewal BC.

OBJECTIVES

Colt Creek Sub-Basin

There are three overall Sub-basin Level Objectives for restoration in Colt Sub-basin:

- re-establish a more stable channel with characteristics that mimic those of a natural stream;
- reduce erosion and sediment loading to downstream habitats; and
- restore summer and winter rearing habitats for salmonids

The primary watershed component for restoration in Colt Sub-basin is instream fish habitat. Component Level Objectives for instream fish habitat are:

- reduce sediment inputs from unstable banks and slopes; and
- increase residual pool depths and fish habitat cover elements.

Site Level Objectives for the instream habitats are:

- increase LWD frequency;
- increase percent LWD cover in pools;
- increase scour in existing pools;
- use LWD structures to re-establish appropriate meander pattern away from unstable banks and sediment sources; and

- establish a pool-riffle sequence for pool tail-out control contiguous to bank revetment structures.

West Kobes Sub-Basin

In the West Kobes Sub-basin, there are three watershed or Sub-basin Level Objectives for restoration:

- stabilize chronic sediment sources;
- re-establish a more stable channel with appropriate bankfull widths in portions of reaches that were relatively stable prior to logging; and
- improve base-flow holding and rearing habitat for salmonids.

The primary watershed component for restoration in West Kobes Sub-basin is instream fish habitat. Component Level Objectives for instream fish habitat are:

- reduce sediment inputs from unstable banks, slopes and road fill; and
- increase residual pool depths and fish habitat cover elements.

Site Level Objectives for the instream habitats are:

- reduce erosion at eroding banks by constructing LWD and boulder structures that will provide bank protection and will adjust the meander curvatures;
- re-establish a narrower channel with an appropriate bankfull width by stabilizing gravel bars and protecting stream banks with boulder and LWD structures;
- increase pool frequency; and
- increase percent pool cover and promote pool scour by constructing LWD structures at work sites.

SCOPE

Routine effectiveness monitoring was conducted at 30 instream restoration sites in Reach 8, West Kobes Creek that were constructed during the work window in 2000 (Table 1) as well as 29 instream restoration sites in Colt Creek that were constructed during the work window in 1999 and 2000 (Table 2). Project effectiveness monitoring was performed at a sub-set of these sites and included measuring pool habitat area, pool scour and fish presence (Tables 3, 4, 5 and 6). Recommendations regarding remedial works are summarized in Table 7.

PERFORMANCE SUMMARY

A total of 59 structures (i.e., 30 in West Kobes Creek and 29 in Colt Creek) were evaluated for physical and biological performance (Tables 1 and 2, respectively). Across all structures, the pooled mean physical performance objective was 3.54 ± 0.559, whereas the mean biological performance objective was 3.55 ± 0.563 (Figure 3).

The 59 structures represented eight structure categories as follows: revetments (LWD-R, n = 20), lateral jams (LWD-A, n = 21), deflectors (LWD-D, n = 3), riffles (RIFF, n = 7), boulder groynes (BLD-G, n = 3), boulder clusters (BLD-C, n = 2), bar stabilizers (BIO-BAR, n = 2) and rock weir (RWEIR, n = 1). Physical and biological performance for each structure category is summarized in Table 3 and illustrated in Figure 4. Although small sample size precludes meaningful discussion, it is interesting to note that highest biological performance occurred among the lateral jam structures.

DETAILED ROUTINE EVALUATION SUMMARY

Pool area and residual pool depth (i.e., maximum pool depth minus depth at riffle crest) was tape-measured at 23 of the constructed instream sites in West Kobes Creek in 2000 and re-measured in 2001. The results are presented in Table 4. Overall, total pool area at these 23 sites increased from 1178 m^2 in 2000 to 1415 m^2 in 2001. Furthermore, mean residual depth increased from 0.37 m to 0.51 m as a result of pool scour and enhanced debris capture and collection on constructed structures. It is interesting to note that at six of seven sites, pool area actually declined, but with a concomitant increase in residual pool depth; suggesting that the channel may be developing a narrower and deeper cross section at these locations. Such a trend would be highly beneficial to alleviating the primary limiting factor to salmonids in Reach 8, West Kobes Creek.

Summary of fish captures in West Kobes Creek and Colt Creek are presented in Table 5 and Table 6, respectively. Multiple-pass removal techniques were employed by a two-man crew contiguous to instream structures using block nets and a Smith-Root Type 12B backpack electro-fisher. In West Kobes Creek, only two of the four summer-residing salmonid species were captured during base flow conditions in late August: namely, rainbow trout and Arctic grayling. Among salmonids, rainbow trout was the most numerous and widespread species present. In Colt Creek, only bull trout and rainbow trout were captured, although Arctic grayling and mountain whitefish have been documented in the lower portions of the watershed. In both systems, late summer fish observations were substantially reduced from those in July; electro-fishing with only a two-man crew was found to be difficult and perhaps ineffective around the constructed works. Perhaps a combination of capture techniques, including baited Gee traps would be a more effective means to estimating fish utilization contiguous to instream works.

CONCLUSIONS

Many benefits to lotic fish communities resulting from instream works are presently in a transitional phase and hence, require additional years of monitoring effort for a more complete understanding of processes. For instance, after one year, LT3 structures out performed LT6 structures in terms of pool scour and maintenance of pool area. Gravel and cobble sediments scoured from the upstream end of LT6 structures invariably infilled the downstream portion of the structure. Accordingly, rearing juvenile salmonids appeared to prefer the smaller LT3 structures. Perhaps LT6 performance will improve over time as excess sediments are flushed through the system and channel stability improves. Trends toward improved habitat complexity and fisheries productivity in YEAR ONE includes:

- increasing holding and rearing potential by increasing pool frequency and pool area;
- increasing pool residual depth initiated by scouring function of LWD;
- increasing woody cover in pools by the natural capture of additional woody debris;
- increasing areas of sorted and un-compacted gravel substrate, in close proximity to escape-cover that are potentially attractive for spawning utilization;
- reducing sediment input from bank erosion;
- reducing lateral migration and subsequent channel widening;
- increasing sediment storage and sediment sorting on stabilized bars; and,
- increasing riparian recovery on banks and bar tops.

RECOMMENDATIONS

Recommendations for remedial works are summarized in Table 7. Remedial works are only recommended for Colt Creek because access is excellent and further riparian disturbance would be minimal. Minor remedial works identified in Kobes Creek (Table1) do not justify disturbing the riparian area, however monitoring should continue until channel stabilization is achieved.

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TABLES

Table 1. Routine Effectiveness Evaluation Restoration Works Summary - Stream Component For Kobes Creek Reach 8.

