Final Report

WATERSHED RESTORATION PROGRAM

MISSION CREEK WATERSHED STREAM ASSESSMENT

Prepared for:

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Southern Interior Sub-Regional Office
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Project 511.01

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Reference: 511.01

Mr. Phil Epp, P.Ag.
B.C. Ministry of Environment, Lands & Parks
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Dear Mr. Epp:

Re: Mission Creek Stream Assessments

Summit Environmental Consultants Ltd. is pleased to provide you with four (4) bound copies and one (1) unbound copy of our **final report** for the above project.

We trust that this completes our assignment to your satisfaction. If you would like to discuss any aspect of this report, please give me a call.

Yours truly,

Summit Environmental Consultants Ltd.

Hugh Hamilton, Ph.D., P.Ag.
Senior Environmental Scientist

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1.0 INTRODUCTION

1.1 General Watershed Description

Mission Creek is the largest tributary of Okanagan Lake and is part of the Columbia River drainage system (Figure 1.1). It flows westward into the lake at the City of Kelowna from the Okanagan Highland, draining a total area of about 830 km^2. The elevation at the mouth is ±342 m and the elevation of the highest point in the watershed (Little White Mountain) is 2170 m, giving a relative basin relief of ±1828 m. Figure 1.2 shows the monthly mean discharge of Mission Creek at East Kelowna, about eight kilometres from the mouth. As indicated by the large late spring/early summer flow peak, much of the annual flow is derived from snowmelt in the upper watershed. The bedrock geology of the Mission basin includes sedimentary (siltstone, sandstone, conglomerate), igneous (grey intermediate volcanic flows, andesite & basaltic flows), and metamorphic rocks (granitic gneiss) (Greenough and Roed, 1995). Surficial deposits include a complex array of deltaic, alluvial fan, fluvial-glacial, and morainal deposits (Nasmith, 1962). Soils include brunisols, chernozems, luvisols and podzols (Luttmerding, 1995).

Fish have been present in the Mission Creek watershed since postglacial times. Rainbow trout (*Oncorhynchus mykiss*), Kokanee salmon (*Oncorhynchus nerka*), and Burbot (*Lota lota*) are the most common indigenous sport species in Mission Creek (Smith, personal communication, 1995). Several non-game fish species are also present. More recently, hatchery releases of trout and char in the small upper lakes of Mission Creek watershed have dispersed sport fish through a wider range of stream habitats. These fish exhibit a variety of life history patterns within the watershed, which can produce complex population dynamics. For example, Rainbow trout can live their entire life cycle within a small stream reach, while other rainbow trout can migrate widely within and between sub-basins of the Mission watershed. There are also spawning populations of sport fish that migrate from Okanagan Lake into Mission Creek. Rainbow trout, Kokanee salmon and Burbot

are some of the lake fish that spend part of their life cycle in Mission Creek, and most of their adult life in Okanagan Lake.

The sport fishery in Okanagan Lake is dependent on tributary streams for trout and Kokanee spawning. During the 1960s and 1970s, annual spawning populations of more than 300,000 Kokanee were common (Smith, personal communication, 1995). Since the mid-1980s, there has been a rapid decline of Okanagan Lake Kokanee stocks. This is reflected in reduced Kokanee returning to spawn in Mission Creek. Less than 100,000 Kokanee have been observed spawning in the last several years, with the lowest return year having less than 20,000 fish return.

In addition to its fisheries values, the Mission Creek system provides domestic and irrigation water for the South East Kelowna and Black Mountain Irrigation Districts, plus a large number of individuals.

1.2 Project Background

In 1994 the Mission Creek watershed was selected for inclusion in the provincial Watershed Restoration Program (WRP). The four phases of WRP are:

1. Assessment
2. Prescription
3. Implementation, and
4. Monitoring

In the Kamloops Forest Region the assessment phase has been divided into i) streams/riparian zones and ii) upslope areas. Summit Environmental Consultants Ltd. ("Summit") was retained by the B.C. Ministry of Environment, Lands and Parks (B.C. MELP) in October 1994 to conduct the stream assessment component of the assessment phase of the WRP for the Mission Creek

Figure 1.1. Mission Creek location map.

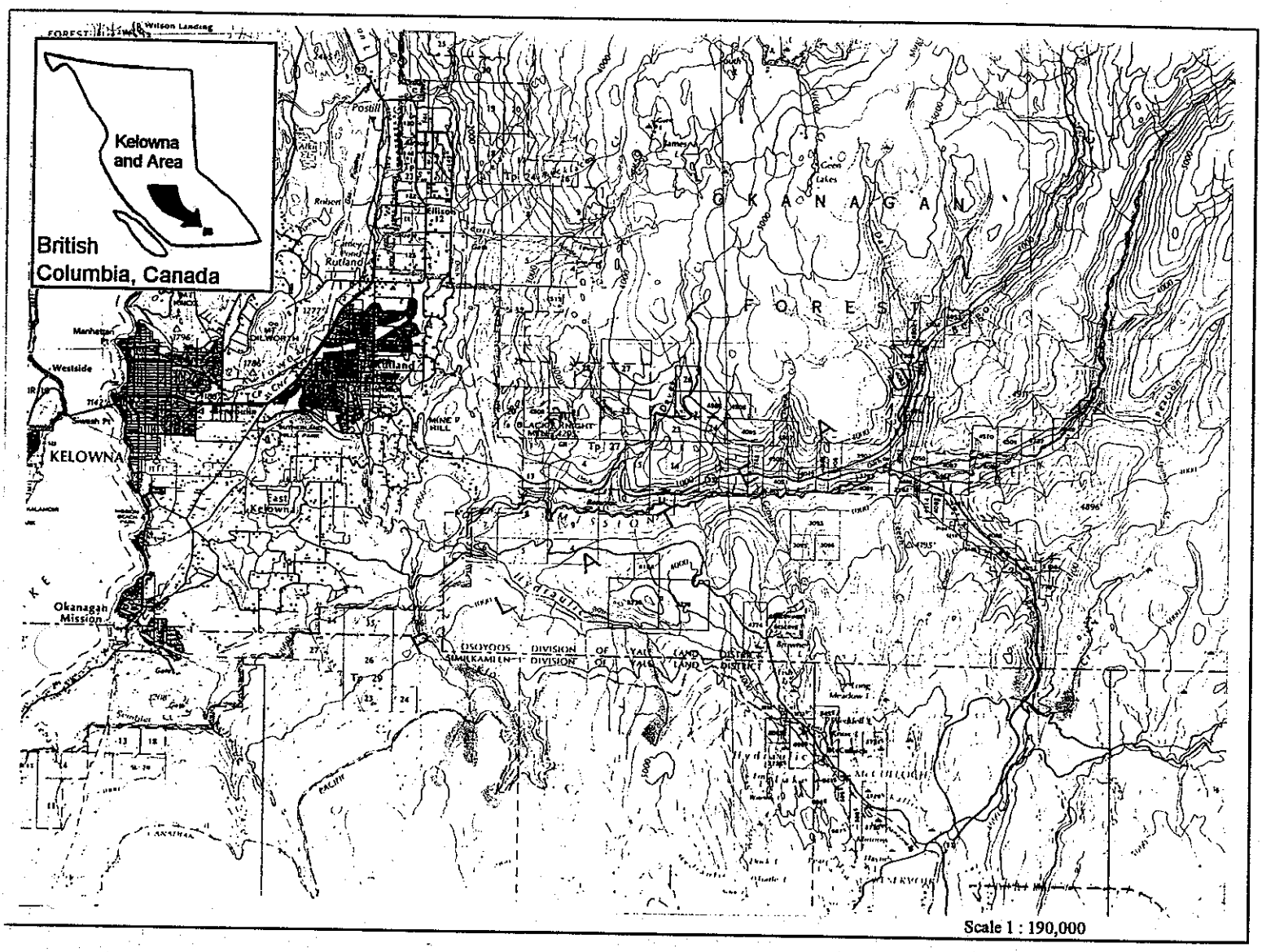
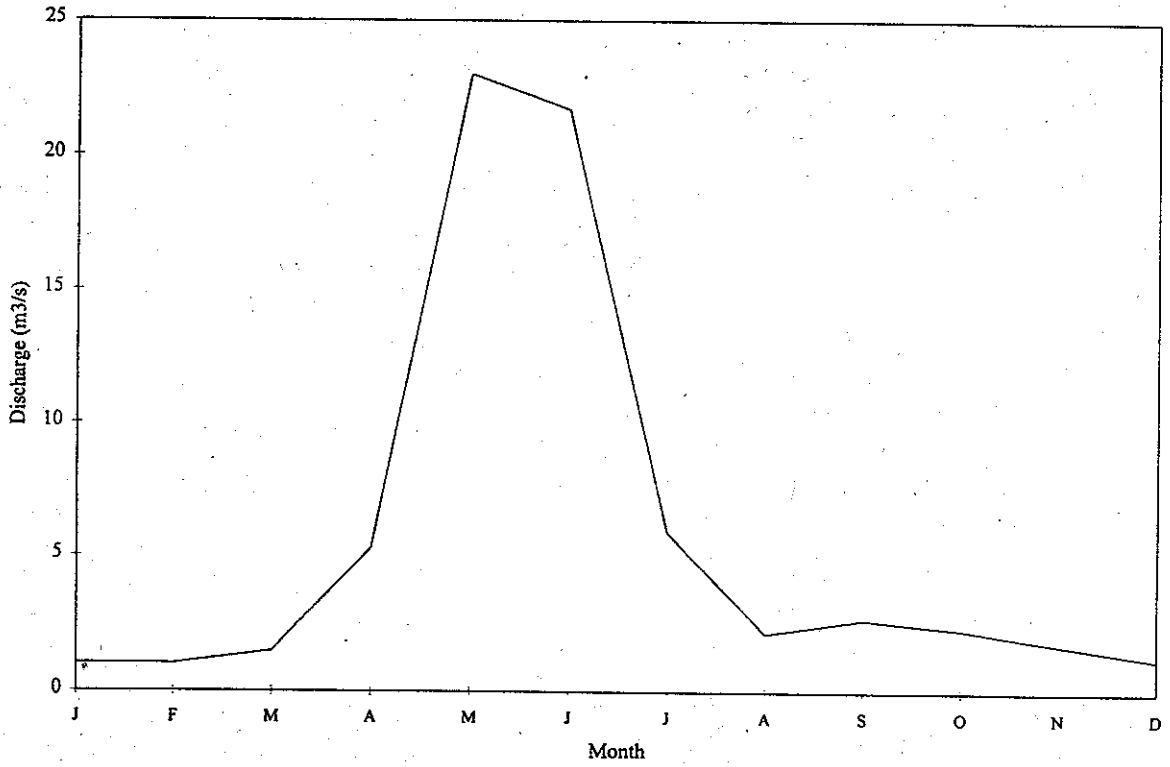


Figure 1.2. Mission Creek mean monthly discharge: WSC Station #08NM116.



watershed. The overall intent of the Mission Creek WRP stream assessment project is to identify and evaluate potential opportunities to improve fish habitat and water quality at locations which have been negatively affected by forest harvesting activities within the watershed (see Appendix A - Terms of Reference). The assessment phase includes fish habitat and stream channel assessments, with emphasis on locations associated with forest harvesting activities.

1.3 Objectives

The specific objectives of the WRP stream assessment for Mission Creek are to:

1. Videotape a selected number of streams from a helicopter and provide audio commentary concerning geomorphological and stream habitat features and possible degraded sites. The streams that were inspected during this study were pre-selected by B.C. MELP staff in Penticton and included Darley, Hilda, Belgo, Pearson, Joe Rich, Hydraulic, Pooley, KLO, and Mission Creeks;

2. Review the videotapes and map those sites which were identified as being potentially degraded. Classify the potentially degraded sites according to type, cause, source and degree of impact;

3. Conduct ground truthing surveys at each of the sites identified on the helicopter video at which there appeared to be significant potential impacts associated with forestry operations. Photograph each site and assess the condition of the channel, and compile habitat information according to Appendices 2 and 3 of Watershed Restoration Technical Circular No. 8. (B.C. MELP/B.C. MOF, 1994);

4. Review existing literature, reports, historic and recent aerial photographs, and hydrotechnical data concerning each stream;

5. Compile a sediment source inventory for each stream;

6. Collect anecdotal information on the streams from persons and agencies familiar with the streams;

7. Priorize degraded sites, reaches and/or streams for restoration and, if possible, propose initial remedial measures; and

8. Identify and recommend further assessment procedures, as required.

2.0 METHODS

2.1 Overview

The methodology employed in this study included an initial helicopter survey of the streams, development of an impact coding system, review of the videotapes obtained during the helicopter surveys, coding of sites, field inspections of potential high impact sites, reviews of aerial photographs, maps and published information, and telephone and personal interviews with persons with knowledge of the streams.

2.2 Helicopter Surveys and Initial Site Classification

The helicopter surveys were conducted on October 22, 1994. A hydrologist/geomorphologist and a fisheries biologist were present on the flights. A video camera was mounted in the nose of the helicopter, and a global positioning system (GPS) receiver in the helicopter provided continuous

location coordinates in latitude/longitude units (degrees/minutes/hundredths of minutes) which were imprinted on the video tape. The helicopter flew up each stream from the mouth to the headwaters at an altitude of about 50-60 m and an air speed of about 60 km/h. All personnel in the helicopter were outfitted with microphones and provided verbal commentary direct to the video/audio tape regarding watershed and habitat characteristics and the location of potentially degraded sites.

When the helicopter surveys were completed, a coding system for stream impacts was drawn up for use when reviewing the video tape (Table 2.1). The intent of the coding system was to provide a standard method for classifying the sites and determining which sites were visited in the field. The coding system includes four elements; impact type, cause, source and potential impact. The video tapes were reviewed in late October and November, 1994. The sites identified on the video were then classified according to the coding system on Table 2.1 and the information summarized into tables, with one table per stream. The locations of the sites were plotted on 1:50,000 scale map sheets.

2.3 Field Surveys

The field surveys were initiated during November 1994 and completed in the spring and summer of 1995. The field crew consisted of a hydrologist/geomorphologist and a fisheries biologist. The objective was to visit all sites which had been classified from the videotape as having a high probable impact and where the source was either forestry (i.e., code ending with "F.1" - source of problem is forestry activities, high probable impact) or unknown (i.e., code ending with "U.1" - uncertain source, high impact). In the field the code assigned to the site was reviewed and modified based on the field inspection, if needed.

Table 2.1 Coding system for stream impacts.

The coding system employed is a combination of four factors: Type, Cause, Source and Impact, which are outlined in the order they appear in the code, as follows:

1. Type (Potential problem)

Water quality	Q
Fish barrier	Fb
Fish spawning habitat degradation	Fs
Fish Rearing habitat degradation	Fr

2. Cause of the Problem

Streambanks (slumps, slides, bank erosion)	S
Road fill-slopes	F
Culverts or bridges	C
Debris	D
Bank Protection	P
Waterfall	W

3. Land Use Activity Contributing to the Problem

Forestry	F
Agriculture	A
Highways/Roads/Railways	Hw
Residential/recreational/industrial	R
Natural	N
Uncertain	U

4. Estimated Degree of Impact

High	1
Medium	2
Low	3
Unknown	4

Examples:

Q.F.F.2	Water quality • Road fill-slopes • Forestry • Medium Impact
Fs.D.F/N.1	Fish spawning habitat degradation • Debris • Forestry/Natural • High

The steps taken in the field included:

1. The site location was verified using a hand-held GPS receiver and maps (1:50,000 NTS and larger-scale forest cover maps).

2. A general reconnaisance of the reach was conducted, typically over a distance of 250 m upstream and 250 m downstream of the site identified from the video.

3. Fish habitat information was compiled by completing DFO/MELP Stream Information Summary System (SISS) forms. The forms include stream gradient, width (channel and wetted), depth, bed material, cover, bank height, debris, obstructions, and observed fish species. The information collected meets and generally exceeds the information required in Technical Circular No. 8 (B.C. MELP/B.C. MOF, 1994).

4 Stream geomorphology was examined and documented, including bed and bank materials, stream gradient, sediment deposition areas, width of floodplain, slope of adjacent hillsides, presence/absence of exposed slopes, tree stability on banks and slopes, and potential sediment sources. The channel assessments were similar to the subsequently released Channel Assessment Procedure (B.C. MOF, 1995).

5. The amount of large woody debris (LWD) present in the streams was noted; implications for fish passage, spawning and rearing were assessed.

6. Stream habitat features and potential sources of problems were photographed.

7. Fish and wildlife observations were noted.

8. Differences between existing stream regimes (geomorphology, water quality, fish habitat) and natural (e.g., pre-harvest) conditions (including natural variation) were estimated.