MYA /AA Holder No. 000-1524 **Watershed: Kobes** **Survey Crew: BA / BM** **REE Interval: year one**

FRBC Activity No. 721549 **Sub-watershed West Basin** **Weather / Flow: clear&dry / low** **Watershed Classification_____**

Project Name: Constructed Works in Kobes Creek, Reach 8, 2000. **Date: Aug 19, 2001** **Forest District: Fort St. John** **In-stream Works Complete: N**

					Performance Objectives														Overall						Comments
					Physical							Biological														
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Block Avulsion Ch	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
Reach 8, Kobes	0+260 to 0+287	260	LWD-R	block avulsion channel, deflect flow	4		3	4	3	(4)	4	RB BT GR	J	3	(4)	3	3	3	4	4	4	4	4	4	Photo 1 (154-23A)	Excellent avulsion block. Apex is also deflecting flow and placed 8 - 10 m US of avulsion resulting in sediment accumulating at entrance of avulsion. Catching debris, providing rearing pool and spawning tail out habitat.
Reach 8, Kobes	0+340 to 0+370	340	LWD-A	overhead cover, bank protection	3			(4)	(4)		4	RB BT GR	J		(4)	3	3	3	4	4	4	4	4	4	Photo 2 (154-20/21A)	unexpected bonus is 6m^2 of spawning subtrate created.
Reach 8, Kobes Creek	0+362 to 0+385	362	LWD-D	block avulsion channel, deflect flow				(4)		(4)	4	RB BT GR	J							4	4	4	4	4	Photo 3 (154-17A)	excellent deflector, sediment is being trapped on retards resulting in increase bar height. Overall, functioning well to narrow channel.
Reach 8, Kobes Creek	0+820 to 0+880	820	LWD-R	bank protection, overhead cover				(3)	(2.5)		2.5	RB BT GR	J		(2.5)				2.5	4	4	4	4	4	Photo 4 (154-16A)	adequately protecting bank, scour pools showing signs of infilling which may be temporary.
Reach 8, Kobes Creek	0+900	900	LWD-D	Deflect flow, protect bank, provide overhead cover	(3)			(3)	(3)		3	RB BT GR	J		(4)	3	3		3	4	4	4	4	4	Photo 5 (154-12A)	spawning gravels accumulating in tail out (<1.0 m^2), scour depth to 0.5 m, moderate debris accumulation. Better cover if further into channel.
Reach 8, Kobes Creek	0+925	925	LWD-D	Deflect flow, protect bank, provide overhead cover	(4)			(4)	(4)		4	RB BT GR	J	3	(4)	3	3		4	4	4	4	4	4	Photo 6 (154-10A)	adequately deflecting high flows, scour pool depth to 0.98 m, moderate debris accumulation, tail out gravel accumulation to 3m^2
Reach 8, Kobes Creek	1+054	1054	LWD-A	Overhead cover, scour pool	(4)				(4)		4	RB BT GR	J		(4)	3	3		4	4	4	4	4	4	Photo 7 (154-7A)	2 m^2 spawning gravels accum in tail out, scour pool depth 1 m, debris accum small, better cover if bole was buried in bank.
Reach 8, Kobes Creek	1+147	1147	LWD-A	Overhead cover, scour pool	(4)				(4)		4	RB BT GR	J	3	(4)	4	3	3	4	4	4	4	4	4	Photo 8 (154-5A)	excellent pool development (A=44 m^2), scour depth (1.2 m), abundant debris accum, tail out gravel accum (30 m^2).

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MYA /AA Holder No. 000-1524 **Watershed: Kobes** **Survey Crew: BA / BM** **REE Interval: year one**

FRBC Activity No. 721549 **Sub-watershed West Basin** **Weather / Flow: clear&dry / low** **Watershed Classification_____**

Project Name: Constructed Works in Kobes Creek, Reach 8, 2000. **Date: Aug 19, 2001** **Forest District: Fort St. John** **In-stream Works Complete: N**

					Performance Objectives														Overall						Comments
					Physical							Biological														
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Block Avulsion Ch.	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
Reach 8, Kobes Creek	1+240 to 1+255	1240	LWD-R	Bank protection				(4)	3		4	RB BT GR	J	3						4	4	4	2	4	Photo 9 (154-2A)	excellent bank protection, structure accumulating SOD debris, overhead cover at high flow only.
Reach 8, Kobes Creek	1+270 to 1+293	1270	LWD-A	Overhead cover, bank protection	(3)			(4)	(3)		3	RB BT GR	J		(3)	3	3		3	4	3	4	3	3	Photo 10 (155-23/25A)	hyraulic log should be more diagonal to flow, hard points should be placed at tail out to reduce headcutting. Max scour depth (0.67).
Reach 8, Kobes Creek	1+381 to 1+395	1395	LWD-A	Overhead cover, bank protection	(3)			(4)	(4)		3	RB BT GR	J		(4)	3	3	3	4	4	4	4	4	4	Photo 11 (153-13/14A)	accumulating spawning gravels at tail out (4 m^2), pool area (112 m^2), max scour depth (0.67 m). collecting debris and scour depth to 1.0 m. Add debris racks at 1+410 m and 1+403 m.
Reach 8, Kobes Creek	1+503	1503	LWD-A	Overhead cover, bank protection				(3)	(3)		3	RB BT GR	J		(3)				3	4	4	4	4	4	Photo 12 (169-32)	this was an experiment, no boulders used to anchor, structures were pencilled into bank. Doing very well structurally. Provides adequate cover and protecting bank.
Reach 8, Kobes Creek	1+518 to 1+526	1518	LWD-A	Deflect flow, provide overhead cover	3				(3)		3	RB BT GR	J		(3)				3	4	3	4	4	4	Photo 13 (153-12A)	excellent deflector, additional benefits include debris capture, added cover, scour pool developing underneath rootwad deflectors.
Reach 8, Kobes Creek	1+549	1549	LWD-R	Protect bank, provide cover	(3)			(4)	(3)		3	RB BT GR	J		(3)	3			3	4	4	4	4	4	Photo 14 (153-11A)	good bank protection and adequate rearing cover. Scour depth to 0.60 m.
Reach 8, Kobes Creek	1+549 to 1+577	1577	LWD-R	Protect bank, provide cover	2.5			(4)	(3)		3	RB BT GR	J		(3)	3	3		3	4	4	4	4	4	Photo 15 (153-9/10A)	good bank protection and adequate rearing cover. Scour depth to 0.60 m. Some infilling and gravel sorting detected.
Reach 8, Kobes Creek	1+578 to 1+608	1608	LWD-A	Overhead cover and scour pool	(3)				(4)		3	RB BT GR	J		(4)	3			4	4	3	4	4	3	Photo 16 (153-8A)	boulder anchor for hydraulic log moved ds into hydraulic pool.

Table 1. Routine Effectiveness Evaluation Restoration Works Summary - Stream Component For Kobes Creek Reach 8.

MYA /AA Holder No. 000-1524 **Watershed: Kobes** **Survey Crew: BA / BM** **REE Interval: year one**

FRBC Activity No. 721549 **Sub-watershed West Basin** **Weather / Flow: clear&dry / low** **Watershed Classification_____**

Project Name: Constructed Works in Kobes Creek, Reach 8, 2000. **Date: Aug 19, 2001** **Forest District: Fort St. John** **In-stream Works Complete: N**

					Performance Objectives														Overall						Comments
					Physical							Biological														
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Block Avulsion Ch	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
Reach 8, Kobes Creek	1+830 to 1+890	1830	LWD-R	Bank Protection	3			(4)	3		4	RB BT GR	J		(4)	3	3		4	4	4	4	4	3	Photos 17&18 (153-4A, 1A)	bank erosion behind RW#5 from DS end needs minor tweeking.
Reach 8, Kobes Creek	2+052 to 2+070	2052	LWD-A	Overhead cover	3				(4)		4	RB BT GR	J		(4)	3	3		4	4	4	4	4	4	Photo 19 (156-35A)	has collected an abundant amount of addition debris.
Reach 8, Kobes Creek	2+135 to 2+145	2135	LWD-A	Overhead cover, scour pool	(4)				(4)		4	RB BT GR	J		(4)	3	4		4	4	4	4	4	4	Photo 20 (156-32A)	other benefits include: max scour depth (0.75 m), pool area 35 m^2, woody cover 15 m^2, spawning gravel accum (10 m^2).
Reach 8, Kobes Creek	2+565	2565	LWD-A	Overhead cover, scour pool	(4)				(4)		4	RB BT GR	J	3	(4)	3	4		4	4	4	4	4	4	Photo 21 (156-27/28A)	other benefits include: max scour depth (1.0 m), increased pool area (70) m^2, woody cover (44.5) m^2, spawning gravel accum (8 m^2).
Reach 8, Kobes Creek	2+579	2579	LWD-A	Overhead cover, scour pool	(3)				(4)		3	RB BT GR	J		(4)	3	4		4	4	4	4	4	4	Photo 22 (156-24A)	excellent development of spawning substrate (12 m^2) close proximity to cover, scour depth (0.65 m), Pool area (44 m^2).
Reach 8, Kobes Creek	2+670 to 2+687	2670	LWD-R	Bank protection, overhead cover	(3)			(4)	(4)		3	RB BT GR	J		(4)	3			4	4	4	4	4	4	Photo 23 (156-17A)	pool area (81 m^2), scour depth (0.63 m)
Reach 8, Kobes Creek	2+810 to 2+830	2810	LWD-A	Overhead cover, scour pool	(4)				(4)		4	RB BT GR	J		(4)	4	3		4	4	4	4	4	4	Photo 24 (156-15A)	pool area (100 m^2), max scour depth (0.85 m), sorted gravel close to cover, LB single log deflector protecting LB point bar, functioning to narrow channel.
Reach 8, Kobes Creek	2+910 to 2+922	2910	LWD-A	Overhead cover, scour pool	(4)				(4)		4	RB BT GR	J		(4)	4	3		4	4	4	4	4	4	Photo 25 (156-12A)	Lots of debris captured on structure, pool area (33 m^2), max scour depth (1.0 m), sorted gravel accum close to cover.
Reach 8, Kobes Creek	3+650 to 3+670	3650	LWD-R	Bank protection, overhead	(4)			(4)	(4)	(4)	4	RB BT GR	J		(4)	3	3		3	4	4	4	4	4	Photo 26 (152-36A)	Pool area (80.8 m2), max depth (0.67 m), moderate collection of debris, excellent revetment.

Table 1. Routine Effectiveness Evaluation Restoration Works Summary - Stream Component For Kobes Creek Reach 8.

MYA /AA Holder No. 000-1524 **Watershed: Kobes** **Survey Crew: BA / BM** **REE Interval: year one**

FRBC Activity No. 721549 **Sub-watershed West Basin** **Weather / Flow: clear&dry / low** **Watershed Classification_____**

Project Name: Constructed Works in Kobes Creek, Reach 8, 2000. **Date: Aug 19, 2001** **Forest District: Fort St. John** **In-stream Works Complete: N**

					Performance Objectives														Overall						Comments
					Physical							Biological													
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Streambank	Stream Cover	Block Avulsion Ch.	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
Reach 8, Kobes Creek	3+680	3680	BLD-G	Deflect flow, scour pool	(3)			(4)	(3)		3	RB BT GR	J		(3)				3	4	4	4	4	4	Photo 27 (152-34A)	max pool depth (0.45 m), channel stabilizing technique too early to evaluate.
Reach 8, Kobes Creek	3+690	3680	BLD-G	Deflect flow, scour pool	(3)			(4)	(3)		3	RB BT GR	J		(3)				3	4	4	4	4	4	Photo 28 (152-33A)	max pool depth (0.40 m), channel stabilizing technique too early to evaluate.
Reach 8, Kobes Creek	3+700	3700	BLD-G	Deflect flow, scour pool	(3)			(4)	(3)		3	RB BT GR	J		(3)				3	4	4	4	4	4	Photo 29 (152-32A)	max pool depth (0.40 m), channel stabilizing technique too early to evaluate.
Reach 8, Kobes Creek	3+750 to 3+752	3750	BLD-C	Overhead cover, scour pool	(3)				(3)		3	RB BT GR	J		(4)				3	4	3	4	4	4	Photo 30 (152-30A)	max pool depth (0.52 m)
Reach 8, Kobes Creek	3+790 to 3+795	3790	BLD-C	Overhead cover, scour pool	(3)				(3)		3	RB BT GR	J		(3)				3	4	4	4	4	4	Photo 30 (152-30A)	max pool depth (0.45 m)

Table 2. Routine Effectiveness Evaluation Restoration Works Summary - Stream Component For Colt Creek.

MYA /AA Holder No. 000-1524 **Watershed: Colt** **Survey Crew: BA / BM** **REE Interval: year one**

FRBC Activity No. 721549 **Sub-watershed** **Weather / Flow: clear&dry / low** **Watershed Classification_____**

Project Name: Constructed works in Colt Creek 1999, 2000. **Date: 28 Sept 2001** **Forest District: Fort St. John** **In-stream Works Complete: N**

					Performance Objectives															Overall						Comments
					Physical							Biological															
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Bar stabilization	Streambank	Stream Cover	Block Avulsion Ch.	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
Colt Reach 5	0+020	1	LWD-R	Bank protection				(4)			4	BT	J							4	4	4	4	4	Photo 31 (150-15A)	
Colt Reach 5	0+045	1	BIO-BAR	Bar stabilization			(4)				4	BT	J							4	4	4	4	4	Photo 32 (150-12/13A)	good deposition of fines on bar top, functioning to narrow channel
Colt Reach 5	0+080	2	BIO-BAR	Bar stabilization			(4)				4	BT	J							4	4	4	4	4	Photo 33 (892-14/15A)	good deposition of fines on bar top, functioning to narrow channel
Colt Reach 5	0+120	2	LWD-R	Bank protection				(4)			4	BT	J							4	4	4	4	4	Photo 34 (150-16A)	
Colt		na	RWIER	provide rearing, holding	(3)				(2.5)		2.5	BT	J						2	3	2	3	2	4	Photo 35 (150-21A)	poorly designed, tends to be an obstruction at low flow
Colt Reach 8	0+425	3	RIFF	Back-water upstream structure	(4)	(4)			(4)		4	BT	J		(4)		3	3	4	4	4	4	4	4	Photo 36 (150-24/25A)	riffle back-watering pool tail-out which is accumulating suitable spawning gravel
Colt Reach 8	0+440	3	LWD-R	bank protection, overhead cover	(3)			(4)	(3)		3	BT	J		(3)	3	3		3	4	4	4	4	4	Photo 36 (150-24/25A)	sorted spawning gravel accum in tail out area
Colt Reach 8	0+785	4	RIFF	Back-water upstream structure	(4)	(4)			(4)		4	BT	J		(4)		(3)	4	4	4	4	4	4	4	Photo 37 (150-27A)	developing spawning substrate in upstream pool tail out and riffle crest
Colt Reach 8	0+795	4	LWD-R	bank protection, overhead cover	(4)			(4)	(4)		4	BT	J	4	(4)	4	4	4	4	4	4	4	4	4	Photo 37 (150-27A)	max pool depth (0.95 m)
Colt Reach 9	0+785	5	RIFF	Back-water upstream structure	(4)	(4)			(4)		4	BT	J		(4)		(3)	4	4	4	4	4	4	4	Photo 38 (150-29A)	spawning substrate accumulating in pool tail-out and riffle crest.