9. The nature and extent of forest harvest impacts was assessed.

10. Site feasibility for restoration was assessed, including site sensitivity to restoration (i.e., level of effort needed to produce a significant result), possible methods, site access and logistics.

2.4 Information Review and Summary

The field investigations were supplemented by reviewing published information on the subject streams and by telephone or personal interviews with persons familiar with each stream. Published information included:

- NTS 1:50,000 topographic maps
- B.C. MOF forest cover maps (typical scales 1:15,000-1:30,000)
- aerial photographs from 1992-1993 (colour) and the 1950s (black and white)
- DFO/MELP Stream Information Summary sheets, where available
- MELP water licence lists
- available geomorphological and soil survey reports and maps

For each stream, reaches were delineated based on changes in stream gradient and/or valley shape (e.g., U-shaped or incised) as determined from the topographic maps, helicopter survey, and field notes.

2.5 Sediment Source Inventory

The black and white aerial photographs from the 1950s were obtained for historical comparison with the 1992-93 aerial photographs. The comparisons assisted in determining locations and degrees of impacts caused by forest harvesting, and were used to locate sediment sources and to estimate rates of sediment supply, where feasible.

Erosion and sedimentation are naturally occurring processes. Even in watersheds where no forest harvest has occurred, erosion (surface, gully, bank) and natural mass movements contribute sediment to streams. These processes are termed geologic or natural erosion. Erosion caused by forest harvest or other land use activities is termed accelerated erosion. The overall contribution of individual sediment sources to the sediment load of a stream is difficult to determine, even in detailed studies. It is possible that high frequency but low magnitude sources, such as bank erosion, contribute as much or more sediment than low frequency - high magnitude sources such as landslides. However the large magnitude sources are easier to identify from aerial photographs and field reconnaisance, and are more likely to respond to mitigative measures. Thus the sediment source inventory focused on two sediment source types:

1. Large natural erosion (e.g., large exposures of soil on the outside of a river meander), and
2. Accelerated erosion (e.g., mass movements related to roads, erosion at bridges, and bank erosion near log jams).

A list of sources was compiled for each creek covered by the assessment. Where possible (e.g., landslide scars), the dimensions were determined and a note was made on changes between the 1950s and 1990s.

3.0 REPORT FORMAT AND PROJECT DELIVERABLES

Each of the nine (9) streams, including the Mission Creek mainstem, included in this report are described in a separate report section. The tributaries of Mission Creek are presented first, in the order Darley Creek, Hilda Creek, Belgo Creek, Pearson Creek, Joe Rich Creek, Hydraulic Creek, Pooly Creek and KLO Creek, followed by the Mission Creek mainstem.

An appendix is included for each stream which was assessed (Appendicies B through J). The appendices contain photographs compiled for each stream, a table with the videotape transcripts and impact codes, and other relevant stream-specific information. Laminated 1:50,000 scale NTS maps for the streams presented in this report are included as Attachment 1, with the 1990s aerial photographs as Attachment 2, and the 1950s aerial photographs as Attachment 3.

4.0 DARLEY CREEK

4.1 General Description

Darley Creek has a watershed area of 29 km^2, and is a tributary of Belgo Creek. It originates on the Okanagan Plateau at an elevation of about 1525 m, and flows in a southerly direction. It joins Belgo Creek just upstream of the site of a major landslide which occured in 1990. In the lower reaches, Darley Creek cuts through fluvioglacial deposits associated with Belgo Creek. Additional descriptive information is contained in Table 4.1. The NTS map sheet covering the creek (#82 E/14) is provided in Attachment 1, colour aerial photographs are in Attachment 2, and black and white aerial photographs are in Attachment 3. Video transcripts, photographs, and other relevant information are provided in Appendix B.

Two (2) sites were classified as ending in "F.1" from the helicopter survey. Neither site was inspected due to lack of road access. The Darley Forest Service Road, which is accessed from Belgo Creek, was overgrown with alders, making truck access to these sites impossible. Therefore the assessment of the two sites was completed from the video transcripts and aerial photograph interpretation.

4.2 Reach Descriptions

Three reaches were identified on Darley Creek (Table 4.2). Reach #1 extends from the mouth to a distance 1.1 km upstream where there is an increase in gradient to delineate the reach break. This reach cuts through a fluvial-glacial terrace associated with the Belgo Creek channel. Reach #2 is the portion of Darley Creek that descends from the Thompson Plateau. The average gradient is 11% and the valley is relatively deeply incised, with little or no valley-flat. Reach #3 is the plateau area, where the gradient is about 6% and the valley is more broad.

Table 4.1 General characteristics of Darley Creek

Parameter	Information
NTS Map sheet no.	82 E/14 Kelowna
Latitude & longitude of mouth	49° 53.6' N, 119°08.4' W
Watershed area (km^2)	29
Stream length (km)	7.4
No. of reaches	3
Discharge (mean/highest month/lowest month)	Not gauged
Biogeoclimatic zones/subzones[1]	MSdm1
General flow direction	South
Next higher order stream or lake	Belgo Creek
Land use	Forestry, recreation
No. of water licences	none
Known fish species	no data
No. of F.1 & U.1 sites identified	2
No. of sites field checked	0

Table 4.2 Stream reach data summary for Darley Creek.

Reach #	Reach length (m)	Gradient (%)	Map sheet #	Site #'s within Reach
1	1250	7	82 E/14	1, 2
2	5000	11	82 E/14	3 - 6
3	1125	6	82 E/14	7
Total	7375			7

[1] Biogeoclimatic zone codes are in Appendix K.

4.3 Site Descriptions

Two sites were identified from the helicopter flight as having high potential impacts due to forestry activities.

Site #: 4 **Date Inspected:** No field inspection (poor road access)
Impact Code: Fs/Q.D.F.1 **Coordinates:** 49°56.1'N 119°09.8'W
Reach #: 2 **Map sheet #:** 82 E/14

Observations from the helicopter survey indicated that logging had taken place across the stream with no buffer, and that woody debris was present in the stream channel. Examination of colour aerial photographs from 1993 showed evidence of erosion on the slope above the left bank. The cutblock on the right bank had been recently burned at the time the photograph was taken. Re-establishment of a riparian buffer should be completed as soon as possible, since the cutblock does appear to be a sediment source.

Site #: 6 **Date Inspected:** No field inspection (poor road access)
Impact Code: Fs/Q.D.F.1 **Coordinates:** 49°56.9'N 119°09.7'W
Reach #: 2 **Map sheet #:** 82 E/14

This site consists of two box culverts located on two branches of Darley Creek, just upstream of their confluence. The crossings are within the same large cutblock as Site #4. A landing with exposed soils is situated on the "wedge" between the two branches. As with Site #4, there appears to be no riparian buffer. Given the closeness to the streams, the landing should be reclaimed. The culverts appear adequately sized (on the basis the helicopter survey and aerial photographs).

4.4 Sediment Source Inventory

The results of the sediment source inventory are summarized in Table 4.3. Three of the sources identified from the aerial photo survey were tributaries to the stream. In addition, the erosion described at Sites #4 and #6 above have been added to the list of sediment sources.

4.5 Darley Creek Summary and Recommendations

A total of two sites on Darley Creek were identified from the helicopter survey as having a high level of impact from forestry (F.1) activities. These sites were not inspected due to poor road access, and the assessment were completed from aerial photographs and the helicopter survey videotape. The F.1 sites are:

Site #4	Logging across stream channel; woody debris in channel; adjacent slope erosion
Site #6	Unvegetated landing adjacent to a fork in the stream; potential sediment source

Both sites are associated with a cutblock that has been harvested since 1990. The cutblock extends across the upper reach of the creek, apparently without a riparian buffer. Exposed landings near the creek and an actively eroding slope suggest that the cutblock is a sediment source. The block should be inspected to assess to what degree riparian vegetation has been re-established, and to assess whether or not the natural regeneration might be enhanced. The landing near Site #6 should be reclaimed, if the surface is still exposed.

Table 4.3 Sediment Source Inventory: Darley Creek

Location symbol(1)	Coordinates		Feature	Composition(2)	Dimensions(3)		Present in(4)		Larger in 1990's yes/no?
	Lat (N)	Long (W)			Width (m)	Length (m)	1950's yes/no?	1990's yes/no?	
2.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
2.2	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
4	49 56.1'	119 9.8'	Cutblock slope erosion	sa, si	n/a	n/a	no	yes	yes
5.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
6	49 56.9'	119 9.7'	Landing at streamside	sa, si, g	n/a	n/a	no	yes	yes

(1): Refer to map: 82 E/14

(2): Composition is determined from aerial photographs. Locations which have been checked in the field are indicated by a subscript 'f'. Compositions in brackets indicate minor amounts of the given texture.

si = silt
sa = sand
g = gravel

(3): Width is distance measured along the stream. Length is distance measured from the toe to the zone of initiation (In the case of an eroding bank, length refers to 'bank height')

(4): Two sets of aerial photos were examined in this study: one set flown in 1950's and second set flown in 1990's

(5): n/c - No aerial photo coverage available at the time of the Sediment Source Inventory

(6): Location symbols designated with "R" are referenced by reach locations (e.g. R3a is located in Reach 3).

(7): Location symbols designated with a number are referenced by site numbers from the video transcript (e.g. 18a is located between sites #18 and #19).

5.0 HILDA CREEK

5.1 General Description

Hilda Creek is another tributary of Belgo Creek and has a watershed area of 21 km^2. A total of four (4) sites were classified as ending in "F.1" or "U.1" from the helicopter survey. All sites were inspected in the summer of 1995. There is a single water licence on the creek, which is held by the Black Mountain Irrigation District. Additional descriptive information is contained in Table 5.1. The NTS map sheets covering the creek (82 E/14, 82 L/3) are provided in Attachment 1, colour aerial photographs are in Attachment 2, and black and white aerial photographs are in Attachment 3. Video transcripts, photographs, and other relevant information are provided in Appendix C.

5.2 Reach Descriptions

A total of six reaches were identified on Hilda Creek. Reach length and gradient data are provided in Table 5.2.

Reach #1 extends from the mouth upstream to a series of beaver dams. There are many sections of channel with a combination of spawning-sized gravels and good cover. The cover is provided by overhanging vegetation, undercut banks and deep pools. Numerous debris jams create the potential for increased bank erosion and fish barriers.

Reach #2 is a low gradient reach with numerous beaver ponds and wetlands. Trout were abundant at the time of the field survey, indicating the presence of good rearing habitat. There is negligible buffer between a cutblock and the ponds, which has greatly reduced the amount of natural cover along the ponds and wetland margins. The water temperature was 5°C warmer at the pond outlet than the inlet at the time of the site inspection. Trout observed in the pond ranged from 80 to 200 mm fork length.

Table 5.1 General Characteristics of Hilda Creek

Parameter	Information
NTS Map sheet no.	82 E/14 Kelowna
Latitude & longitude of mouth	50°00.1' N, 119°04.5' W
Watershed area (km^2)	21
Stream length (km)	5.3
No. of reaches	6
Discharge (mean/highest month/lowest month)	Not gauged
Biogeoclimatic zones/subzones[2]	MSdm1, ESSFxc
General flow direction	South
Next higher order stream or lake	Belgo Creek
Land use	Forestry, recreation
No. of water licences	1
Known fish species	Rainbow trout
No. of F.1 & U.1 sites identified	4
No. of sites field checked	4

Table 5.2 Stream reach data summary for Hilda Creek.

Reach #	Reach length (m)	Gradient (%)	Map sheet #	Site #'s within reach
1	750	3	82 L/3	1 - 3
2	250	1	82 L/3	4
3	1000	2	82 L/3	5
4	250	6	82 L/3	6-7
5	500	10	82 L/3	8-9
6	2500	9	82 L/3	-
Total	5250			

[2] Biogeoclimatic zone codes are in Appendix K.

Reach #3 is characterized by an incised bedrock channel with numerous deep pools and overhanging bedrock banks. The gradient is about 1-2%. There is a considerable amount of windfall along the right bank, but the woody debris is not blocking the channel, and has improved the cover in places. Numerous deposits of spawning-sized gravels were noted, and the presence of fry (age 0+ based on fork length) within the reach indicates that spawning has occurred (Note: length-age relationships from Scott and Crossman, 1973).

Reach #4 has a gradient of about 6% and has a gravel-cobble substrate. No sites with spawning-sized gravels were noted.

Reach #5 is 0.5 km in length and has a mean gradient of about 10%. The upper limit of the reach is a dam and weir which are used to divert water to Ideal Lake. Additional information on reach characteristics is unavailable, since no sites were inspected within this reach.

Reach #6 extends from a weir up to the headwaters. The weir diverts flow from Hilda Creek to Ideal Lake via a ditch. The gradient is low (5%) with good cover and primarily gravel substrate. Despite moderate fish rearing habitat values, no fish were observed and it is unlikely that fish are present past the weir.

5.3 Field Check Site Descriptions

Site #: 2 **Date Inspected:** July 17/95

Impact Code: Fb/Fs/Q.D.F.1 **Coordinates:** 50°00.204'N 119°04.181'W

Reach #: 1 **Map sheet #:** 82 L/3

Hilda Creek at this site is a low gradient (2%), meandering stream with a 3 m wide channel. A large cutblock, harvested in 1987, has been logged across the channel of Hilda Creek. All the trees were logged on both banks of Hilda Creek with the exception of a few areas with a small buffer of 2-3 trees. This site was coded as "F.1" due to the presence of fish resident in the stream.

There are several logging-related debris jams and substantial LWD is present in the channel (Photograph 1). The LWD is causing some localized accumulation of sediment and undercutting of the channel banks. The majority of the debris jams are not barriers to fish migration. However one jam was noted that is definitely a barrier to fish migration during low flows. There is excellent rearing and spawning habitat at this site that has been impacted by the presence of logging debris.

Several trout fry ranging in size from 50-60 mm were observed in the channel at this site. One 200 mm trout was caught angling with a fly in the beaver pond just upstream at site #3. These trout were originally thought to be Cutthroat trout (*Oncorhynchus clarki lewisi*). However natural populations of Cutthroat trout are absent in the Okanagan system (McPhail and Carveth, 1984), and there have been no recorded releases of Cutthroat in the Mission Creek watershed (Smith, Personal communication, 1995). This suggests that the fish were likely Rainbow trout. Fish samples should be obtained from this reach in order to verify the species present.

Possible remedial actions could include selective removal and/or stabilization of debris in the channel.

Site #: 5 **Date Inspected:** July 17/95

Impact Code: Q.D.N/F.3 **Coordinates:** 50°00.825'N 119°04.083'W

Reach #: 3 **Map sheet #:** 82 L/3

Hilda Creek at this site is a low gradient (1-2%) stream, incised though a bedrock canyon for approximately 500 m. The canyon is approximately 20 m wide and 5 m deep. There is good fish habitat in this section of the stream with many deep pools and overhanging bedrock banks. Spawning-sized gravel is abundant throughout the channel bed. Forest roads are present along both banks and a cutblock, logged in 1987, is located near the right bank. A 5 m and 15 m buffer exists between Hilda Creek and the roads located along the right and left banks respectively. There has been a considerable amount of windfall from the 5 m buffer along the right bank. Some of the LWD has fallen across the channel, but does not form any barriers to fish migration, and the banks are stable. The roads and cutblock located at this site have had a minor impact upon Hilda Creek. The site was originally classified as Fs/Q.F.F.1, but was changed to Q.D.N/F.3 following field inspection. It is considered to be a low priority site for restoration.

Site #: 6 **Date Inspected:** July 17/95

Impact Code: Fb/Q.C.F.1 **Coordinates:** 50°01.180'N 119°03.808'W

Reach #: 4 **Map sheet #:** 82 L/3

A forest road crosses Hilda Creek with a log culvert at this site (Photograph 2). The log culvert is constricting the channel width, reducing the natural channel width from 4 m upstream of the inlet to 1 m through the log culvert. Some erosion was observed where flows were directed at the right abutment. A small dip in the road indicates that road materials are slumping into the channel. The culvert at this site, should either be replaced or removed and the channel re-contoured to its natural condition.

Site #: 6A
Date Inspected: July 17/95
Impact Code: Q.D.F.2
Coordinates: 50°01.180'N 119°03.808'W
Reach #: 4
Map sheet #: 82 L/3

An old cutblock, logged approximately 30 years ago, is also located at site #6. The cutblock was logged across the channel at this site, however the site has revegetated with a mix of coniferous and deciduous vegetation. There are moderate amounts of logging related LWD in the channel. Most of the LWD is hung up on the channel banks and is not creating any debris blockage of the channel. The LWD appears stable and is not contributing to bank erosion. There is good fish rearing habitat, although no fish were observed. Some debris removal and stabilization could be beneficial at this site, but the site is not a priority for restoration.