Table 2. Routine Effectiveness Evaluation Restoration Works Summary - Stream Component For Colt Creek.

MYA /AA Holder No. 000-1524 **Watershed: Colt** **Survey Crew: BA / BM** **REE Interval: year one**

FRBC Activity No. 721549 **Sub-watershed** **Weather / Flow: clear&dry / low** **Watershed Classification_____**

Project Name: Constructed works in Colt Creek 1999, 2000. **Date: 28 Sept 2001** **Forest District: Fort St. John** **In-stream Works Complete: N**

					Performance Objectives														Overall						Comments
					Physical							Biological														
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Bar stabilization	Streambank	Stream Cover	Block Avulsion Ch	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
Colt Reach 9	0+800	5	LWD-R	bank protection, overhead cover	4			4	4		4	BT	J	4	4	4	4	4	4	4	4	4	4	4	Photo 38 (150-29A)	max pool depth (0.60 m)
Colt Reach 9	0+890	6	RIFF	Back-water upstream structure	3	2			2		2	BT	J		2.5		3		2.5	2	1	2	2	1	Photo 40 (150-32A)	riffle at risk of unraveiliing due to headcutting
Colt Reach 9	0+900	6	LWD-R	bank protection, overhead cover	3			4	3		3	BT	J		3				3	4	4	4	3	2	Photo 39 (150-30/31A)	tweeking required to add debris catcher and back water LWD structure
Colt Reach 9		LT3	LWD-A	Overhead cover and scour pool	3			3	4		3	BT	J		4				4	4	4	4	4	4	Photo 41 (150-33A)	moderate debris collection
Colt Reach 9	0+980	7	RIFF	Back-water upstream structure	4	4			4		4	BT	J		4		3	3	3	4	4	4	4	4	Photo 42 (150-34A)	spawning in pool tail out and us side riffle crest
Colt Reach 9	0+992	7	LWD-R	Bank protection, overhead cover	4			4	4		4	BT	J	4	4	4	4	3	4	4	4	4	4	3	Photo 43 (150-35/36A)	buck off RW#4 and RW#7 for better pool habitat development
Colt Reach 9	1+312	8	RIFF	Back-water upstream structure	3	4			4		3	BT	J		4	3	3		3	4	4	4	4	4	Photo 44 (148-1)	
Colt Reach 10	0+000	8	LWD-R	Bank Protection	4			4	4		4	BT	J		4	4	4	4	4	4	4	4	4	4	Photo 45 (148-2)	nice pool developed between RW#5 and RW#6

Table 2. Routine Effectiveness Evaluation Restoration Works Summary - Stream Component For Colt Creek.

MYA /AA Holder No. 000-1524 **Watershed: Colt** **Survey Crew: BA / BM** **REE Interval: year one**

FRBC Activity No. 721549 **Sub-watershed** **Weather / Flow: clear&dry / low** **Watershed Classification_____**

Project Name: Constructed works in Colt Creek 1999, 2000. **Date: 28 Sept 2001** **Forest District: Fort St. John** **In-stream Works Complete: N**

					Performance Objectives														Overall						Comments
					Physical							Biological														
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Bar stabilization	Streambank	Stream Cover	Block Avulsion Ch.	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
Colt Reach 10	0+126	9	RIFF	Back-water upstream structure, tail-out control	3	4			3		3	BT	J		4		3		3	3	3	3	3	2	Photos 46 (148-3)	too turbulent can be better stepped, add boulder to crest and apron
Colt Reach 10	0+140	9	LWD-R	Overhead cover, scour pool	4			4	4		4	BT	J	4	4	4	4	4	4	4	4	4	4	4	Photo 47 (148-4)	
Colt Reach 10	0+980	10	LWD-A	Bank protection, overhead cover	3			4	4		3	BT	J		4	4			4	4	4	4	4	4	Photo 48 (148-5)	gravel sorting active in tail-out, active debris capture
Colt Reach 10	1+060	11	LWD-R	Bank protection, overhead cover	4			4	4		4	BT	J		3	4			3	4	4	4	4	4	Photo 49 (148-7)	pool scour at RW#4 and #5 is 0.60 m
Colt Reach 10	1+280	12	LWD-A	Overhead cover, scour pool	4				4		4	BT	J	3	4	4	3	3	4	4	4	4	4	4	Photo 50 (148-8)	active gravel sorting and debris capture in progress
Colt Reach 10	1+300	13	LWD-A	Overhead cover, scour pool	3				4		3	BT	J		4	3			3	4	3	4	4	4	Photo 51 (148-9)	active debris capture in progress
Colt Reach 10	1+340	14	LWD-A	Overhead cover, scour pool	3				3		3	BT	J		4	3			4	4	4	4	4	4	Photo 52 (148-11)	active pool scour to 0.55 m, active debris accumulation
Colt Reach 10	1+350	14	LWD-R	Bank protection	2			3	2.5		2	BT	J		2				2	4	4	4	4	4	Photo 53 (148-13/14)	

Table 2. Routine Effectiveness Evaluation Restoration Works Summary - Stream Component For Colt Creek.

MYA /AA Holder No. 000-1524 **Watershed: Colt** **Survey Crew: BA / BM** **REE Interval: year one**

FRBC Activity No. 721549 **Sub-watershed** **Weather / Flow: clear&dry / low** **Watershed Classification_____**

Project Name: Constructed works in Colt Creek 1999, 2000. **Date: 28 Sept 2001** **Forest District: Fort St. John** **In-stream Works Complete: N**

					Performance Objectives														Overall						Comments
					Physical							Biological														
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Bar stabilization	Streambank	Stream Cover	Block Avulsion Ch.	Overall rating	Species	Life Stage	Overwinter	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Recommendation	Photo Numbers	
Colt Reach 10	1+511	15	LWD-A	Overhead cover, scour pool	(4)				(4)		4	BT	J		(4)				4	4	4	4	4	4	Photo 54 (148-15)	bony substrate scour to 0.50 m, pool area increasing, active debris collector
Colt Reach 10	1+523	15	LWD-A	Bank protection, overhead cover	(4)			(4)	(4)		4	BT	J		(4)	4			4	4	4	4	4	2	Photo 55 (148-16)	scour to 0.6 m, debris accumulating, RB needs bio-engineering-slippage behind structure, no tail-out control.
Colt Reach 11	0+560	16	LWD-R	Bank protection	(3)			(4)	(3)		3	BT	J		(3)				3	4	4	4	2.5	2	Photo 56 (148-16)	roof should be cabled to RW support.

Table 3. Summary of performance ratings for each structure type (± one standard deviation).