Site #: 7
Date Inspected: July 17/95
Impact Code: Q.W.R.2
Coordinates: 50°01.274'N 119°03.326'W
Reach #: 4
Map sheet #: 82 L/3

Hilda Creek at this site is of moderate gradient (5%), and constricted to a single channel. The channel is approximately 3-5 m wide and the bed is composed of gravels and cobbles. Two large sluice gates have been constructed at this site. One sluice gate is constructed across the main channel of Hilda Creek and another at the entrance to a diversion ditch which leads to Ideal Lake which is a water supply for the Black Mountain Irrigation District. When the site was visited, none of the flow was being diverted to the Ideal Lake watershed.

A small debris jam, consisting of four six foot long by 2"x10" timbers, is approximately 10 m downstream in the main channel of Hilda Creek. The debris appears to be stable and does not

appear to be a barrier to fish migration. There is moderate fish rearing habitat at this site, although no fish were observed.

5.4 Sediment Source Inventory

The results of the sediment source inventory are summarized in Table 5.3. Only one major sediment source was identified from the aerial photograph review, a tributary which enters Hilda Creek about 6.1 km from the mouth. As described above, debris at Site #2 and the culvert at Site #6 contribute to accelerated bank erosion.

5.5 Hilda Creek Summary and Conclusions

A total of four sites on Hilda Creek were identified from the helicopter survey as having a potentially high level of impact from forestry (F.1) or unknown (U.1) activities. Five sites were inspected. Following the field inspections, two sites remained with an F.1 rating. These are:

Site #2	Logging across stream channel, debris barriers to fish passage, possible impacts on spawning habit, water quality implication
Site #6	Log culvert constricting flow; resulting bank erosion and possible road instabilty

Hilda Creek does contain some very good fish habitat, and fish were observed during the site inspections. In addition to the specific forestry impacts listed above, the stream has been impacted by the weir and water diversion at Site #7, minimal buffers in wetland areas, and high amounts of woody debris.

Table 5.3 Hilda Creek Sediment Source Inventory.

Location symbol(1)	Coordinates		Feature	Composition(2)	Dimensions(3)		Present in(4)		Larger in 1990's yes/no?
	Lat (N)	Long (W)			Width (m)	Length (m)	1950's yes/no?	1990's yes/no?	
6.1	n/a	n/a	Tributary	g, sa	n/a	n/a	yes	yes	no

(1): Refer to map: 82 L/3

(2): Composition is determined from aerial photographs. Locations which have been checked in the field are indicated by a subscript 'f'. Compositions in brackets indicate minor amounts of the given texture.

si = silt
sa = sand
g = gravel

(3): Width is distance measured along the stream. Length is distance measured from the toe to the zone of initiation (In the case of an eroding bank, length refers to 'bank height')

(4): Two sets of aerial photos were examined in this study: one set flown in 1950's and second set flown in 1990's

(5): n/c - No aerial photo coverage available at the time of the Sediment Source Inventory

(6): Location symbols designated with "R" are referenced by reach locations (e.g. R3a is located in Reach 3).

(7): Location symbols designated with a number are referenced by site numbers from the video transcript (e.g. 18a is located between sites #18 and #19).

6.0 BELGO CREEK

6.1 General Description

Belgo Creek originates in the Thompson Plateau about 25 km west of Winfield, B.C.. It flows in a general south by southwest direction until it joins Mission Creek at 49° 29.05' N lat, 119° 09.12'W long near the point where Joe Rich Creek also joins Mission Creek. Its major tributaries include Darley Creek (see Section 4.0) and Hilda Creek (Section 5.0). Additional descriptive information about Belgo Creek is found in Table 6.1. The NTS map sheet covering the creek (#82 E/14) is provided in Attachment 1, colour aerial photographs are in Attachment 2, and black and white aerial photographs are in Attachment 3. Video transcripts, photographs, and other relevant information are provided in Appendix D.

A total of 12 sites were classified with codes ending in F.1 or U.1 from the helicopter video, and all of these plus two additional sites were inspected.

6.2 Reach Descriptions

A total of four (4) stream reaches were identified on Belgo Creek. Reach length and gradient data for the individual reaches are found in Table 6.2. Stream survey forms for the reaches surveyed are included in Appendix D.

Reach #1 is generally a low gradient, meandering and slightly confined portion of the stream with bank heights ranging from 0.5-1 m. The upper reach break is the confluence with Darley Creek. The maximum channel width is about 10 m and the average wetted width was 7 m when the reach was inspected. The substrate consists mainly of gravels with a small amount of fines and some small cobbles, and a medium degree of compaction. The fish habitat in this reach

Table 6.1. General characteristics of Belgo Creek.

Parameter	Information
NTS Map sheet no.	82 E/14 Kelowna
Latitude & longitude of mouth	49° 29.05' N lat, 119° 09.12'W long
Watershed area (km^2)	122
Stream length (km)	22.5
No. of reaches	4
Discharge (mean/highest month/lowest month)	Not gauged
Biogeoclimatic zones/subzones[3]	IDFmw1, Msmm, MSdm1
General flow direction	South-Southwest
Next higher order stream or lake	Mission Creek
Land use	Forestry, some agriculture near mouth
No. of water licences	8 (Black Mountain Irrigation District & Individuals)
Known fish species	Rainbow trout
No. of F.1 & U.1 sites identified	12
No. of sites field checked, Autumn 1994	12 + 2 other

Table 6.2 Stream reach data summary for Belgo Creek.

Reach #	**Reach length (m)**	**Gradient (%)**	**Map sheet #**	**Site #'s within Reach**
1	4500	2.8	82 E/14	1 - 8
2	7000	3.1	82 E/14	9 - 15
3	8500	1.9	82 E/14, 82 L/3	16 - 26
4	2500	0 (lake)	82 L/3	27
Total	22500			27

[3] Biogeoclimatic zone codes are in Appendix K.

appears to be good. There are numerous sections of the channel with spawning-sized gravel and deep pools. Cover is provided by undercut banks and overhanging vegetation. Upstream migration of fish may be somewhat impeded by the amount of LWD and numerous debris jams in the reach.

The lower portion of Reach #1 is characterized by outwash terraces and other fluvioglacial deposits adjacent to the stream. The terrace surfaces have been cleared for agriculture. The floodplain at the confluence with Mission Creek includes a fan deposit which causes Mission Creek to bend around the confluence point. Upslope from site #7 is a large deposition area from a slide which occurred in 1990. It appears on the 1993 air photograph that a "finger" of depositional material extends down to Belgo Creek, although this is a very small portion of the deposit. The slide originated in a poorly to moderately drained, till-mantled swale which drains a number of cutblocks (clearcut and selective cut) to the west of the creek (Roed, 1995)[4]. Although the road has been re-established over the slide deposit, revegetation is incomplete and the deposit remains a sediment source to the creek.

The valley of Reach #2 is generally more confined than Reach #1. A series of outwash terraces run parallel to the stream. The maximum channel width is 20 m and the average wetted width was about 7 m when inspected. The substrate consists mainly of gravels and small cobbles and a medium degree of compaction. The fish habitat in this reach appears to be good. The reach includes many sections with spawning-sized gravel, deep pools, undercut banks and overhanging vegetation.

Reach #3 has a wider floodplain than Reach #2. Outwash terraces upslope from the stream are complemented by hummocky kame deposits. The maximum channel width is 15 m and the average wetted width was 7 m when inspected. The substrate consists mainly of gravels and fines

[4] Additional information on this slide is available in B.C. Ministry of Forests (1990) and Cass et al. (1992).

and a medium degree of compaction. The fish habitat in this reach is good, with habitat features similar to Reach #2. Several juvenile fish (Rainbow trout) were seen in this reach.

Ideal Lake forms Reach #4. The lake outlet is controlled by a weir. It was not possible to determine if the weir prevents fish from moving between the stream and the lake. The lake possesses excellent rearing habitat for resident fish, with abundant food in the littoral zone. Spawning is possible in the inlet streams which flow into Ideal Lake.

6.3 Field Check Site Descriptions

Site #: 2
Impact Code: N/A
Reach #: 1

Date Inspected: Nov. 4/94
Coordinates: 49°52.02'N 119°09.31'W
Mapsheet #: NTS 82 E/14

This site is the Highway 33 crossing which was inspected while characterizing Reach #1. Belgo Creek at this site is a low gradient (1.5%), meandering stream with low banks (<1 m) and a moderate amount of natural LWD. The site was initially given an Fs/Q•C•Hw•2 code relating to the road bridge, but was revised to "not applicable" following the field check. The bridge appears to be in good condition with no encroachment on the stream, although there are some exposed cut slopes associated with Highway 33.

Site #: 3
Impact Code: Fb/Q•D•N•3
Reach #: 1

Date Inspected: Nov. 4/94
Coordinates: 49°52.21'N 119°08.74'W
Mapsheet #: NTS 82 E/14

The natural stream gradient of this site is low (1.5%). The stream is meandering and occasionally splits around islands and bars in sections, with low banks (<1 m) and a moderate amount of natural LWD. This site was initially given an Fb/Q•D•U•1 code but as a result of the field check the code was revised to Fb/Q•D•N•3. The woody debris is scattered throughout the channel appears to be natural in origin, coming from the active undercutting of the banks on both sides of the channel.

There has been some selective logging done on the floodplain on the right bank but it does not appear to have impacted the stream.

Site #: 4
Impact Code: Fb/Q•D•N•3
Reach #: 1

Date Inspected: Nov. 4/94
Coordinates: 49°52.32'N 119°08.65'W
Mapsheet #: NTS 82 E/14

This site is similar to site #3. The natural condition of site #4 is a low gradient (1.5%), meandering stream with low banks (<1 m). There is a moderate amount of natural LWD. From the helicopter videotape, this site was initially given an Fb/Q•D•U•1 code but was changed to Fb/Q•D•N•3 as a result of the field check. The debris is scattered throughout the channel but appears to be natural in origin, coming from the active undercutting of the banks on both sides of the channel. The channel is somewhat confined through this reach, which may contribute to the tendency for the stream to undercut the banks.

There is an old road which comes down the hill from the end of the farm field to within 10 m of the right bank of the stream, but it has not impacted the stream. Some of the LWD in the debris jam at this site (photograph #4) has been apparently cut and removed.

The reach between sites #4 and #5 includes some pasture land where floodplain deposits were visible on the aerial photographs. The deposits show that the channel has shifted in the past, indicating that bank erosion in the reach is a natural process, although the fluvial processes may have been slightly modified by land use activities.

Site #: 11
Impact Code: Q•S•F•3
Reach #: 2

Date Inspected: Nov. 4/94
Coordinates: 49°55.14'N 119°06.15'W
Mapsheet #: NTS 82 E/14

Like the downstream sites, the natural condition of site #11 is meandering with a low gradient (1.5%), low banks (<1m), and a moderate amount of natural LWD. It was initially given an Fs/Q•F•F•2 code but was changed to Q•S•F•3 on the basis of the field inspection. This site appears to be very similar to site #4. A slide/slump from the road is located more than 100 m from the right bank of the stream and all of the LWD in the channel appears to be natural in origin. There is

evidence of old logging on the floodplain of the right bank and there is an overgrown trail on the floodplain. No impacts on the stream channel from the trail were noted.

Site #: 12 **Date Inspected:** July 19/95
Impact Code: Fs/Q•D•F•2 **Coordinates:** 49°55' 4N 119°05.7 W
Reach #: 2 **Mapsheet #:** NTS 82 E/14

Site #12 is the location of an old log jam, but fish passage does not appear to be impaired. When logged, harvesting took place up to streamside, as indicated by stumps. There is very good fish habitat at this site, similar to sites upstreams, although there are fewer side channels. Rainbow trout to 100 mm fork length were observed. The channel is about 8 m wide. The banks are composed of sand overlying boulders, and the substrate is composed of boulders and cobble. There has been some undercutting of the banks, but they appear generally stable.

Site #: 13 **Date Inspected:** see description
Impact Code: Fb/Q•D•F•1 **Coordinates:** 49°56.2' N 119°04.8' W
Reach #: 2 **Mapsheet #:** NTS 82 E/14

Site #13 was not inspected due to lack of access. The issue of concern is log jams apparently blocking the channel. This is the same issue as at Site #14, and the two sites can be treated together for watershed restoration purposes (see below). Originally coded as "U.1", the code was changed to "F.1" based on observations at Site #14.

Site #: 14 **Date Inspected:** July 19/95
Impact Code: Fb/Q•D•F/N•1 **Coordinates:** 49°56.7' N 119°04.6' W
Reach #: 2 **Mapsheet #:** NTS 82 E/14

Site #14 is composed of woody debris at the upstream end of an island, which blocks the channel to fish passage at least part of the year (Photograph 1). The debris is largely of logging origin, although some beaver fall is also present. The floodplain was apparently logged to streamside. A recent cutblock comes within 10 m of the stream. There are several side channels which go around the debris jam. The side channels were dry at the time of the site inspection. The banks are

composed of riverine sands overlying gravel. The banks appeared stable and well-vegetated, with few signs of erosion. There is good cover with alder trees overhanging the channel.

This site could benefit from debris removal and/or stabilization. The reach areas upstream and downstream (including Site #13) should be examined at the same time for other debris potentially blocking either the main or side channels.

Site #: 16
Impact Code: Fb/Q•D•F/N•1
Reach #: 3

Date Inspected: July 19/95
Coordinates: 49°56.7' N 119°04.6' W
Mapsheet #: NTS 82 E/14

Site #16 is also a log jam which blocks the channel (Photograph 2). It appears to have existed since the riparian area was logged, and an island has formed around the jam. The island is vegetated with alders and shrubs. The logs are well embedded within the banks. There are a number of side channels which carry flow during freshet, and these are partially blocked. The banks include a sand/silt layer over cobbles and boulders. The substrate is cobble/boulder.

The debris jam is a barrier to both the upstream and downstream migration of fish. The reach contains some very good fish habitat, and about six rainbow trout (80-150 mm) were observed nearby. Debris removal is suggested as a means to enhance fish access through the reach.

Site #: 19
Impact Code: Fs/Q•D•F/N•2
Reach #: 3

Date Inspected: July 19/95
Coordinates: 49°58.1' N 119°04.3' W
Mapsheet #: NTS 82 E/14

This site is a log jam at a bend in the creek. It was originally coded as Fb/Q.D.U.1. Inspection revealed that the site possesses some areas of good spawning and rearing habitat that is being influenced by the debris jam, notably some accumulation of fines. The majority of debris appears natural, but some logging debris is present. Side channels have been created to accomodate the flow around the jam at high flow. One side channel is blocked by a beaver dam.

The channel is about 15 m wide at this site, with banks about 0.5 m high. The gradient is about 2%. The banks are composed of sand and fine gravel, and the substrate ranges from sand to boulder.

There is good cover. Unlike some nearby sites, logging does not appear to have taken place in the riparian zone.

Site #: 20 **Date Inspected:** Nov. 4/94
Impact Code: Fb/Q•D•N•2 **Coordinates:** 49°58.2'N 119°04.4'W
Reach #: 3 **Mapsheet #:** NTS 82 E/14

Potential concerns at this site include a bridge crossing and nearby cutblock. The channel is naturally a low gradient (1.5%), meandering stream with low banks (<1 m) with a moderate amount of natural LWD. The field inspection resulted in the coding being changed from Fs/Q•C•F•1 to Fb/Q•D•N•2. The bridge does not encroach on the stream channel and a 20 m buffer has been maintained on both sides of the stream. The cutblock is relatively large and the terrain is a mixture of floodplain, outwash terrace, and kettled outwash. Two fish were observed at this site. Two debris jams were noted at the time of the site inspection; Photograph 6 shows the debris jam 50 upstream from the bridge and Photograph 7 shows the debris jam 20 m below the bridge. Both debris jams appear to consist of natural LWD, originating from the undercut banks on both sides of the stream. However, it is possible that some of the LWD is a result of blowdown from within the buffer.

Site #: 21 **Date Inspected:** Not inspected
Impact Code: Q•S•F•2 **Coordinates:** 49°59.1'N 119°04.4' W
Reach #: 3 **Mapsheet #:** NTS 82 L/3

Lack of access prevented inspection of this site. The helicopter survey identified this site as having very narrow buffers between the stream and cutblocks on both sides, and the site was coded Q.S.F.1. The buffers are as small as 10 m in places. Based on field observations at Sites #20 and #23, plus the absence of directly visible impacts (e.g., log jams) from the helicopter, the code was changed to Q.S.F.2

Site #: 23
Impact Code: Fs/Q•D•N•3
Reach #: 3

Date Inspected: Nov. 4/94
Coordinates: 49°59.2'N 119°04.5' W
Mapsheet #: NTS 82 L/3

The channel substrate and bank material were obscured by snow cover during the field inspection. A small amount of natural LWD was lying across and within the channel, possibly a result of the wet soil conditions contributing to tree falls due to low soil strength. The stream at this site is low gradient (1.5%), with meanders, low banks (<1 m), and a moderate amount of natural LWD. This site was initially given an Fs/Q•D•F•1 code but was changed to Fs/Q•D•N•3 following the field visit. Historic logging was done on the floodplain of the stream and more recent logging is apparent on both sides of the channel. The buffer on the left bank is 5-10 m wide and the buffer on the right bank is about 30 m wide. There is evidence of beaver activity.