Type of Structure →	Revetment (LWD-R)	Lateral Jam (LWD-A)	Riffle (RIFF)	Deflector (LWD-D)	Boulder Groyne (BLD-G)	Boulder Cluster (BLD-C)	Bar Stabilizer (BIO-BAR)	Rock Weir (RWIER)
Mean Physical Performance	3.575 ±0.545	3.571 ±0.507	3.71 ±0.756	3.66 ±0.577	3.0 ± 0.	3.0 ± 0.	4.0 ± 0.	2.5
Mean Biological Performance	3.417 ±0.549	3.81 ±0.402	3.79 ±0.567	3.50 ±0.707	3.0 ± 0.	3.0 ± 0.	na	2
Physical Performance Sample Size (n)	20	21	7	3	3	2	2	1
Biological Performance Sample Size (n)	18	21	7	2	3	2	na	1

Table 4. Maximum and residual pool depth, pool area and pool cover in Reach 8, Kobes Creek. Constructed works completed in September 2000 and monitored in 2000 and 2001. Monitoring survey dates: 23 July 2000 and 7 August 2001.

Site Location	Structure Type	Bank Location	Maximum Pool Depth (m)		Riffle Crest Depth (m)		Residual Depth (m)		Pool Area (m^2)		Pool Cover (m^2)	
			2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
0+260	LWD-R	RB	0.48	0.90	0.30	0.11	0.18	0.79	55	68		6
0+340	LWD-A	RB	0.76	0.60	0.28	0.11	0.48	0.49	58	79		38
0+820	LWD-R	RB	0.34	0.60	0.37	0.20	0.00	0.40	110	36		17
0+850	LWD-R	RB	0.31	0.40	0.37	0.20	0.00	0.20	69	21		11
0+900	LWD-D	LB	0.46	0.50	0.37	0.20	0.09	0.30	24	24		4
0+925	LWD-D	LB	0.46	0.98	0.37	0.19	0.09	0.79	32	32		6
1+054	LWD-A	LB	0.60	1.00	0.31	0.20	0.29	0.80	47	36		4
1+147	LWD-A	RB	0.68	1.20	0.38	0.20	0.30	1.00	36	44		16
1+270	LWD-A	RB	0.69	0.67	0.19	0.20	0.50	0.47	41	60		30
1+381	LWD-A	LB	0.80	0.67	0.29	0.20	0.51	0.47	69	112		45
1+503	LWD-A	LB		0.37		0.15		0.22		6		3
1+518	LWD-A	RB	0.76	0.60	0.19	0.22	0.57	0.38	14	43		19
1+549	LWD-R	RB	0.54	0.60	0.30	0.20	0.24	0.40	69	91		27
1+585	LWD-R	RB	0.84	0.70	0.30	0.22	0.54	0.48	77	28		17
1+830	LWD-R	RB	0.58	0.60	0.20	0.20	0.38	0.40	44	185		26
1+860	LWD-R	RB	0.59	0.60	0.20	0.20	0.39	0.40	61	136		29
2+052	LWD-A	RB	0.64	0.67	0.38	0.20	0.26	0.47	14	14		8
2+135	LWD-A	LB	0.70	0.75	0.32	0.20	0.38	0.55	83	35		15
2+565	LWD-A	RB	0.80	0.60	0.32	0.20	0.48	0.40	69	70	21	45
2+670	LWD-R	RB	0.86	0.63	0.30	0.20	0.56	0.43	52	81		27
2+810	LWD-A	LB	0.84	0.85	0.18	0.25	0.66	0.60	47	100		32
2+910	LWD-A	RB	0.76	1.00	0.24	0.25	0.52	0.75	44	33		20
3+650	LWD-R	RB	1.00	0.67	0.20	0.18	0.80	0.49	63	81	25	29
3+680	BLD-G	RB	na	0.40	na	0.10	na	0.30	na	20	na	na
3+690	BLD-G	RB	na	0.40	na	0.10	na	0.30	na	8	na	na
3+700	BLD-G	RB	na	0.45	na	0.10	na	0.35	na	2	na	na
3+750	BLD-C	MC	na	0.45	na	0.10	na	0.35	na	4	na	na
3+790	BLD-C	MC	na	0.52	na	0.08	na	0.44	na	5	na	na

Table 5. Summary of fish captured at structures in Reach 8, West Kobes Creek, 22 August 2001.

Location [1] (chainage in m)	Type of Structure	Survey Method	Pass No.	Sample Time (seconds)	Salmonids Captured						Sculpin
					Rainbow Trout			Arctic Grayling			
					Number	Length (cm)	CPE[2]	Number	Length (cm)	CPE[2]	Number
0+340	LWD-A	EF	1	623	5	9, 13, 15, 16, 20	29				1
0+340	LWD-A	VO			2	<10, 25					
0+820	LWD-R	EF	1		5	11,13.5,13.5,13.5,15					1
0+820	LWD-R	VO			2	20, <10					
0+900	LWD-D	VO			2	10, 15					
0+925	LWD-D	EF	1	138	1	13	26				
1+054	LWD-A	EF	1	154	3	20, 15, 10	70				1
1+147	LWD-A	EF	3	344	4	25, 15, 10, 8	42				2
1+270	LWD-A	EF	1	467	4	18, 8.5, 13.5, 11	31	1	21	8	2
1+395	LWD-A	EF	1	123	1	16	29				1
1+395	LWD-A	EF	2	242	1	14	15				1
1+395	LWD-A	EF	3	353	1	16	10				
1+395	LWD-A	VO			1	20					2
1+503	LWD-A	EF	1	44	1	12	82				
1+503	LWD-A	EF	2	40	1	15	90				
1+503	LWD-A	EF	3	41	0		0				
1+518	LWD-A	EF	1	38	0		0				
1+518	LWD-A	EF	2	33	3	12, 12.5, 14	327				
1+518	LWD-A	EF	3	42	0		0				
1+549	LWD-R	EF	1	393	2	16.5, 12.5	18				13
to		EF	2	373	4	13.5, 12, 15, 15	39				11
1+608	LWD-A	EF	3	395	1	19	9				4
		EF	4	324	0		0				3
1+830	LWD-R	EF	1	376	4	13.5, 15.5, 14, 11,	38				1
1+830	LWD-R	EF	2	331	4	17, 15, 18, 12	44				3
1+830	LWD-R	EF	3	261	2	10, 12	28	1	26	14	3
1+830	LWD-R	EF	4	189	2	14, 16	38				1
1+830	LWD-R	VO			3	30, 30, 16					
2+135	LWD-A	EF	1	58	2	16, 12	124				
2+135	LWD-A	EF	2	70	1	13	51				
2+135	LWD-A	EF	3	14	0		0				
2+579	LWD-A	EF	1	116	1	16	31				
2+579	LWD-A	EF	2	135	2	17, 12	53				
2+579	LWD-A	EF	3	145	1	17	25				
2+579	LWD-A	EF	4	119	0		0				
2+670	LWD-R	EF	1	114	0		0				
2+670	LWD-R	EF	2	115	0		0				1
2+670	LWD-R	EF	3	87	0		0				
2+810	LWD-A	EF	1	96	0		0				
2+810	LWD-A	EF	2	101	0		0				
2+810	LWD-A	EF	3	80	0		0				
2+810	LWD-A	VO			1	11					2
2+910	LWD-A	EF	1	96	1	10	38	1	24	38	
2+910	LWD-A	EF	2	87	0		0				
2+910	LWD-A	VO			1	16					1
3+650	LWD-R	EF	1	195	2	13.5, 11.5	37				3
3+650	LWD-R	EF	2	145	1	11	25				2
3+650	LWD-R	EF	3	138	0		0				2

[1] Location chainage is distance upstream of reach break between Reach 7 and Reach 8.