Site #: 24
Impact Code: Fs/Q•C•F•3
Reach #: 3

Date Inspected: Nov. 4/94
Coordinates: 50°00.02'N 119°04.4'W
Mapsheet #: NTS 82 L/3

The stream at this site is similar to the downstream sites, with a low gradient (1.5%), meanders, low banks (<1 m) and a moderate amount of natural LWD. Originally coded as Fs/Q•C•F•1, it was revised to Fs/Q•C•F•3 in the field. A bridge at this site is a relatively new steel span bridge with no encroachment on the stream. A fish was seen at this site.

Site #: 25
Impact Code: Fb/Q•C•F•1
Reach #: 3

Date Inspected: Nov. 4/94
Coordinates: 50°00.1N 119°04.7'W
Mapsheet #: NTS 82 L/3

Belgo Creek at this site flows through two 1.2 m diameter culverts beneath a road crossinng. The channel in the vicinity of the crossing is meandering with low banks (<1m), a low gradient (1.5%), and a moderate amount of natural LWD. The impact code should be considered tentative, since it was not properly verified in the field due to heavy snow cover. However it was determined that the stream crossing may be a barrier to fish passage because of a drop at the outlet of 0.15 m.

6.4 Sediment Source Inventory

The sediment source inventory for Belgo Creek is summarized on Table 6.3. Eight sediment sources were delineated from the review of aerial photographs, made up of seven tributaries to Belgo Creek and one eroding bank. The area of the eroding bank was about the same size on the 1990s photo as on the 1950s photo, indicating that the exposed bank is not increasing is size. In addition to these sources, the deposit of colluvium at the toe of the 1990 slide (Site #7) remains as a potential sediment source (see Section 6.2).

6.5 Belgo Creek Summary and Recommendations

A total of 12 sites on Belgo Creek were identified from the helicopter survey as having a high level of impact from forestry (F.1) or unknown (U.1) activities. Fourteen sites were inspected. Following the field inspections, four sites remained with an F.1 rating. These are:

Sites #13 & #14	Debris jams blocking the channel to fish passage. Flow is diverted around during periods of high flow. Considerable woody debris throughout reach.
Site #16	Debris jam blocking fish passage. Very good fish habitat in this area.
Site #25	Culverts potentially blocking fish passage.

Some areas on Belgo Creek contain good fish habitat. Removal of the above barriers could result in an overall improvement of habitat quality. In addition to these specific areas, Belgo Creek is characterized by buffer strips that are less than 30 m wide, and accumulations of woody debris. The large landslide scar near the confluence with Darley Creek has not been completely revegetated since the slide occurred in 1990, and remains a sediment source.

Table 6.3 Belgo Creek Sediment Source Inventory

Location symbol(1)	Coordinates		Feature	Composition(2)	Dimensions(3)		Present in(4)		Larger in 1990's yes/no?
	Lat (N)	Long (W)			Width (m)	Length (m)	1950's yes/no?	1990's yes/no?	
5	n/a	119°08.63'	Eroding bank	sa, g	10	10	yes	yes	no
6.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
7	49 53.5'	119 08.2'	Toe of landslide	sa, si, g			no	yes	yes
7.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
8.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
20.1	n/a	119°04.36'	Tributary		n/a	n/a			
22.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
24.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
26.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no

(1): Refer to map: 82 L/3, 82 E/4

(2): Composition is determined from aerial photographs. Locations which have been checked in the field are indicated by a subscript 'f'. Compositions in brackets indicate minor amounts of the given texture.

si = silt
sa = sand
g = gravel

(3): Width is distance measured along the stream. Length is distance measured from the toe to the zone of initiation (In the case of an eroding bank, length refers to 'bank height')

(4): Two sets of aerial photos were examined in this study: one set flown in 1950's and second set flown in 1990's

(5): n/c - No aerial photo coverage available at the time of the Sediment Source Inventory

(6): Location symbols designated with "R" are referenced by reach locations (e.g. R3a is located in Reach 3).

(7): Location symbols designated with a number are referenced by site numbers from the video transcript (e.g. 18a is located between sites #18 and #19).

7.0 PEARSON CREEK

7.1 General Description

Pearson Creek is a tributary to Mission Creek and flows generally southwest from St. Margaret Lake and Loch Long. Additional descriptive information is provided in Table 7.1. The NTS 1:50,000 scale maps covering the creek (82 E/14, 82 E/15) are included as Attachment 1, the colour aerial photographs are included as Attachment 2, and the black and white aeria; photographs are included as Attachment 3. Video transcripts, photographs and and other relevant materials are included in Appendix E.

The review of the helicopter video footage identified a total of five (5) sites that were assigned codes ending in F.1 or U.1. All of these sites plus one additional site were field checked. Site descriptions for the F.1/U.1 sites are provided in Section 7.3.

7.2 Reach Descriptions

There are a total of five (5) stream reaches identified on Pearson Creek. Length and gradient data for the individual reaches are provided in Table 7.2. Stream survey forms for the reaches surveyed are included in Appendix E.

Reach #1 is generally a moderate gradient stream (average 9.7%) with bank heights ranging from 0.5-1 m. Flow in some sections is split around bars and islands and there are a number of side channels. The floodplain near the confluence with Mission Creek is relatively broad and is framed by outwash terraces. The maximum stream channel width is 20 m and the average wetted width was 3.5 m when inspected. The substrate consists mainly of gravels with a small amount of fines and some small cobbles and a medium degree of compaction. Snow cover during the inspection made fish habitat characterization difficult.

Table 7.1 General characteristics of Pearson Creek.

Parameter	Information
NTS Map sheet no.	82 E/14 Kelowna, 82 E/15 Damfino Creek
Latitude & longitude of mouth	49°53.0' N lat, 119°03.7'W long
Watershed area (km^2)	77
Stream length (km)	19.5
No. of reaches	5
Discharge (m^3/s)[5] (mean/highest month/lowest month)	Mean 0.975/Jun 4.18 /Feb 0.121
Biogeoclimatic zones/subzones[6]	IDFmw1, MSmm
General flow direction	Southwest
Next higher order stream or lake	Mission Creek
Land use	forestry, recreation
No. of water licences	None
Known fish species	Rainbow trout
No. of F.1 & U.1 sites identified	5

Table 7.2 Stream reach data summary for Pearson Creek.

Reach #	Reach length (m)	Gradient (%)	Map sheet #	Site #'s within reach
1	2250	9.7	82 E/14	1 - 4
2	2750	4.7	82 E/14	5
3	4250	5.5	82 E/14, 82 E/15	6 - 11
4	2500	12.8	82 E/15	12 - 15
5	7750	3.8	82 E/15	16 - 20
Total	19500			20

[5] Source: Water Survey of Canada (1989).

[6] Biogeoclimatic zone codes are in Appendix K.

Reach #2 has abundant spawning and rearing habitat for fish. The average gradient is 4.7%. Numerous trout were observed, ranging in age from 0+ to 2 years, indicating that suitable habitats are present. Many deep pools (approx. 0.8 m deep) are present, as well as overhanging vegetation and boulders for cover, and adequate flow. Most of the woody debris in the reach appears natural in origin.

Reach #3 is characterized by a low gradient (average 5.5%), multiple channels, and good cover. There are numerous deep pools up to (1 m deep), as well as abundant overhanging vegetation. These factors combine to create excellent fish habitat. Resident trout were noted, along with abundant aquatic insects. Numerous natural woody debris piles were noted, which contribute to habitat heterogeneity.

Reach #4 is the reach in which Pearson Creek descends from the plateau. At 12.8% (average), it is the steepest of the five reaches. The upper limit of the reach is the break in slope that marks the start of the plateau.

Reach #5 has an average gradient of about 3.8%. It meanders through a number of wetland areas, and ends at the headwaters of Pearson Creek just west of St. Margaret Lake.

7.3 Field Check Site Descriptions

Site #: 3
Impact Code: Q•S•F•3
Reach #: 1

Date Inspected: Nov. 9/94
Coordinates: 49°53.1'N 119°03.2'W
Mapsheet #: NTS 82 E/14

The natural condition of Pearson Creek at this site is a low gradient, meandering stream with low banks (<1 m) with a moderate amount of natural LWD in the stream channel. This site was initially given an Fs/Q•S•U•1 code because of a slide observed from the helicopter, but following the field check and aerial photograph review the code was changed to Q•S•F•3. The slide originated from a

road but did not reach the stream. The debris track from the slide stopped about 5 m upslope from the floodplain limit on the right bank of the stream. However review of the 1993 aerial photographs indicate that some debris and sediment may have reached the floodplain. This material on the floodplain may have been removed or modified during the 1994 freshet such that it was not detected in fall 1994. Although this site does not warrant further attention as a stream restoration opportunity, road instability may still exist in the area, and could contribute to further slides. The cutblock above the slide area was cut to the break in slope, which may have contributed to the instability.

Site #: 5 **Date Inspected:** July 16/95

Impact Code: Fb/Q.D.N/F.2 **Coordinates:** 49°54.3'N 119°00.7'W

Reach #: 2 **Map sheet #:** 82 E/14

Pearson Creek at this site is a moderate gradient (5%), meandering stream with gravels and cobbles dominating the channel substrate. Two large debris jams span the main channel of Pearson Creek at this site. Both LWD jams are storing a fair amount of sediment, and have caused the main channel of Pearson Creek to widen significantly and carve several side channels though the floodplain. The channel banks are undercut and there are signs of localized bank erosion where flows have been deflected around the debris. Several trees have fallen into the channel as a result of localized fluvial erosion of the channel banks. Most of the debris in the jams appears to be natural, however some cut stumps were observed. The jams do not presently form any barriers to fish migration, however there is a potential to form a barrier in the future.

Site #: 6 **Date Inspected:** July 16/95

Impact Code: Fs/Q.C.F.1 **Coordinates:** 49°54.2'N 119°00.6'W

Reach #: 3 **Map sheet #:** 82 E/14

The issue at this site is a damaged culvert which is presently a source of fine sediments to Pearson Creek. The road culvert is situated along the lower edge of a large cutblock, logged

since 1990, and is approximately 50 m horizontally from the left bank of Pearson Creek. The culvert has a 30 m long section of pipe which joins the culvert outlet and transmits flows downslope to prevent erosion of the hillslope. However, a 4 m section of this pipe has been cut out and water flowing out of the culvert has eroded approximately 60 m^3 through glacial till sediments (Photograph 1). A large fan of sediments has been deposited on the floodplain of Pearson Creek and a significant amount of fine material has entered the channel from the left bank, possibly affecting spawning habitat.

The culvert at this site should be relocated to a site that is less susceptible to hillslope erosion, or the culvert should be extended and the outlet area armoured with rip-rap to prevent further erosion of the hillslope. This site requires further attention.

Site #: 7 **Date Inspected:** July 17/95

Impact Code: Fs/Q.D.F.2 **Coordinates:** 49°54.4'N 119°00.5'W

Reach #: 3 **Map sheet #:** 82 E/14

Pearson Creek at this site is a moderate gradient (5%), meandering stream with gravels and cobbles dominating the channel substrate. Extensive logging was done along both banks of the channel in the past. Cut stumps and very old logging roads along the channel banks were observed. Two small log jams across Pearson Creek were noted at this site. The LWD in the jams consisted almost entirely of old logging related debris with cut ends. The debris jams are not blocking the channel and appear to be relatively stable. Flows have scoured many deep pools in and around the debris that are beneficial to fish habitat and cover. This site has excellent fish habitat with numerous side channels and areas with spawning-sized gravels. Numerous trout fry were observed in and around the LWD jams and in the deep pools at this site.

Site #: 8 **Date Inspected:** July 17/95

Impact Code: Fs/Q.D.N.1 **Coordinates:** 49°55.1'N 118°59.5'W

Reach #: 3 **Map sheet #:** 82 E/15

There is no evidence of historical riparian logging occurring at this site. A very large debris jam composed of natural LWD is present across the main channel of Pearson Creek. The debris jam has widened the channel from approximately 10 m to 20 m. Numerous smaller debris jams were also observed 50 m downstream. Several side channels have been created and there are numerous deep pools (1-2 m) beneficial for fish rearing habitat. Flows have also been diverted around the debris causing localized erosion of the channel banks. Several trees have fallen across the channel as a result of fluvial undercutting of the channel banks. There are several old side channels along the left bank of Pearson Creek that historically conveyed flows but are presently inactive. The debris jam is presently not forming a barrier to upstream fish migration and the LWD in the debris jam appears to be stable.

This site could benefit from selective removal of LWD in the debris jams, however the site is presently only accessible on foot.

7.4 Sediment Source Inventory

The sediment source inventory for Pearson Creek is summarized on Table 7.3. Six sources were identified from the aerial photograph survey, of which five were tributaries to the creek. A landslide was noted on the 1990s photographs which was not present in the 1950s. This slide has been described as Site #3 above.

7.5 Pearson Creek Summary and Recommendations

A total of five sites on Pearson Creek were identified from the helicopter survey as having a high level of impact from forestry (F.1) or unknown (U.1) activities. Following the field inspections, one site remained with an F.1 rating:

Site # 6 Drainage culvert has been cut off and is currently causing serious erosion near creek; requires repair or replacement plus armouring with rip-rap at outlet

In addition, a very large debris jam is present at Site #8 which could benefit from selective debris removal, even though the debris appears to be largely natural in origin. An old landslide scar at Site #3 suggests that the area may be prone to mass movements.

Table 7.3 Pearson Creek Sediment Source Inventory.

Location symbol(1)	Coordinates		Feature	Composition(2)	Dimensions(3)		Present in(4)		Larger in 1990's yes/no?
	Lat (N)	Long (W)			Width (m)	Length (m)	1950's yes/no?	1990's yes/no?	
3	n/a	119°03.17'	Slide	f, sa, g	20	100	no	yes	yes
4.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
4.2	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
5.1	n/a	119°00.92'	Tributary	sa, g	n/a	n/a	yes	yes	no
11	n/a	118°58.26'	Tributary	sa, g	n/a	n/a	yes	yes	no
18.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no

(1): Refer to map: 82 E/14, 82 E/15

(2): Composition is determined from aerial photographs. Locations which have been checked in the field are indicated by a subscript 'f'. Compositions in brackets indicate minor amounts of the given texture.

si = silt
sa = sand
g = gravel

(3): Width is distance measured along the stream. Length is distance measured from the toe to the zone of initiation (In the case of an eroding bank, length refers to 'bank height')

(4): Two sets of aerial photos were examined in this study: one set flown in 1950's and second set flown in 1990's

(5): n/c - No aerial photo coverage available at the time of the Sediment Source Inventory

(6): Location symbols designated with "R" are referenced by reach locations (e.g. R3a is located in Reach 3).

(7): Location symbols designated with a number are referenced by site numbers from the video transcript (e.g. 18a is located between sites #18 and #19).

8.0 JOE RICH CREEK

8.1 General Description

Joe Rich Creek originates in the Okanagan Highland about 30 km east-southeast of the city of Kelowna. It initially flows south before turning back near the intersection of Highway 33 and the road to the Big White ski area, from where it flows in a general north-northwest direction. It joins Mission Creek at 49° 52'N latitude, 119° 09'longitude, just upstream of where Belgo Creek flows into Mission Creek. Major tributaries include Schram Creek and Tress Creek. Additional descriptive information about Joe Rich Creek is found in Table 8.1. The NTS map sheet covering the creek (#82 E/14) is provided in Attachment 1, the colour aerial photos are in Attachment 2, and the black and white aerial photos are in Attachment 3. The video transcripts, photographs, and other relevant information are provided in Appendix F.

Three (3) sites were classified as ending in F.1 or U.1 from the helicopter video and each was field checked.

8.2 Reach Descriptions

A total of five (5) stream reaches were identified on Joe Rich Creek. Reach length and gradient data for the individual reaches are presented in Table 8.2.

Reach #1 is situated in an area where the floodplain is up to 700 m wide, much of which has been cleared for agriculture. It has a low gradient except in the last 1 km before the confluence with Mission Creek where it drops about 40 m to meet Mission Creek. Bank erosion is visible in places within the agricultural land, and there are several eroded gullies formed in the outwash terraces south of the creek which drain to the creek. There is little if any recent forest harvest activity in the reach and the second growth is well established.

Table 8.1. General characteristics of Joe Rich Creek.

Parameter	Information
Map sheet no.	82 E/14 Kelowna
Latitude & longitude of mouth	49° 52'N latitude, 119° 09'longitude
Watershed area (km^2)	45
No. of reaches	7
Discharge (m^3/s)[7] (mean/highest month/lowest month)	Mean 0.22/May 0.89/Jan 0.05
Biogeoclimatic zones/subzones[8]	IDFmw1, MSmm
General flow direction	South then North-Northwest
Next higher order stream or lake	Mission Creek
Land use	Forestry, some agriculture near mouth. Roads parallel for about 2/3 of stream length
No. of water licences	16 (mostly individuals)
Known fish species	Rainbow trout
No. of F.1 & U.1 sites identified	3
No. of field sites checked	4

Table 8.2 Stream reach data summary for Joe Rich Creek.

Reach #	Reach length (m)	Gradient (%)	Map sheet #	Site #'s within Reach
1	6250	3	82 E/14	1 - 5
2	6250	7	82 E/14	6 - 12
3	1000	2	82 E/14	13
4	500	0	82 E/14	14
5	500	5	82 E/14	-
6	500	10	82 E/14	15
7	750	7	82 E/14	-
Total	15750			15

[7] Source: Water Survey of Canada (1989).

[8] Biogeoclimatic zone codes are in Appendix K.

Reach #2 has generally a moderate gradient (7%) with bank heights ranging from 0.5-1 m. There is a large amount of LWD in the channel, mostly of logging origin, which has caused localized accumulations of gravels and fines. A high percentage of the natural channel substrate (about 70%) consists of gravels, including many areas with spawning-sized gravels. The reach has some excellent spawning and rearing habitat, but fish access is presently restricted by LWD accumulations in the channel. Rainbow trout (80-120 mm fork length) were observed.

Reach #3 possesses good fish habitat. The habitat has been recently improved by the creation of a series of four pools and riffles within a wooden box culvert that runs under a forest road crossing. Rainbow trout were observed travelling through the culvert, and access is good in both directions. Upstream from the culvert the stream passes through a meadow. Downstream the riparian area is forested. Gradient averages 1-2%, there is abundant cover, and a high percentage of small gravel substrate. Instream aquatic vegetation, mosses, and insects provide excellent foraging opportunities for fish.

Reach #4 meanders through a large sedge meadow wetland. The downstream edge of the meadow is bordered by a broken beaver dam that is about 1 m high. Many deep pools, overhanging banks, and overhanging vegetation contribute to habitat quality. Fish have good access to Reach #3 through the break in the dam.

Reaches #5 extends for 0.5 km from the upper end of the sedge meadow to a point where the gradient steepens. The average gradient is 5%.

Reach #6 is a short (0.5 km) section of Joe Rich Creek with a mean gradient of 10%.

Reach #7 is the final reach. It is about 0.8 km long and has an average gradient of 7%.

8.3 Field Check Site Descriptions

Site #: 7
Impact Code: Fb/Q•D•F•1
Reach #: 2

Date Inspected: Nov. 9/94
Coordinates: 49°48.5'N 119°04.9W
Mapsheet #: NTS 82 E/14

At this site Joe Rich Creek is a low gradient, meandering stream with low banks (1 m) and a moderate amount of natural LWD (Photograph 3, Appendix F). The general condition of the site at the time of the survey is shown in Photographs 1-5 Appendix F. This site was initially given an Fs/Q•F•F•1 code based on the proximity of a landslide above the channel. As a result of the field check the code was revised to Fb/Q.D.F.1. The slide (Photograph 5) originated from an old logging road 100 m above the channel on the right bank and has deposited a substantial amount of LWD and other organic debris on the right bank and into the channel (Photograph 1). This slide has caused increased erosion and undercutting on the left bank of the stream.

In addition to this slide, there is substantial erosion of the Highway 33 fillslope above the left bank of the stream (Photograph 4). A large composite fan of deposited sediment from the fillslope has formed on the floodplain, and in places it is no more than 5 m from the channel. As this fan progresses towards the channel, the stream is simultaneously eroding its left bank and moving towards the fan.

The area between sites 7 and 9 includes several old slumps or slides on the right valley wall and Highway 33 fillslope erosion on the left wall. The old logging areas are now well revegetated but gully areas are probably still an important source of sediment and the old roads may still be unstable.

Site #: 11

Impact Code: Fb/Q.C.F.1

Reach #: 2

Date Inspected: July 16/95

Coordinates: 49°48.5'N 119°04.1'W

Map sheet #: 82 E/14

At this site, Joe Rich Creek is a moderate gradient (7%), meandering stream with low banks (<1 m). An old log culvert crossing the channel of Joe Rich Creek is providing access to a cutblock logged in 1975. The log culvert consists of a series of logs across the channel with 30 cm of fill material on top. The downstream end of the culvert has eroded with five logs exposed. There is a small accumulation of debris at the upstream end of the culvert which may be a potential barrier to fish passage. Several trout were observed in the channel at this site.

The log culvert should be removed, the channel restored to its natural condition, and the banks revegetated.

Site #: 11A

Impact Code: Fb/Q.D.F.1

Reach #: 2

Date Inspected: July 16/95

Coordinates: 49°48.463'N 119°04.090'W

Map sheet #: 82 E/14

This site is adjacent to site #11. A large cutblock has been logged across the channel of Joe Rich Creek for approximately 250 m upstream of the log culvert. Several logging related debris jams were observed in the channel that are trapping sediment. However, only one debris jam located 10 m upstream of the log culvert appears to be a barrier to fish passage. Some logging-related LWD remains across the channel and is providing excellent cover for fish. Upstream of the cutblock, the natural channel is clogged with natural LWD from windfall, but is not forming a barrier to fish passage. There is excellent fish rearing and spawning habitat at this site. Two small trout were observed in the channel upstream of the log culvert.

The debris jam located 10 m upstream of the log culvert should be removed, and any other accumulations of logging-related debris should also be examined closely for their potential as fish barriers.

Site #: 13 **Date Inspected:** July 16/95

Impact Code: Fs/Q.C.F.3 **Coordinates:** 49°49.3'N 119°03.7'W

Reach #: 3 **Map sheet #:** 82 E/14

This site is located just downstream from a large sedge meadow, approximately 10 ha in area, located in the headwaters of Joe Rich Creek. An old beaver pond was once present in the wetland, however the beaver dam has been broken and there is no evidence of recent beaver activity. Joe Rich Creek at this site is a low gradient, meandering stream with a channel width of approximately 3 m.

Approximately 100 m downstream of the sedge meadow, a road crosses Joe Rich Creek with a log culvert. The log culvert is in very good condition and the log stringers and cribs do not show signs of rot. The culvert is constricting the channel width by 1 to 2 m. A small pool has formed at the inlet to the culvert, indicating that the culvert may back up flows during peak flow periods. Four logs have been embedded in the channel bed beneath the log culvert. The logs lie perpendicular to the flow and have created pools and riffles beneficial to fish habitat. Two trout (80 mm and 120 mm) were observed upstream of the culvert at this site.

Although the log culvert is restricting the channel, it is having a minor impact upon the channel. The benefits of the log culvert to fish rearing habitat and cover outweigh the impacts of the channel restriction.

8.4 Sediment Source Inventory

The sediment source inventory for Joe Rich Creek is summarized in Table 8.3. Nine major sediment sources were identified from the aerial photograph survey, five of which were tributaries entering the main stem. Three of the four other sources appeared to be larger in the most recent aerial photos than in photos from the 1950's. The fillslope for Highway 33 is a sediment source in several areas along Highway 33, notably near the point where the creek turns west at the intersection with the road to the Big White ski area (locations 7 & 8A, Table 8.3).

8.5 Joe Rich Creek Summary and Recommendations

A total of three sites on Joe Rich Creek were identified from the helicopter survey as having a high level of impact from forestry (F.1) or unknown (U.1) activities. An additional F.1 site was identified during the field work. Following the field inspections, three sites remained with an F.1 rating. These are:

Site # 7 — Landslide has deposited sediment and LWD in channel. Erosion from Highway 33 fillslope is a sediment source.

Site # 11 — Log culvert in poor condition. Contributing to erosion. Potential fish barrier if plugged by debris. Should be removed and channel restored.

Site # 11A — Woody debris in channel within cutblock with no buffer. One debris jam is a fish barrier.

The stream is presently utilized by fish, and restoration of the above sites shows potential to improve fish habitat. In addition to these forest harvest related impacts, Joe Rich Creek is influenced by road construction and agricultural activity near the channel.

Table 8.3 Sediment Source Inventory: Joe Rich Creek

Location symbol(1)	Coordinates		Feature	Composition(2)	Dimensions(3)		Present in(4)		Larger in 1990's yes/no?
	Lat (N)	Long (W)			Width (m)	Length (m)	1950's yes/no?	1990's yes/no?	
2	n/a	119°07.51'	Eroding bank	sa, g, si	40	2	yes	yes	no
2a	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
2b	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
4a	n/a	119o05.38'	Tributary	sa, g	n/a	n/a	yes	yes	no
5a	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
7	49°48.48'	119°04.92'	Road fillslope	sa, g	70	60	yes	yes	yes
8a	n/a	n/a	Road fillslope	sa, g	40	60	no	yes	yes
8b	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
9	n/a	119°05.19'	Slumps/slides	sa, g	30	50	no	yes	yes

(1): Refer to map: 82 E/14

(2): Composition is determined from aerial photographs. Locations which have been checked in the field are indicated by a subscript 'f'. Compositions in brackets indicate minor amounts of the given texture.

si = silt
sa = sand
g = gravel

(3): Width is distance measured along the stream. Length is distance measured from the toe to the zone of initiation (In the case of an eroding bank, length refers to 'bank height')

(4): Two sets of aerial photos were examined in this study: one set flown in 1950's and second set flown in 1990's

(5): n/c - No aerial photo coverage available at the time of the Sediment Source Inventory

(6): Location symbols designated with "R" are referenced by reach locations (e.g. R3a is located in Reach 3).

(7): Location symbols designated with a number are referenced by site numbers from the video transcript (e.g. 18a is located between sites #18 and #19).

9.0 HYDRAULIC CREEK

9.1 General Description

Hydraulic Creek is a tributary to Mission Creek, and flows generally east and north upstream of Hydraulic Lake (McCullough Reservoir), and then northwest downstream of the lake. The creek has a long history of use as a source of irrigation and domestic water. Additional descriptive information is provided in Table 9.1. The NTS 1:50,000 scale maps covering the creek (82 E/14, 82 E/11) are included as Attachment 1, colour aerial photographs are included as Attachment 2, and black-and-white aerial photographs are included as Attachment 3. Video transcripts, photographs and DFO/MELP stream survey forms are included in Appendix G.

The review of the helicopter video footage identified only two (2) sites that were assigned F.1 or U.1 codes. Both of these sites, and one additional site, were field checked in the fall of 1994. These sites are discussed in Section 9.3.

9.2 Reach Descriptions

A total of 10 stream reaches were identified on Hydraulic Creek. Length and gradient data for the individual reaches are in Table 9.2. Specific information regarding fish habitat in the majority of reaches is unavailable, since all the sites that were inspected were within Reach #4.

Reach #1 extends from the mouth to a small reservoir that is behind a dam. The reach has some steep sections, including several chutes and small falls. Reach #2 is contained in a confined valley and has an average gradient of 7%. Reach #3 has a similar average gradient, but the valley is broader.

Table 9.1. General characteristics of Hydraulic Creek.

Parameter	Information
Map sheet no.	82 E/14 Kelowna, 82 E/11
Latitude & longitude of mouth	49° 50.81'N latitude, 119° 21.21'W longitude
Watershed area (km^2)	121
Stream length (km)	29.5
No. of reaches	6
Discharge (m^3/s)[9] (mean/highest month/lowest month)	Mean 0.166/May 0.805/Feb 0.048
Biogeoclimatic zones/subzones[10]	IDFxh1a, IDFxh1, IDFmw1, MSmm, MSdm1, ESSFdm1
General flow direction	East and North then Northwest
Next higher order stream or lake	Mission Creek
Land use	Forestry, some agriculture near mouth and downstream of Hydraulic Lake. Hydraulic L. is a drinking/irrigation water reservoir.
No. of water licences	6 (South East Kelowna Irrigation District & individuals)
Known fish species	Rainbow trout
No. of F.1 & U.1 sites identified	2
No. of field sites checked	3

Table 9.2 Stream reach data summary for Hydraulic Creek.

Reach #	Reach length (m)	Gradient (%)	Map sheet #	Site #'s within Reach
1	250	18	82 E/14	1
2	2000	7	82 E/14	2 - 6
3	6500	7	82 E/14	7 - 13
4	5500	3	82 E/14	14 - 19
5	3250	0 (Hydraulic Lake)	82 E/14	20
6	950	1	82 E/14	-
7	1250	1	82 E/14	21 - 24
8	1250	2	82 E/14, 82 E/11	25
9	2850	4	82 E/14	-
10	5300	1	82 E/14	-
Total	29100			25

*Sites 26-30 are on Stirling Creek, a tributary of Hydraulic Creek.

[9] Source: Water Survey of Canada (1989).

[10] Biogeoclimatic zone codes are in Appendix K.

Reach #4 is generally a low gradient and meandering portion of the stream with bank heights ranging from 0.5-1 m. The maximum channel width is 12 m and the average wetted width was 6 m during inspections. The substrate consists mainly of gravels with a small amount of fines and some small cobbles and a medium degree of compaction. This reach has excellent fish habitat but fish access is currently restricted to some areas due to the excessive amount of LWD in the channel. Several areas with spawning-sized gravel were noted as well as many deep pools, undercut banks and overhanging vegetation.

Reach #5 is Hydraulic Lake. Reaches #6 through #10 extend from the upper limit of Hydraulic Lake to the headwaters. These reaches are generally low gradient (< 4%) and include a number of wetland areas.

9.3 Field Check Site Descriptions

Site #: 15 **Date Inspected:** Nov. 2/94

Impact Code: Fb/Q•D•F•1 **Coordinates:** 49°48.8'N 119°13.1W

Reach #: 4 **Mapsheet #:** NTS 82 E/14

At Site #15 the stream has a low gradient, meanders, low banks (<1 m) and a relatively small amount of natural LWD. No buffer strip is present along the stream at this site, however it is possible that a buffer was initially retained and that all of the trees have since blown down. There is a substantial amount of windfall into and across the stream, most of which is creating water quality and fish barrier concerns. Also, an ephemeral channel which discharges directly to Hydraulic Creek is forded twice by a logging road.

Site #15 is a strong candidate for a restoration. Possible steps include debris removal, riparian zone planting, and road repair.

Site #: 16

Impact Code: Fb/Q•D•F•1

Reach #: 4

Date Inspected: Nov. 2/94

Coordinates: 49°48.1N 119°12.5'W

Mapsheet #: NTS 82 E/14

This site is very similar to Site #15 and is located adjacent to the same cutblock. The debris jam at this location is apparently primarily an accumulation of the LWD which has come from the windfall upstream of this point. Just upstream from the SE block boundary there is a marked decrease in the amount of LWD across the channel, indicating that the removal of timber from the cutblock is the cause of the substantial windfall at both sites #15 and #16. This site can be restored at the same time as Site #15.

Site #: 18

Impact Code: Fb•D•N•2

Reach #: 4

Date Inspected: Nov. 2/94

Coordinates: 49°47.8'N 119°12.0'W

Mapsheet #: NTS 82 E/14

This site was initially given an Fb/Q•C•R•2 code but as a result of the field check the code was revised to Fb•D•N•2. The natural condition of this site is low gradient, meandering stream with low banks (<1 m) and a relatively small amount of natural LWD. A rectangular concrete culvert (1.25 m square) was installed in 1945 as part of the Kettle Valley Railway crossing at this site. Water is still passing through the culvert but the culvert opening is restricted to approximately one-half the original size due to a beaver dam at the upstream end. This beaver dam has created a large pond upstream of the culvert which provides excellent fish rearing and wetland habitat. However, fish migration through the culvert to the pond is presently not possible.

9.4 Sediment Source Inventory

The sediment source inventory for Hydraulic Creek is summarized in Table 9.3. Nine sources were identified, all tributaries to Hydraulic Creek. Sediment loads in the creeks are likely to be relatively small due to the presence of the wetlands in the upper reaches, Hydraulic Lake, and a reservoir at Site #6. These features act as sediment sinks, limiting downstream sediment movement.