[2] CPE is number of salmonids caught per hour of effort

Table 6. Summary of fish survey at restoration structures in Colt Creek, 9 September 2001.

Site Number	Location [1] (chainage in m)	Survey Method	Pass No.	Sample Time (seconds)	Salmonids Captured						Sculpin
					Rainbow Trout			Bull Trout			
					Number	Length (cm)	CPE[2]	Number	Length (cm	CPE[2]	Number
1 (LWD-R)	0+020 (R 5)	EF	1	137	0		0	0		0	0
			2	156	0		0	0		0	0
			3	128	0		0	0		0	0
3 (LWD-R)	0+440 (R 8)	EF	1	128	0		0	0		0	0
			2	123	0		0	0		0	0
			3	113	0		0	0		0	0
4 (LWD-R)	0+795 (R 8)	EF	1	108	0		0	0		0	0
			2	116	0		0	0		0	0
			3	91	0		0	0		0	0
4 (RIFF)	0+785 (R 8)	EF	1	62	0		0	0		0	0
			2	42	0		0	0		0	0
			3	44	0		0	1	14.5	82	0
			4	53	0		0	0		0	0
			5	64	0		0	0		0	0
5 (LWD-R)	0+800 (R 9)	EF	1	156	0		0	2	14, 25	46	0
			2	187	0		0	2	25.5, 26	39	0
			3	153	0		0	0		0	0
6 (LWD-R)	0+900 (R 9)	EF	1	140	1	18.5	26	0		0	0
			2	106	0		0	0		0	0
			3	109	0		0	0		0	0
7 (LWD-R)	0+992 (R 9)	EF	1	148	1	21	24	0		0	0
			2	137	0		0	1	21	26	0
			3	137	0		0	0		0	0
8 (LWD-R)	0+000 (R10)	EF	1	106	0		0	1	21	34	0
			2	96	0		0	1	20	38	0
			3	97	0		0	0		0	0
9 (LWD-R)	0+140 (R10)	EF	1	100	0		0	0		0	0
			2	105	0		0	0		0	0
			3	95	0		0	0		0	0
10 (LWD-A)	0+980 (R10)	EF	1	33	0		0	0		0	0
			2	40	0		0	0		0	0
			3	36	0		0	0		0	0

Table 6. Summary of fish survey at restoration structures in Colt Creek, 9 September 2001.

Site Number	Location [1] (chainage in m)	Survey Method	Pass No.	Sample Time (seconds)	Salmonids Captured						Sculpin
					Rainbow Trout			Bull Trout			
					Number	Length (cm)	CPE[2]	Number	Length (cm	CPE[2]	Number
11 (LWD-R)	1+060 (R10)	EF	1	66	0		0	0		0	0
			2	71	0		0	0		0	0
			3	67	0		0	0		0	0
12 (LWD-A)	1+280 (R10)	EF	1	18	0		0	0		0	0
			2	14	0		0	0		0	0
			3	15	0		0	0		0	0
13 (LWD-A)	1+300 (R10)	EF	1	44	0		0	0		0	0
			2	49	0		0	0		0	0
			3	41	0		0	0		0	0
14 (LWD-A)	1+340 (R10)	EF	1	15	0		0	1	15	240	0
			2	28	0		0	0		0	0
			3	15	0		0	0		0	0
14 (LWD-R)	1+350 (R10)	EF	1	67	0		0	1	13	54	0
			2	67	0		0	0		0	0
			3	54	0		0	0		0	0
15 (LWD-A)	1+511 (R10)	EF	1	26	0		0	0		0	0
			2	16	0		0	0		0	0
			3	14	0		0	0		0	0
15 (LWD-A)	1+523 (R10)	EF	1	30	0		0	0		0	0
			2	36	0		0	0		0	0
			3	19	0		0	0		0	0
16 (LWD-R)	0+560 (R11)	EF	1	78	0		0	0		0	0
			2	66	0		0	0		0	0
			3	63	0		0	0		0	0

[1] Location chainage is distance upstream of reach break.

[2] CPE is number of salmonids caught per hour of effort

Table 7. Summary of remedial work recommendations.

Priority	Watershed	Distance	Site ID	Maintenance Score	Problem / Fix	Estimated Cost of Work	Person Days Required	Materials and Equipment Required	Prescription Required
1	Colt, Reach 9	0+890	Site 6 RIFF	1	riffle unravelling do to headcutting. Add boulders	$5,000	4	Cat E120B and 30 m^3 boulders	No
2	Colt, Reach 9	0+900	Site 6 LWD-R	2	Tweeking required to add debris catcher and back water LWD structure.	$3,000	2	Cat E120B, 4 logs, drill, epoxy, cable, 8 boulders	No
3	Colt, Reach 10	0+126	Site 9 RIFF	2	should be better stepped. Add boulders to crest and apron.	$5,000	2	Cat E120B and 20 m^3 boulders	No
4	Colt, Reach 10	1+523	Site 15 LWD-A	2	patch-work, bank slippage behind structure. No tailout contol.	$10, 000	4	Cat E120B and 10 m^3 boulders	No