9.5 Hydraulic Creek Summary and Recommendations

A total of two sites on Hydraulic Creek were identified from the helicopter survey as having a high level of impact from forestry (F.1) activities. Three sites were inspected. Following the field inspections, two sites remained with an F.1 rating. These are:

Site #15 — No buffer strip; substantial windfall and other debris in creek; road crossing over ephemeral tributaries. Debris removal and road maintenance recommended.

Site #16 — Similar to Site #15; can be remediated at the same time.

Table 9.3 Sediment Source Inventory: Hydraulic Creek

Location symbol(1)	Coordinates		Feature	Composition(2)	Dimensions(3)		Present in(4)		Larger in 1990's yes/no?
	Lat (N)	Long (W)			Width (m)	Length (m)	1950's yes/no?	1990's yes/no?	
2.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
7.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
10.1	49°49.32'	119°17.47'	Tributary	sa, g	n/a	n/a	yes	yes	no
11.1	49°49.25'	119°16.29'	Tributary	sa, g	n/a	n/a	yes	yes	no
11.2	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
15.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
15.2	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
19.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
28.1	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no

(1): Refer to map: 82 E/14

(2): Composition is determined from aerial photographs. Locations which have been checked in the field are indicated by a subscript 'f'. Compositions in brackets indicate minor amounts of the given texture.

si = silt
sa = sand
g = gravel

(3): Width is distance measured along the stream. Length is distance measured from the toe to the zone of initiation (In the case of an eroding bank, length refers to 'bank height')

(4): Two sets of aerial photos were examined in this study: one set flown in 1950's and second set flown in 1990's

(5): n/c - No aerial photo coverage available at the time of the Sediment Source Inventory

(6): Location symbols designated with "R" are referenced by reach locations (e.g. R3a is located in Reach 3).

(7): Location symbols designated with a number are referenced by site numbers from the video transcript (e.g. 18a is located between sites #18 and #19).

10.0 POOLEY CREEK

10.1 General Description

Pooley Creek is a tributary of KLO Creek. It originates on the north slope of Little White Mountain, and flows north until it meets KLO Creek at an elevation of about 1000 m, just north of a crossing of the Kettle Valley Railway. The creek has three water licences, all held by the South East Kelowna Irrigation District. Additional descriptive information is contained in Table 10.1. The NTS 1:50,000 scale maps covering the creek (82 E/14, 82 E/11) are included as Attachment 1, colour aerial photographs are included as Attachment 2, and black-and-white aerial photographs are included as Attachment 3. Video transcripts, photographs and DFO/MELP stream survey forms are included in Appendix H.

Two (2) sites were classified as ending in F.1 or U.1 from the helicopter survey. These sites are described in Section 10.3.

10.2 Reach Descriptions

A total of four (4) reaches were identified on Pooley Creek. There was no flow in Reaches 1-3 at the time of the site inspections.

Reach #1 extends from the mouth for a distance of 0.5 km. The channel cuts through a series of fluvial deposits associated with the confluence of Pooley Creek and KLO Creek.

Reach #2 is a moderately steep (average 10%) section through a bedrock canyon. The upper reach break is marked by a decrease in gradient as the channel moves onto the plateau.

Table 10.1 General descriptions of Pooley Creek

Parameter	Information
Map sheet no.	82 E/14 Kelowna
Latitude & longitude of mouth	49°47.2' N, 119°19.9' W
Watershed area (km^2)	27
Stream length (km)	9.5
No. of reaches	4
Discharge (m^3/s) (mean/highest month/lowest month)	not gauged
Biogeoclimatic zones/subzones[11]	MSmm
General flow direction	north
Next higher order stream or lake	KLO Creek
Land use	forestry, recreation
No. of water licences	4 (All South East Kelowna Irrigation District)
Known fish species	no data
No. of F.1 & U.1 sites identified	2
No. of field sites checked	2

Table 10.3 Stream reach data summary for Pooley Creek

Reach #	Reach length (m)	Gradient (%)	Map sheet #	Site #'s within Reach
1	500	10	82 E/14	1
2	3000	11	82 E/14	2, 3
3	1750	7	82 E/14, 82 E/11	4, 5
4	4250	7	82 E/11	6 - 8
Total	9500			8

[11] Biogeoclimatic zone codes are in Appendix K.

Reach #3 has a gradient of about seven percent, and the substrate is composed of large gravels and cobbles. There was no flow at the time of the field inspection due to an upstream diversion. An inspection of the ditch which carries water away from Pooley Creek revealed an abundance of spawning gravel and numerous juvenile trout were observed (70-100 mm fork length). The fish may have access to the Pooley Creek main channel at high flows.

Reach #4 is immediately upstream of the diversion weir (Site #5, Section 10.3). Any fish in the diversion ditch cannot access Reach #4 due to a 2 m high concrete foundation wall on the weir. However excellent rearing habitat is present in the reach, with pools and abundant cover. The gradient (7%), flow and substrate contribute to the habitat values.

10.3 Field Check Site Descriptions

Site #: 4
Impact Code: Q.S.R.2
Reach #: 3

Date Inspected: July 15/95
Coordinates: 49°45.2'N 119°20.2'W
Map sheet #: 82 E/11

This site is located immediately downstream from the diversion located at site #5 and was coded from the air as Fs/Q.F.F.1. A road located along the right bank of Pooley Creek provides access to the flow diversion structure at site #5, and does not appear to be used for forest harvest activities. The road fill slope is partly vegetated with alders and small shrubs, however a significant portion of the slope (approximately 30%) remains unvegetated. The fill-slope appears to be relatively stable and shows minimal signs of surface erosion. The channel substrate of Pooley Creek consists of boulders and cobbles. There are no signs of accumulation of fine sands or gravels in the bed that may have been derived from the road fill slope.

At the time of the site inspection, the weir at site #5 was diverting 100% of surface flow from Pooley Creek into Hydraulic Creek. Since the slope appears to be stable, this site appears to

have a minimal impact on downstream water quality. Thus the coding for the site was changed to Q.S.R.2.

Site #: 5 **Date Inspected:** July 15/95

Impact Code: Fb.W.R.1 **Coordinates:** 49°45.1'N 119°20.2'W

Reach #: 3 **Map sheet #:** 82 E/11

A large weir constructed with gabions and a concrete sluice gate have been installed across the channel of Pooley Creek at this site. This diversion takes flows from the upper Pooley Creek watershed into the Hydraulic Creek watershed to augment community water supply.

Pooley Creek above the diversion is a single channel approximately 10 metres wide with channel substrate consisting of cobbles, gravels, and some boulders. Discharge of Pooley Creek at the time the site was visited was estimated by the floating chip method to be 0.1 m^3/s. When the site was visited, the weir was diverting 100% of surface flow. No flows were observed in the channel of Pooley Creek downstream of the diversion. It is believed that flow in Pooley Creek downstream of the weir is present only during high flow periods. Clearly this presents a significant impact on fish habitat.

As outlined in the reach description, fish in the diversion ditch cannot get past the weir to take advantage of good upstream rearing habitat. A fish ladder over the 2 m barrier could provide access. The site should be re-visited to further investigate this possibility.

10.4 Sediment Source Inventory

The sediment source inventory for Pooley Creek is summarized in Table 10.3. Six sources were identified from the aerial photo review, three of which are landslides originating from the fill

Table 10.3 Pooley Creek Sediment Source Inventory.

Location symbol(1)	Coordinates		Feature	Composition(2)	Dimensions(3)		Present in(4)		Larger in 1990's yes/no?
	Lat (N)	Long (W)			Width (m)	Length (m)	1950's yes/no?	1990's yes/no?	
R1a	n/a	n/a	Slide (from KVR)	sa, si, g	50	250	yes	yes	no
R1b	n/a	n/a	Slide (from KVR)	sa, si, g	10	200	yes	yes	no
3	n/a	119°19.67'	Slide (from KVR)	sa, si, g	150	80	yes	yes	no
3a	n/a	n/a	Eroding bank	sa, si, g	10	40	yes	no	no
3b	n/a	n/a	Slide	sa, si, g	30	160	yes	yes	no
3c	n/a	n/a	Slide	sa, si, g	80	160	yes	yes	no

(1): Refer to map: 82 E/14, 82 E/11

(2): Composition is determined from aerial photographs. Locations which have been checked in the field are indicated by a subscript 'f'. Compositions in brackets indicate minor amounts of the given texture.

si = silt
sa = sand
g = gravel

(3): Width is distance measured along the stream. Length is distance measured from the toe to the zone of initiation (In the case of an eroding bank, length refers to 'bank height')

(4): Two sets of aerial photos were examined in this study: one set flown in 1950's and second set flown in 1990's

(5): n/c - No aerial photo coverage available at the time of the Sediment Source Inventory

(6): Location symbols designated with "R" are referenced by reach locations (e.g. R3a is located in Reach 3).

(7): Location symbols designated with a number are referenced by site numbers from the video transcript (e.g. 18a is located between sites #18 and #19).

slope of the Kettle Valley Railway. Two additional slides were noted, as well as an eroding bank. None of the sites appeared larger on the 1990s photos compared to the 1950s photos.

10.5 Pooley Creek Summary and Recommendations

There is one site on Pooley Creek impacting fish habitat; a diversion weir at Site #5. The weir is not related to forest activities, but diverts water into Hydraulic Creek for use by the South East Kelowna Irrigation District. On the day of the field inspection the diversion removed 100% of the flow of Pooley Creek. The weir is a barrier to fish, which could be corrected by the addition of a fish ladder. In addition, the feasibility of re-establishing year-round flow in Pooley Creek should be examined. Even very low flows can help maintain aquatic life along the stream channel.

11.0 KLO CREEK

11.1 General Description

KLO[12] Creek is a tributary to Mission Creek. It originates on the Okanagan Highland at an elevation of about 1530 m and flows in a general north by northwest direction until it reaches Mission Creek about 8.5 km upstream of Kelowna. Deposits of river gravels, stratified sands and basal till are exposed near the mouth (Nasmith, 1962). Additional descriptive information is provided in Table 11.1. The NTS 1:50,000 scale map covering the creek (82 E/14) is included as Attachment 1, colour aerial photographs are included as Attachment 2, and black-and white aerial photographs are included as Attachment 3. Video transcripts, photographs and DFO/MELP stream survey forms are included in Appendix I.

On the basis of the aerial inspection, three (3) sites were assigned codes ending in F.1. A total of five sites were inspected. The assessments for these sites are presented in Section 11.3.

11.2 Reach Descriptions

Five (5) stream reaches were identified on KLO Creek. Reach length and gradient data for each reach are presented in Table 11.2.

Reach #1 extends from the mouth through the fluvial deposits associated with Mission Creek until the break in slope where the channel is incised into bedrock.

[12] KLO originally was an acronym for Kelowna Land and Orchard Company.

Table 11.1. General characteristics of KLO Creek.

Parameter	Information
Map sheet no.	82 E/14 Kelowna
Latitude & longitude of mouth	49° 50.5'N latitude, 119° 21.8'W longitude
Watershed area (km^2)	30
Stream length (km)	13.75
No. of reaches	5
Discharge (m^3/s) (mean/highest month/lowest month)	Mean 0.287/May 1.70/Feb 0.051[13]
Biogeoclimatic zones/subzones[14]	IDFxh1, IDFmw1, MSmm, PPxh1
General flow direction	Northwest
Next higher order stream or lake	Mission Creek
Land use	forestry, recreation
No. of water licences	4 (All South East Kelowna Irrigation District)
Known fish species	Rainbow trout
No. of F.1 & U.1 sites identified	3
No. of field sites checked	5

Table 11.2 Stream reach data summary for KLO Creek.

Reach #	Reach length (m)	Gradient (%)	Map sheet #	Site #'s within Reach
1	1500	5	82 E/14	1, 2
2	8500	9	82 E/14	3 - 9
3	2500	3	82 E/14	10 - 13
4	1000	5	82 E/14	14
5	250	0 (pond)	82 E/14	15
Total	13750		82 E/14	15

[13] At McCullough Rd. 1976-1982 only. Water Survey of Canada (1989)

[14] Biogeoclimatic zone codes are in Appendix K.

Reach #2 ranges from a somewhat open channel configuration with low banks below site #3 to an incised portion with higher banks from site #4 through to the end of the reach. The maximum channel width is about 11 m and the average wetted width during the site inspections was 3.3 m. Although the average gradient is about 9%, there are some steep sections ranging up to 25%. The substrate consists mainly of large gravels and small cobbles with a high degree of compaction. This reach has moderate to poor fish habitat. No areas with spawning-sized gravel were seen.

Reach #3 has an average gradient of 3%. There was very low flow at the time of the site visit. Moderate fish habitat is present due to about 60% cover, the presence of pools, and good food sources, notably stone flies. However, fish access to the reach is unlikely due to a section of 25% gradient in Reach #2.

Reach #4 is typically narrow (1-2 m) with 5% gradient, low flow, and a high percentage of fines in the substrate and bank materials. These factors create generally poor spawning and rearing habitat in the reach. As well, the channel probably freezes in winter due to the high elevation. Cover is about 60%.

Reach #5 is a pond at the headwaters.

11.3 Field Check Site Descriptions

Site #: 3 **Date Inspected:** Nov. 2/94
Impact Code: Q•C•R•2 **Coordinates:** 49°49'.6 N 119°21.9'W
Reach #: 2 **Mapsheet #:** NTS 82 E/14

The stream at this site has a low gradient, but is relatively straight with confining valley walls. This site was initially given an Fb/Q•C•F•1 code, but as a result of the field check, the code was revised to Q•C•R•3. Both of the bridge crossings at this site consist of concrete abutments with wood decks, and were probably used to access the Kettle Valley Railway further upstream or to service an

irrigation pipe at Site #4. The wood decks were in poor condition at the time of the field inspection, and some undermining of the abutments by the stream current was evident. However the banks are armoured and vegetated, and there is minimal erosion.

A sand and gravel extraction operation is located near the stream at site #3. It appeared to be closed at the time of the field visit. In some sections there is little buffer between the gravel operation and the creek.

Site #: 4
Impact Code: Q.D.N.2
Reach #: 2

Date Inspected: Nov. 2/94
Coordinates: 49°49.6'N 119°21.9'W
Mapsheet #: NTS 82 E/14

This low gradient site was initially given an Fb/Q•D•R•1 rating which was revised to Q.D.N.2 after the field visit. The water pipeline which crosses the creek is suspended about 5 m above the channel (Photograph 1), and does not represent a sediment source, since the banks are well vegetated and apparently stable. Just upstream from the pipe there has been some windfall across the stream and it is possible that it could cause the accumulation of more LWD in the stream. The debris could potentially move downstream and impact one or both of the bridge structures at site #3.

Site #: 10
Impact Code: N/A
Reach #: 3

Date Inspected: July 15/95
Coordinates: 49°46.5'N 119°18.1'W
Map sheet #: 82 E/14

A cutblock, logged in 1986 across a large gully, is located approximately 50 metres from the right bank of KLO Creek at Site #10. This was identified from the air as a possible sediment source. However, field inspection found no signs of sediment or surface flow entering KLO Creek from this gully.

Site #: 11

Impact Code: Q.C.F.3

Reach #: 3

Date Inspected: July 15/95

Coordinates: 49°46.3'N 119°18.0'W

Map sheet #: 82 E/14

KLO Creek at this site has a moderate gradient of 4%, and the channel substrate consists of mainly cobbles and boulders. A relatively recent bridge constructed of timber stringers crosses the channel at this site. The bridge appears to be in very good condition and does not show any signs of degradation. The bridge does not appear to constrict the channel width and there are no signs of erosion or undermining along the bridge abutments. The impact of the bridge upon KLO Creek is minimal.

Site #: 14A

Impact Code: Q.C.F.1

Reach #: 4

Date Inspected: July 15/95

Coordinates: 49°45.668'N 119°16.477'W

Map sheet #: 82 E/14

Although not identified as a site of concern from the air, an old log culvert crossing over KLO creek is collapsing into the channel (Photograph 2). KLO Creek at this site is only 1-2 m wide, and very low flows were observed when the site was visited. Several large openings in the culvert box were present where road fill had slumped into the channel. Approximately 0.7 m^3 of sediment has entered the creek, affecting downstream water quality. The road materials are dominantly fine grained (about 70% are less than 2 mm diameter) and are easily transported during higher flows.

The log culvert at this site should be removed, the channel restored to its natural condition, and the banks and exposed surfaces revegetated. If this site is considered as a WRP project, then other road crossings in the area (particularly site #14) should be examined to see if they also show signs of collapse.

11.4 Sediment Source Inventory

The sediment source inventory for KLO Creek is summarized in Table 11.3. Six sediment sources were identified, two eroding banks and four tributaries. All sources were present on both the 1950s and the 1990s aerial photos, and none appeared larger on the newer set of photos.

11.5 KLO Creek Summary and Recommendations

Three sites on KLO Creek were identified from the helicopter survey as having a high level of potential impact from forestry activities. Five sites were inspected. Following the field inspections, only one site remained with an F.1 rating:

Site #14A — Old log culvert collapsing into the channel; erosion of adjacent river bank. Culvert should be removed and the channel restored to its original configuration, and the banks re-vegetated.

Table 11.3 KLO Creek Sediment Source Inventory.

Location symbol(1)	Coordinates		Feature	Composition(2)	Dimensions(3)		Present in(4)		Larger in 1990's yes/no?
	Lat (N)	Long (W)			Width (m)	Length (m)	1950's yes/no?	1990's yes/no?	
5	n/a	119 21.10'	Eroding bank	sa, g	100	15	yes	yes	no
6	n/a	119 20.44'	Eroding bank	sa, g	40	10	yes	yes	no
6a	n/a	119 20.44'	Tributary	sa, g	n/a	n/a	yes	yes	no
7a	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
8a	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no
8b	n/a	n/a	Tributary	sa, g	n/a	n/a	yes	yes	no

(1): Refer to map: 82 E/14

(2): Composition is determined from aerial photographs. Locations which have been checked in the field are indicated by a subscript 'f'. Compositions in brackets indicate minor amounts of the given texture.

si = silt
sa = sand
g = gravel

(3): Width is distance measured along the stream. Length is distance measured from the toe to the zone of initiation (In the case of an eroding bank, length refers to 'bank height')

(4): Two sets of aerial photos were examined in this study: one set flown in 1950's and second set flown in 1990's

(5): n/c - No aerial photo coverage available at the time of the Sediment Source Inventory

(6): Location symbols designated with "R" are referenced by reach locations (e.g. R3a is located in Reach 3).

(7): Location symbols designated with a number are referenced by site numbers from the video transcript (e.g. 18a is located between sites #18 and #19).

12.0 MISSION CREEK MAINSTEM

12.1 General Description

Mission Creek drains into Okanagan Lake at the City of Kelowna. The city is largely constructed on the alluvial fan that has been deposited by Mission Creek and several smaller creeks since deglaciation (Nasmith, 1962). Mission Creek is diked for its lowest 5-6 km and portions of the floodplain and some upslope areas in reaches 1-8 have been cleared for agriculture and/or residential development. Additional descriptive information is provided in Table 12.1. The NTS 1:50,000 scale maps covering the creek (82 E/14, 82 E/15 and 82 L/2) are included as Attachment 1, colour aerial photographs are included as Attachment 2, and black-and-white aerial photographs are included as Attachment 3. Video transcripts, photographs and DFO/MELP stream survey forms are included in Appendix J.

The aerial inspection revealed eight (8) sites that were assigned codes ending in F.1 or U.1. All eight sites were field-checked as well as two (2) non-F.1/U.1 sites. The assessments for these 10 sites are presented in Section 12.3.

12.2 Reach Descriptions

Twelve (12) stream reaches were delineated on Mission Creek. Gradient and length data for the individual reaches are provided in Table 12.2. Reach descriptions are only available for Reaches 5-8, since only these reaches had sites which were inspected.

Reach #5 is a deeply incised portion of the stream with a gradient ranging from 10-15%. The substrate consists mainly of bedrock and boulder/cobble with a maximum channel width ranging

Table 12.1. General characteristics of Mission Creek.

Parameter	Information
Map sheet no.	82 E/14, 82E/15, 82 L/2
Latitude & longitude of mouth	49° 50.63'N, 119° 29.01'W
Watershed area (km^2)	836
Stream length (km)	68
No. of reaches	12
Discharge (m^3/s)[15] (mean/highest month/lowest month)	Mean 6.05/May 23.0/Feb 1.01
Biogeoclimatic zone(s)[16]	PPxh1, IDFxh1a, IDFxh1, IDFmw1, MSmm
General flow direction	South-Southwest then West
Next higher order stream or lake	Okanagan Lake
Land use	residential, recreation, agriculture, forestry
No. of water licences	168 (Wide variety)
Known fish species	Kokanee salmon, Rainbow trout, Burbot
No. of F.1 & U.1 sites identified	8
No. of field sites checked	10

Table 12.2 Stream Reach Data Summary for Mission Creek

Reach No.	Reach length (km)	Gradient (%)	Site #s within Reach
1	11.0	0.7	1-12
2	5.0	1.1	13-17
3	2.0	1.3	18-19
4	1.3	5.4	20-22
5	1.3	2.3	-
6	1.0	3.5	23
7	11.5	1.5	24-39
8	11.3	1.8	40-54
9	6.5	2.8	55-57
10	8.3	4.0	58-64
11	8.5	4.1	65-69
12	0.5	0 (lake)	-
Total	68.0		

[15] Water Survey of Canada (1989).

[16] Biogeoclimatic zone codes are in Appendix K.

from 15-20 m. One large waterfall and a series of small falls/chutes combine to make this reach an impassable barrier to upstream fish migration.

Reach #6 is a low gradient (2-3%), relatively wide, and meandering section of the stream in which the channel is occasionally split around islands and bars. The substrate consists mainly of coarse gravel and small cobble with some boulders. Many deep pools and off-channel habitat are present within this reach. There were some areas noted with spawning-sized gravel, and overall this reach possesses good fish habitat.

Reach #7 has similar gradient, substrate and channel characteristics to reach #6 with the exception of having some bedrock outcrops creating deep pools and concentrating the flow. There are numerous small islands, gravel bars and anastomozing sections throughout the reach. Some of the islands are vegetated indicating relative stability. A substantial amount of beaver activity was noted within this reach. Some of the banks within the reach are 2-3 m high consisting of fluvial deposits. This reach also has areas of good fish habitat.

Reach #8 has a higher gradient than reach #7 and a change in substrate to a higher proportion of cobbles and small boulders. The channel is more confined with generally higher, actively eroding banks (2-3 m) on both sides of the stream. Beaver activity is also present in this reach.

12.3 Field Check Site Descriptions

Site #: 23
Impact Code: Fb•W/D•N•3
Reach #: 6

Date Inspected: Nov. 9/94
Coordinates: 49°51.2'N; 119°18.3'W
Mapsheet #: NTS 82 E/14

Site #23 is a steep-walled bedrock canyon (Photograph 1) with a series of small falls or chutes that are 3-5 m high, and at least one larger waterfall. Initially coded as Fb•W/D•N/U•1, the coding was changed to Fb•W/D•N•3 during the field check because the barriers are largely natural in origin. It

was noted from the air that there was a debris jam at the downstream end of the large waterfall, but the jam could not be inspected during the site visit because access by foot to the large falls was impossible. A number of incised gullies reach the creek near Site #23.

Site #: 27
Impact Code: Q•S•N•3
Reach #: 7

Date Inspected: Nov. 9/94
Coordinates: 49°51.31'N; 119°15.62'W
Mapsheet #: NTS 82 E/14

Features of this site include a 30-50 m high eroding bank on the right side of the stream (Photograph 2), and woody debris in the channel. This site was initially given an Fb/Q•S•N•3 code but the code was revised to Q•S•N•3 in the field since fish, if present, can apparently by-pass the debris. This site was surveyed at the recommendation of Mr. Malcolm Campbell of Black Mountain Irrigation District.

Site #: 29
Impact Code: Q•D•N/F•1
Reach #: 7

Date Inspected: Nov. 9/94
Coordinates: 49°51.5'N; 119°14.3'W
Mapsheet #: NTS 82 E/14

At Site #29 the stream has a low gradient and is relatively wide with coarse substrate material. This site was initially given an Fb•D•F•1 code but as a result of the field check the code was revised to Q•D•N/F•1. Photograph 3 shows a large debris jam on the left bank which has the potential to travel further downstream during high flows. The majority of the debris consists of trees with root-wads and beaver-cut trees, however there are several pieces of LWD with cut ends and some milled timbers (6"x10"x6'). LWD at this site is scattered throughout the channel for a distance of 500 m, the majority being natural in origin. Two domestic water wells/pump houses are within 50 m of the channel and the accompanying road ends at the right stream bank. The road is a potential source of sediment to the stream.

Steps that could be taken at this site include the selective removal of woody debris from the stream, and road maintenance to prevent sediment from reaching the stream.

Site #: 31

Date Inspected: July 17/95

Impact Code: Fb/Q.D.N/F.1

Coordinates: 49°51.7'N 119°12.9'W

Reach #: 7

Map sheet #: 82 E/14

Mission Creek at this site is a low gradient (2%), meandering stream which is deeply incised into a series of old alluvial or glacial terraces and bedrock. Two small debris accumulations have formed at the upstream end of a large island which is situated along the right bank of Mission Creek. The LWD is composed of a combination of natural and forestry-related debris that has blocked the upstream entrance to two small side channels which flow through the island (Photograph 4). The first side channel is located immediately adjacent to the right bank and extends downstream for 200 m. The second side channel is located in the middle of the island and extends downstream for 50 m. Both side channels are approximately 8-10 m wide. At present the side channels are not conveying flow due to debris blockage at the upstream end of the island. It is believed that flow is present in the side channels only during freshet conditions in the spring.

The side channels, especially the first channel, have potentially excellent fish habitat for rearing. A few small deposits of spawning-sized gravels were observed which could be utilized for spawning. The side channels provide excellent cover and many deep areas which would form pools. Fish habitat at this site would be improved if the side channels were re-activated through the selective removal of LWD blocking the upstream entrance to the side channels. It should be noted that the debris accumulations at the entrance to the side channel also play a role in deflecting flows away from the right bank. Complete removal of the LWD accumulations could therefore increase fluvial erosion along the right bank.

Access to this site is from an old road which winds down through private land from Highway 33. For permission to access this site, it is necessary to contact Bill Jurome (phone # 763-9175). This site presents a very good opportunity to improve fish habitat in Mission Creek.

Site #: 43
Impact Code: Fb•D•R•1
Reach #: 8

Date Inspected: Nov. 3/94
Coordinates: 49°52.04'N; 119°06.84'W
Mapsheet #: NTS 82 E/14

Site #43 was initially given an Fb•D•U•1 code but as a result of the field check the code was revised to Fb•D•R•1. A series of intricate rock weirs and pools have been constructed in the channel, spanning the entire channel width at this location. It is unclear whether or not this was done as part of a fisheries enhancement project. About 20 m upstream from the weirs, a deep pool (> 2 m) is controlled by LWD across the channel. LWD is scattered throughout the channel for a distance of 300m upstream from the weirs, including two large debris jams. All of the debris appears to be natural in origin, but some pieces have cut-ends, probably due to past attempts to remove some of the debris. Most of the debris appears stable but the site could be enhanced by selective removal or by anchoring some of the pieces.

An old cut block is located about 400 m upslope on the north side of the channel, that is apparently currently used for grazing. An ephemeral stream drains this area to Mission Creek.

Site #: 45
Impact Code: Fb/Q•D•N•1
Reach #: 8

Date Inspected: Nov. 3/94
Coordinates: 49°52.12'N 119°06.78'W
Mapsheet #: NTS 82 E/14

This site is similar to site #43. Initially classed as Q•D•F•1 from the helicopter survey, the code was revised to Fb/Q•D•N•1 in the field. A large debris jam (approx. 30 m x 4 m x 1 m) is blocking a secondary channel along the right bank flowing around a vegetated island that is approximately 6 m wide. Most of the debris consists of beaver-cut or uprooted trees, and some of the longer pieces extending over the channel have been cut. Similar to site #43, most of the debris appears stable but the site could be enhanced by selective removal or by anchoring some of the pieces. LWD

scattered across the channel continues upstream for 200 m. There are several large pools at this site controlled by downstream accumulations of gravel.

Site #: 47
Impact Code: Q•D•N•2
Reach #: 8

Date Inspected: Nov. 3/94
Coordinates: 49°52.71'N; 119°04.43'W
Mapsheet #: NTS 82 E/14

The natural condition of this site is similar to that at site #45. This site was initially given an Fb•D•U•1 code but as a result of the field check the code was revised to Q•D•N•2 since the majority of woody debris was from beaver activity. There are four debris jams at this site and all appear to be old beaver dams which have been broken apart by the streamflow cutting away the centre portions of the dams. The debris in the channel continues for approximately 200 m, but all of the debris at this site appears to be stable.

Site #: 51
Impact Code: Q•D•F•1
Reach #: 8

Date Inspected: Nov. 3/94
Coordinates: 49°53.25'N; 119°03.83'W
Mapsheet #: NTS 82 E/14

This site is similar to the other Reach 7 sites. The site is very close to site #52 and together could be treated as one site for restoration purposes. There is a substantial amount of LWD scattered across the channel, most of the pieces are in relatively short lengths (2-3 m) and have cut-ends. At high water levels this debris could be carried further downstream and possibly impact the bridge located immediately downstream.

Site #: 52
Impact Code: Q•D•F•1
Reach #: 8

Date Inspected: Nov. 3/94
Coordinates: 49°53.52'N; 119°03.64'W
Mapsheet #: NTS 82 E/14

This site is similar to the other Reach 7 sites. Logging has recently taken place (probably 1994) within 10 m of the stream, and some trees were felled directly into the channel. Historically the floodplain has been selectively logged on both sides of the stream and many large diameter stumps remain. Some of these stumps have been transported into the channel from the eroding, undercut banks. As with site #51, the debris could be transported downstream and impact the bridge.

A debris removal and/or stabilization program is suggested for this site. As well, the feasibility of local bank stabilization should be investigated.

Site #: 56
Impact Code: Fb/Q•D•N•3
Reach #: 9

Date Inspected: Nov. 4/94
Coordinates: 49°56.94'N; 119°02.56'W
Mapsheet #: NTS 82 E/14

The condition of this site is similar to that at site #52 but the stream banks are higher (2-3 m) and there is a substantial amount of bank undercutting. This site was initially given an Fb/Q•D•U•1 code but as a result of the field check the code was revised to Fb/Q•D•N•3. One large debris jam was observed which appears to be stable (Photograph 30). The LWD in the debris jam consists of beaver-cut trees and other natural LWD. This debris jam would only constrict the flow of the stream, and become unstable, at peak water levels because it is currently stranded on a gravel bar 2-3 m above the thalweg of the channel. There is recent evidence of beaver-cut trees 100 m upstream from the debris jam.

12.4 Sediment Source Inventory

The sediment source inventory for the main stem of Mission Creek is summarized in Table 12.3. A total of 15 sources were identifed from the aerial photo survey, of which seven were tributaries entering the main stem. Of the remainder, one landslide or slump was identified on the 1990s aerial photos that was not present on the 1950s photos. This slide plus a bank failure near Site #20 were identified as being larger in area on the newer photos. The remaining six sources did not change in size btween the 1950s and the 1990s photos. None of the sediment sources identified from the aerial photograph review appear to be related to forest harvest activities.

12.5 Mission Creek Summary and Recommendations

A total of eight sites on the mainstem of Mission Creek were identified from the helicopter survey as having a potentially high level of impact from forestry (F.1) or unknown (U.1) activities. Ten sites were inspected. Following the field inspections, four sites remained with an F.1 rating. These are:

Site #29 — Extensive woody debris (both natural and logging) extending for 500 m. Potential instability and bank erosion. Also a road runs into the stream and is a potential sediment source.

Site #31 — Debris blocks fish access to two side channels with excellent fish habitat characteristics.

Site #51 — Considerable amounts of unstable woody debris. Could impact bridge downstream.

Site #52 — Woody debris and stumps in channel, contributing to bank erosion.

All of the above sites would benefit from debris removal and stabilization. In particular, Sites #51 and #52 should be addressed due to on-going bank erosion related to woody debris, and the potential for the nearby bridge to be impacted if the debris is mobilized.