FIGURES

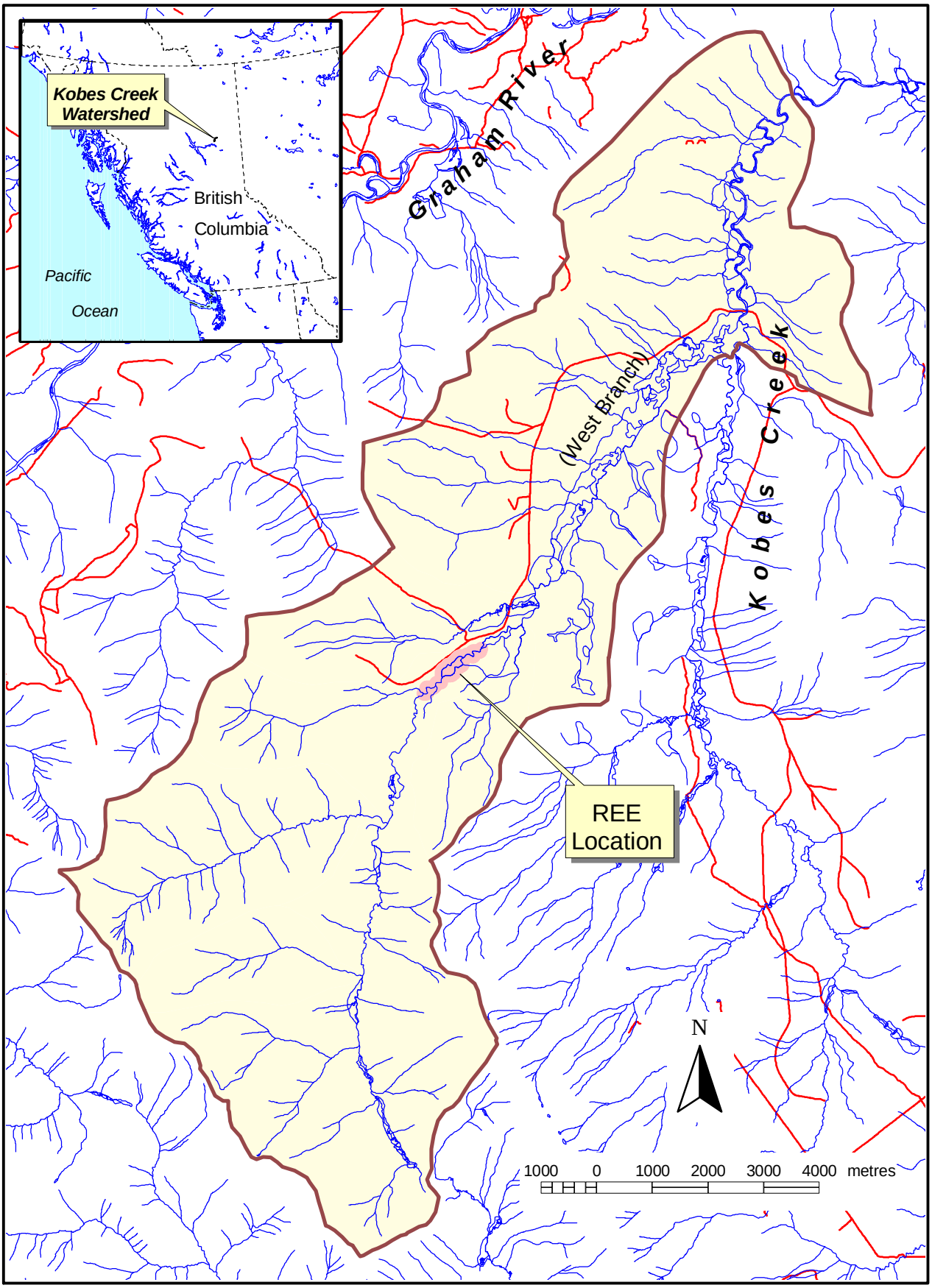

Figure 1. Location of routine effectiveness evaluation (REE) in Kobes Creek, August 2001.

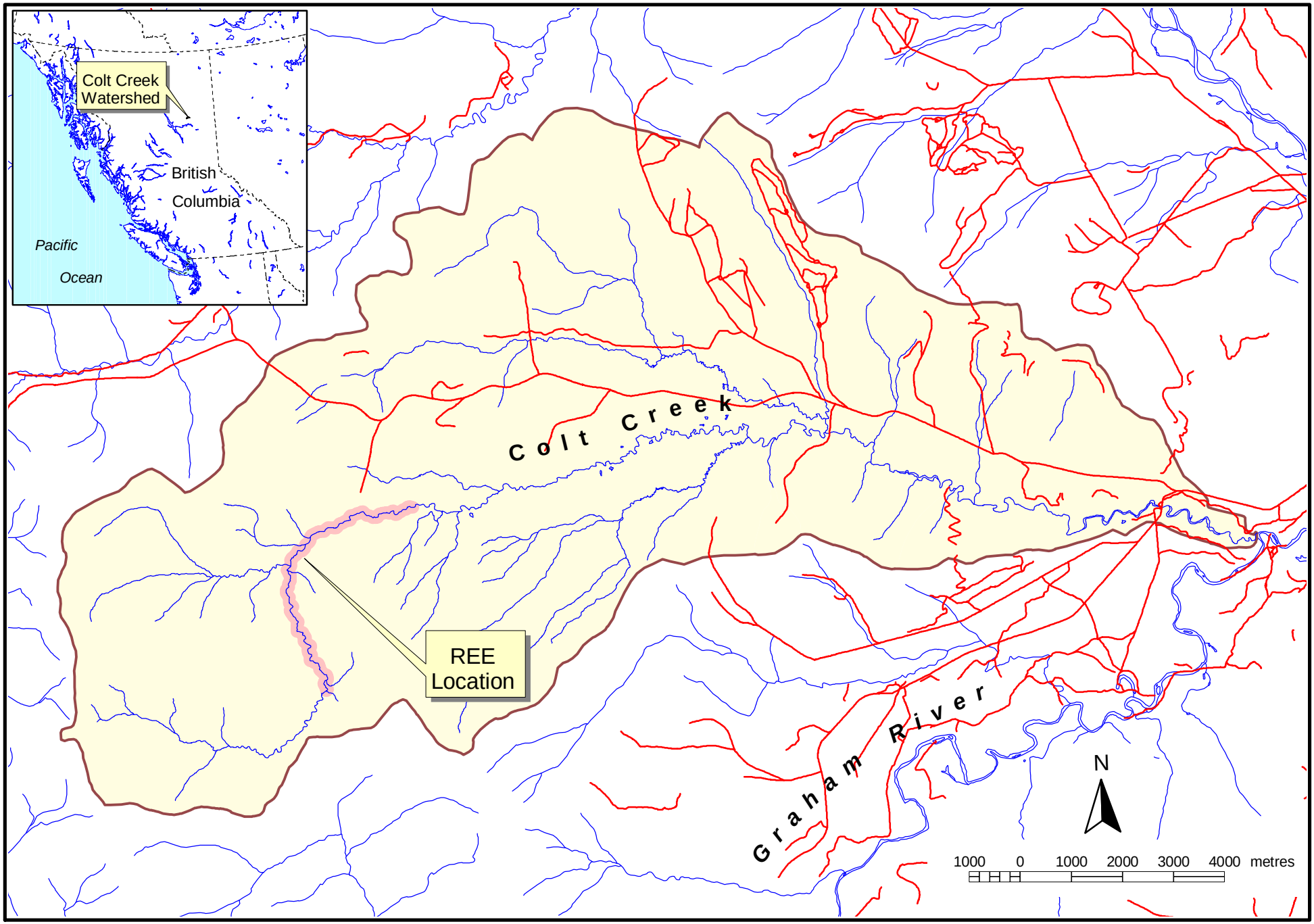

Figure 2. Location of routine effectiveness evaluations (REE) in Colt Creek, August 2001.

Figure 3. Summary of performance ratings across all structure types (± one standard deviation).

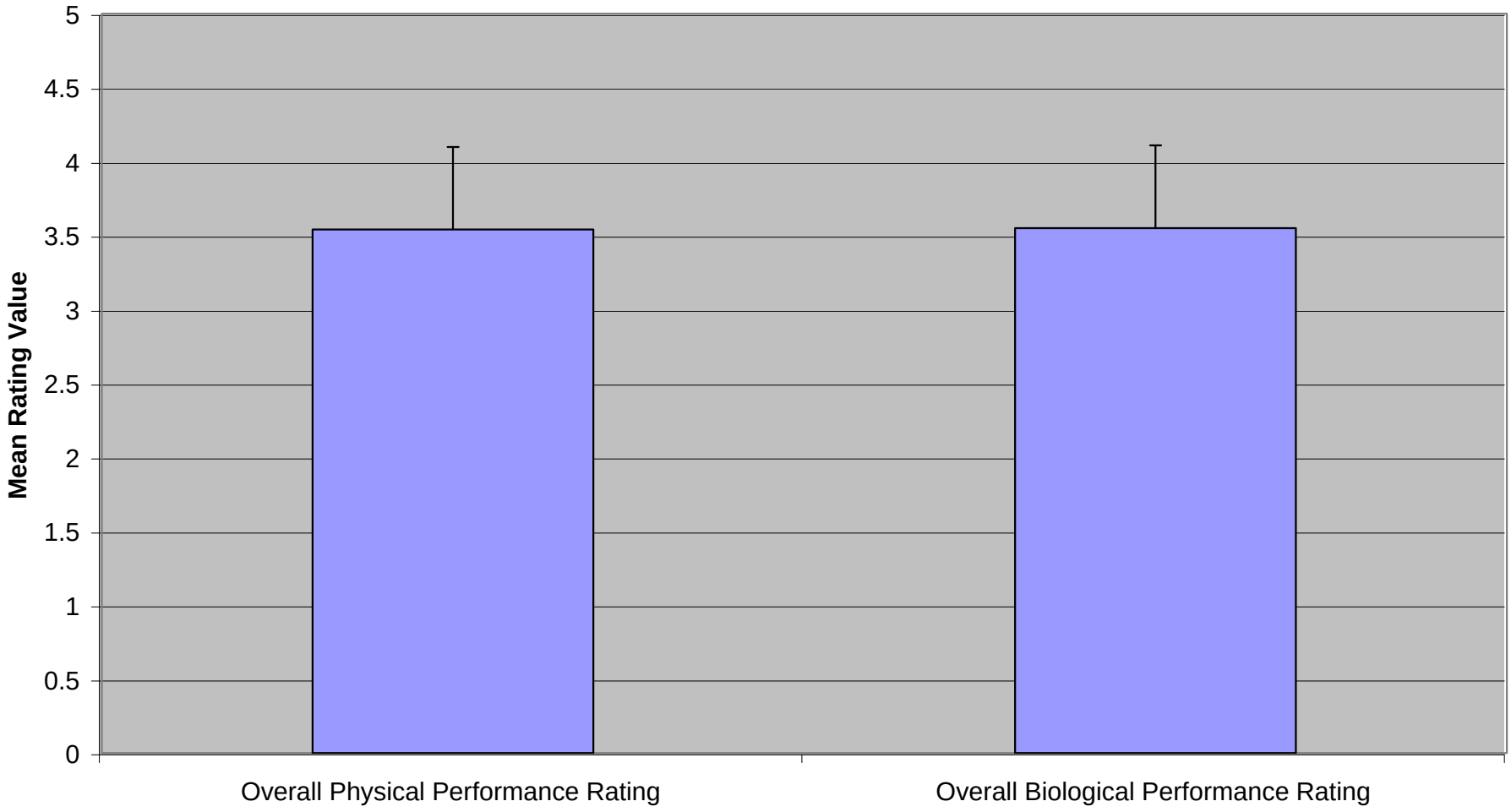

Figure 4. Summary of performance ratings for individual structure types (± one standard deviation)

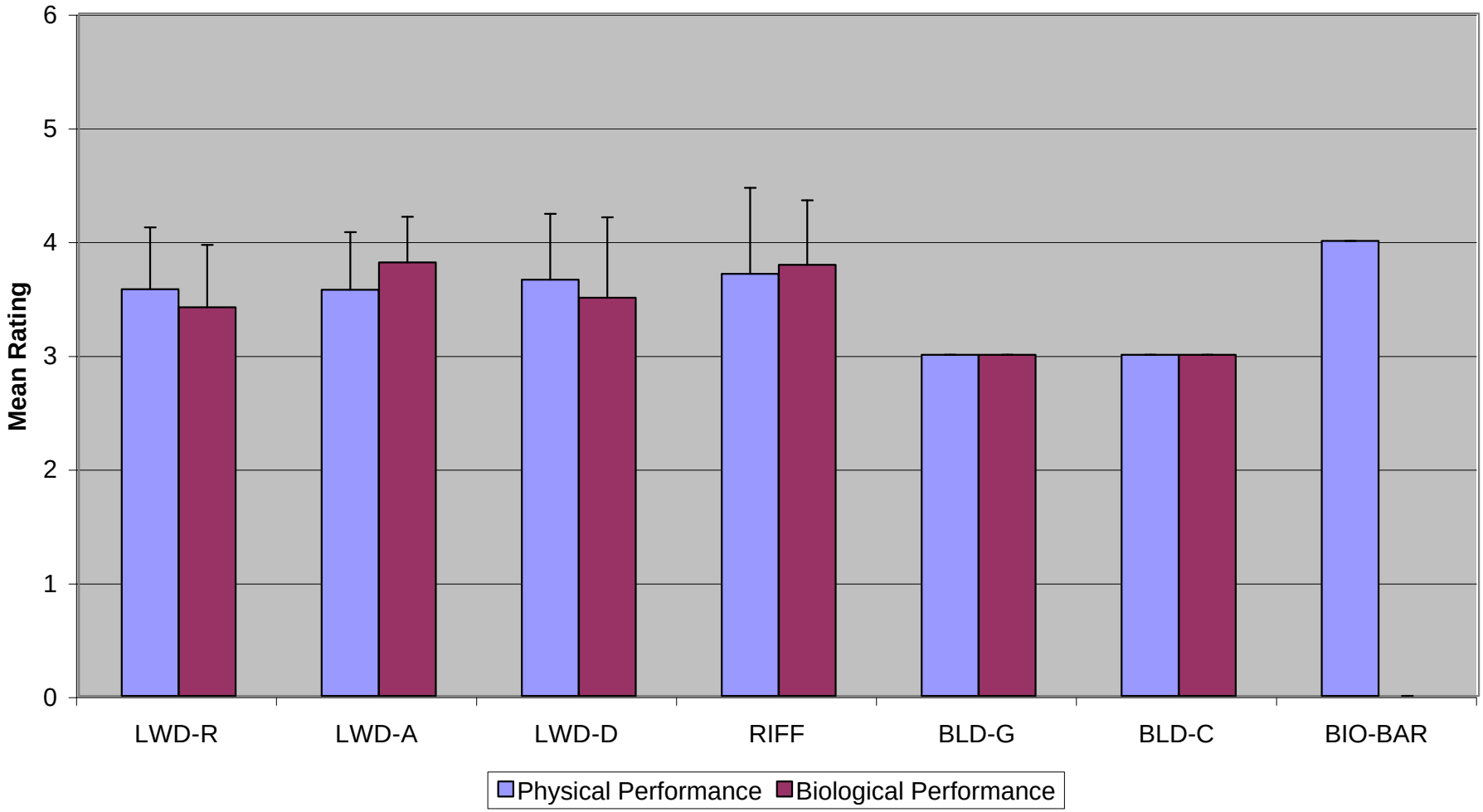

PHOTO PLATES

Photo 1. Downstream view of LWD-R (LBJ5) on RB West Kobes Creek at chainage 0+260 m (N 56º19.944 W 122º23.999). Photo ref. 154-23A, 24 Sept 2001.

Photo 2. Downstream view of LWD-A (LT7) on RB West Kobes Creek at chainage 0+340 m (N 56º19.900 W 122º24.001). Photo ref. 154-20/21A, 24 Sept 2001.