Table 12.3 Mission Creek Sediment Source Inventory

Location symbol(1)	Coordinates		Feature	Composition(2)	Dimensions(3)		Present in(4)		Larger in 1990's yes/no?
	Lat (N)	Long (W)			Width (m)	Length (m)	1950's yes/no?	1990's yes/no?	
12	49°51.63'	119°23.36'	Eroding bank	g, sa	40	20	yes	yes	no
13.1	49°51.06'	119°23.03'	Slide/Slump	sa, g	60	130	no	yes	yes
15	49°50.94'	119°22.63'	Eroding bank	sa, g	200	70	yes	yes	no
16	49°50.86'	119°22.14'	Tributary	g, sa	n/a	n/a	yes	yes	no
16.1	49°50.86'	119°22.14'	Eroding bank	g, sa	150	40	yes	yes	no
18	49°50.56'	119°21.01'	Tributary	g, sa	150	40	yes	yes	no
20	49°51.33'	119°19.87'	Bank failure	g, sa, si	30	2	yes	yes	yes
24.1	n/a	n/a	Tributary	g, sa	n/a	n/a	yes	yes	no
27	49°51.31'	119°15.62'	Eroding bank	g, sa	100	30	yes	yes	no
28	49°51.38'	119°14.72'	Slump	g, sa, si	320	250	yes	yes	no
30.1	n/a	n/a	Tributary	g, sa	n/a	n/a	yes	yes	no
31.1	n/a	n/a	Tributary	g, sa	n/a	n/a	yes	yes	no
31.2	n/a	n/a	Tributary	g, sa	n/a	n/a	yes	yes	no
32	49°51.65'	119°12.42'	Slump	g, sa, si	80	50	yes	yes	no
33.1	n/a	n/a	Tributary	g, sa	n/a	n/a	yes	yes	no

(1): Refer to map: 82 E/14, 82 E/15

(2): Composition is determined from aerial photographs. Locations which have been checked in the field are indicated by a subscript 'f'. Compositions in brackets indicate minor amounts of the given texture.
si = silt
sa = sand
g = gravel

(3): Width is distance measured along the stream. Length is distance measured from the toe to the zone of initiation (In the case of an eroding bank, length refers to 'bank height')

(4): Two sets of aerial photos were examined in this study: one set flown in 1950's and second set flown in 1990's

(5): n/c - No aerial photo coverage available at the time of the Sediment Source Inventory

(6): Location symbols designated with "R" are referenced by reach locations (e.g. R3a is located in Reach 3).

(7): Location symbols designated with a number are referenced by site numbers from the video transcript (e.g. 18a is located between sites #18 and #19).

13.0 MISSION CREEK WATERSHED SUMMARY AND RECOMMENDATIONS

Stream channel assessments were conducted on Mission Creek and eight of its tributary streams during the period October 1994 to July 1995. The assessments were aimed at identifying sites that have been impacted by forest harvest activities, including road building, and establishing priorities for stream channel restoration. The assessment program began with a helicopter survey in which sites of concern were identified along each stream, and assigned a code identifying the type, source, cause, and degree of problem (Table 2.1). Thus the helicopter survey served as a first-cut attempt at identifying priority restoration sites. Those sites that were ranked as having a high potential impact from forestry-related activities (code ending in "F.1"), or where the cause of the impact was uncertain (code ending in "U.1"), were inspected by a field crew. The initial site selection from the helicopter survey was intentionally conservative. As a result, a portion of the high potential impact sites were downgraded to moderate or low potential impact following the field inspection. Thus the remaining "F.1" sites are those sites identified as priorities for stream channel restoration work.

From the helicopter survey, a total of 40 sites were given codes ending in F.1 or U.1. When the field inspections were complete, 20 sites remained with the F.1 ranking. Table 13.1 summarizes these sites, including a brief description of the problem associated with each site. Detailed information on each site inspected is found in Sections 4.0 through 12.0 of this report.

Four general types of stream channel problems were identified in the Mission Creek watershed:

1. Woody debris in the stream channel acting as a barrier to fish passage (6 sites)
2. Woody debris in the channel causing bank erosion and bank instability (6 sites)
3. Logging to streamside with adjacent slope or bank erosion (4 sites), and
4. Culverts in poor condition; either a potential fish barrier or contributing to erosion (5 sites).

Table 13.1 Summary List of Priority Sites for Restoration in the Mission Creek Watershed

DARLEY CREEK	
Site #4	Logging across stream channel; woody debris in channel; adjacent slope erosion
Site #6	Unvegetated landing adjacent to a fork in the stream; potential sediment source
HILDA CREEK	
Site #2	Logging across stream channel, debris barriers to fish passage, possible impacts on spawning habit, water quality implication
Site #6	Log culvert constricting flow; resulting bank erosion and possible road instabilty
BELGO CREEK	
Sites #13 & #14	Debris jams blocking the channel to fish passage. Flow is diverted around during periods of high flow
Site #16	Debris jam blocking fish passage. Very good fish habitat in this area.
Site #25	Culverts potentially blocking fish passage.
PEARSON CREEK	
Site # 6	Drainage culvert has been cut off and is currently causing serious erosion near creek; requires repair or replacement plus armouring with rip-rap at outlet
JOE RICH CREEK	
Site # 7	Landslide has deposited sediment and LWD in channel: Erosion from Highway 33 fillslope is a sediment source
Site # 11	Log culvert in poor condition. Contributing to erosion. Potential fish barrier if plugged by debris. Should be removed and channel restored.
Site # 11A	Woody debris in channel within cutblock with no buffer. One debris jam is a fish barrier.
HYDRAULIC CREEK	
Site #15	No buffer strip; substantial wind-fall and other debris in creek; road crossing over ephemeral tributaries. Debris removal and road maintanence recommended.
Site #16	Similar to Site #15; can be remediated at the same time.

Table 13.1 (continued)

POOLEY CREEK	
Site #5	Weir which diverts flow to Hydraulic Creek. All flow taken away from the creek at low flows. Barrier to fish.
KLO CREEK	
Site #14A	Old log culvert collapsing into the channel; erosion of adjacent river bank. Culvert should be removed and the channel restored to its original configuration, and the banks re-vegetated.
MISSION CREEK MAINSTEM	
Site #29	Extensive woody debris (both natural and logging) extending for 500 m. Potential instability and bank erosion. Also a road runs into the stream and is a potential sediment source.
Site #31	Debris blocks fish access to two side channels with excellent fish habitat characteristics.
Site #51	Considerable amounts of unstable woody debris.
Site #52	Woody debris and stumps in channel, contributing to bank erosion.

In addition to these categories which are related to forest harvest, a number of problem sites were identified relating to transportation routes and water works. Agriculture and residential development also have the potential to impact fish habitat and water quality in the Mission Creek basin.

Landslides and other mass movements were not identified as a major issue, since few slides were identified which directly impacted stream channels. One slide was identified as an "F.1" on Joe Rich Creek (Site #7). That slide originated from an old logging road and resulted in sediment and woody debris being deposited in the channel, and the flow being directed onto the opposite bank. Another notable slide scar is present near the confluence of Belgo and Darley Creeks. This slide caused considerable damage, but the slide material was mostly deposited on the Belgo Creek floodplain. However the slide scar was not completely revegetated when inspected in 1995, and thus does remain as a potential sediment source.

At least one impacted site was identified on each of the nine streams which were assessed. Given the size of the Mission Creek watershed, and the number of kilometres of stream channel assessed, it is somewhat surprising that more sites with potential problems were not identified. There are several reasons for this. The first is the long history of domestic and irrigation water withdrawals from the Mission system. Concerns about water quality have existed for some time, resulting in less logging near streams in recent years compared to other areas in the B.C. Interior. The second is the length of time since logging took place in riparian areas. Although harvest to streamside did historically occur in many places, the debris is usually relatively stable and does not currently create fish barriers or accelerated erosion. However, in the absence of pre-harvest information on the ecology of fish in the Mission Creek watershed, it is difficult to say whether or not forest harvest has influenced fish species distribution or populations. Nevertheless, restoration of the sites listed in Table 13.1 should be initiated as soon as possible, since all the identified sites are presently affecting or have the potential to negatively affect fish habitat and/or water quality.

14.0 REFERENCES

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15.0 GLOSSARY

Alluvial fan	Sediment deposit usually occurring where a stream emerges from a confined valley into a broader valley. Typically resembles a segment of a cone.
Anastomozing	Stream channel consisting of distributaries which branch and rejoin. They resemble braided streams except that the channels are discrete, interconnected channels separated by bedrock or stable alluvium. Thus they are erosional rather than depositional forms.
Braided streams	Flow is divided by islands or bars formed of alluvium. Formed by excessive sediment deposition in stream channels.
Colluvial deposits	Gravity deposits (e.g., rock falls) along valley sides. Usually found in the more confined stream reaches.
Fluvial deposits	Generally well sorted gravels, sands and silts transported and deposited by streams and rivers.
Fluvioglacial deposits	Materials deposited by glacial meltwater either in contact with ice or beyond the ice margin as outwash.
Kames	Ice contact deposits resembling steep knolls. Formed when stagnant ice left hummocks of drift which were modified by water flowing around the base.

Kame terraces	Ice contact, stratified deposits along the valley sides originating from meltwaters flowing between the glacier and the valley wall.
Outwash terraces	Materials deposited by meltwaters downstream from a glacier. Subsequent downcutting leaves terrace features on the valley sides.
Oxbow Lake	Small lake created when a stream meander is isolated by the stream channel overrunning the meander loop during high flows. Oxbow lakes typically accumulate channel-fill deposits during subsequent floods.
Thalweg	In a stream, the line of maximum depth along the channel bottom.

APPENDIX A

Terms of Reference

SCHEDULE A – SERVICES

Mission Creek Stream Assessment

CONTROL NO.: 1080-20
Water Restoration
8SC-94-27

TERMS OF REFERENCE

Background: This contract is funded under the Watershed Restoration Program. The intent of this project is to identify and evaluate potential stream restoration opportunities to improve fish habitat and water quality within the Mission Creek watershed. This will include fish habitat and stream channel assessments with emphasis on impacts associated with forest harvest activities.

The contractor will:

1) Provide fish habitat and hydrology assessments on preselected watersheds (Appendix 1) as follows:

A) Video tape existing stream conditions using helicopter video with GPS mapping, all of which will be provided by MOELP.

- participate directly in accompanying the helicopter and providing voice over describing the fish habitat and hydrological conditions of the subject stream. Stream habitat features should be recorded using the methods provided in Appendix 2 and 3 of Watershed Restoration Technical Circular No. 8 (attached) where applicable.
- communicate directly with the helicopter contractor provided by MOELP to set up logistics of scheduling the flights on the preselected watersheds (Appendix 1).
- helicopter flights should be timed to coincide with deciduous leaf drop and high sun angle to ensure good visibility.

B) Review video tapes and compare with supplemental information as follows:

- review existing literature, historical watershed information, relevant hydrotechnical data bases (including individuals with experience in the watershed).
- review historical and recent air photos and interpret the degree of stream degradation and instability by stream reach.
- document results of the video tape and supplemental information review on air photos and maps as appropriate.

C) Ground truthing video habitat\feature parameter estimates.

- for each stream reach, visually estimated values of parameters should be confirmed \ calibrated by ground measurement; ground truthing should not exceed 10% of representative habitat.
- photographic records and stream habitat features from Appendix 2 and 3, Tech. Circular No. 8 should be recorded at ground truthing locations.

BTG

- weather may prevent completion of ground measurements, so a prioritized list of stream reaches should be completed after or during the video work; the prioritized list must be discussed with and approved by the contract monitors prior to execution.

D) Priorize Impacts and Propose Possible Remedial Measures

- identify near channel instabilities and all active or potential sources of stream sediment in the watershed on maps of appropriate scale.
- identify reaches that require remediation on maps of appropriate scale.
- suggest initial remedial measures for each stream reach or stream, and recommend further prioritized fish and hydrology assessment or restoration.

2) Provide progress reports on work to date with each billing period.

3) Be prepared to communicate closely with MOELP contract monitors and MOF upslope contractors for selected watersheds.

4) Be prepared to attend meetings with agency staff or the public regarding mitigation\restoration measures that the contractor may recommend.

5) Provide a draft final report by February 1, 1995 and a final report by March 31, 1995. Five (5) copies of the final report are required, including one (1) unbound master with maps suitable for copying.

An interim report documenting the results of the work carried out may be required instead of a final report in the event that the ground truthing specified in Item 1C is not completed during the 1994 field season.

6) Be familiar with, and conform to the Worker's Compensation Board Industrial Health and Safety Regulations.

APPENDIX B

Darley Creek
Stream Information File

MISSION CREEK STREAM ASSESSMENT

Field Copy

STREAM: DARLEY CREEK
DATE: October 22, 1994
TAPE: WRP Tape 8

LOCATION SYMBOL	CODE		COMMENTS	TIME	COORDINATES North	West
1		▸	mouth of the stream	38:29	49.51.73*	119.08.36
2	Q-S-N-2	▸	historic (famous) slides of 1990 on the left	38:46	49°53.857 49.51.73	119°08.735 119.08.66
3	Fb/Q-D-N-2	▸	LWD in the channel (natural)	44:14	49.51.73	119.09.73
* 4	Fs/Q-D-F-1	▸	cutblock logged across the stream with LWD in the channel @ ~4700' elevation	44:36	49.51.73	119.09.81
5	Q-S-F-2	▸	cutblock on the right side & left side	45:14	49.51.73	119.09.81
* 6	Fb/Q-C-F-1	▸	road crossing over two branches of the stream through wooden box culverts, no buffer for ~50m along the stream	45:52	49.51.73	119.09.70
7		▸	headwaters @ ~5300' elevation	47:13	49.51.73	119.10.07

= to visit

Not visited on July 19/95
- road closed over by alder
- note coordinate correction on site 2

* at bridge

*GPS coordinate for latitude stuck
NOTE: Map 82 E/14 1:50,000

APPENDIX C

Hilda Creek
Stream Information File

Photograph 1. Debris jam at Hilda Creek Site #2. Note lack of riparian buffer.

Photograph 2. Wooden box culvert in poor condition at Hilda Creek Site #6.

MISSION CREEK STREAM ASSESSMENT

STREAM: HILDA CREEK
DATE: October 22, 1994
TAPE: WRP Tape 8

to visit	LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	West
	1		▸ mouth of the stream	30:42	49.51.73*	119.04.3
July 17/95 DH/MG *	2	~~Fb/Q-D-F-1~~ Fb/Fs/a-D-F-1	▸ cutblocks on both sides logged over the stream, LWD in the channel	31:22	50°00.204'	119°04.18 ~~119.04.2~~
	3	Fb/Q-D-N-2	▸ beaver dam	31:38		119.04.2
	4	Q-S-F-2	▸ continuation of site #2 cutblocks on ~~both sides~~ but now is a buffer ~10m ~~wide on both sides~~ (less on the left side)	32:08		119.04.2
July 17/95 DH/MG *	5	~~Fs/Q-F-F-1~~ Q-D-N/F-3	▸ road immediately adjacent to the stream; Road on right ~15m from stream on left	33:27	50°00.825'	119°04.08 ~~119.04.0~~
July 17/95 DH/MG *	6	Fb/Q-C-F-1 No change	▸ culvert @ ~4500' elevation	33:37	50°01.180'	119°03.80 ~~119.04.0~~
July 17/95 DH/MG *	7	~~Fb/Q-C-F-1~~ a-W-R-2	▸ road crossing on a tributary, engineered channel with a steel grate on the d/s end see below	34:55	50°01.274'	119°03.320 ~~119.03.7~~
	8	Q-S-F-2	▸ passing through an old cutblock with ~30 years regen.	36:17		119.03.5
	9		▸ headwaters @ ~4700' elevation	36:31		119.03.5
	#8 + #9 not Hilda; actually a tributary - not inspected					
	6A	Q-D-F-2	▸ Old cutblock logged across channel. LWD in stream.		50°01.180'	119°03.80

* Comment for site #7: Engineered channel on Right with a steel grate and a ½ m pipe at right angles to the channel leading to a tributary to Ideal Lake.

* GPS Coordinate for latitude stuck
NOTE: 1-9: Map 82 L/3 1:50,000

SITE 5

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Hilda Creek	(local)		Access	Method
Watershed Code		Reach No.		Length(km)	
Location	site #5	Map		Length Surv.(m)	100
		U.T.M.		Fish Card Y N	Field ☐ Hist. ☐
Date Y.M.D.	95 07 17	Time	1500	Agency / Crew	MG/DH
Photos		Air Photos			

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	Ave.Chan.Width (m)	4	GE	
	Ave.Wet.Width (m)	3	↓	
	Ave.Max.Riffle Depth (cm)	10		
	Ave.Max.Pool Depth (cm)	50	↓	
	Gradient %	1-2	CL	
	% Pool 40 Riffle 50 Run 10 Other		GE	
	Side Chan.%	0	↓	
	Debris Area%	10		
	Stable %		↓	
	COVER: Total %	40		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
	30	10	20		20	20

Crown Closure %: 20 | Aspect:

BED MATERIAL		%
Fines	clay, silt, sand (<2mm)	
Gravel	small (2–16mm)	
	large (16–64mm)	
Cobble	sm.cobble (64–128mm)	
	lge.cobble (128–256mm)	
	boulder (>256mm)	
Bedrock		

D_{90}(cm): | Compaction: L M H

BANKS	
Height(m)	5
%Unstable	10
Texture	(F) G L (R)
Confinement	EN (CO) FC OC UC N/A
Valley: Channel Ratio	0–2 2–5 5–10 10+ N/A
Stage	Dry (L) M H Flood
Flood Signs Ht(m)	1
Braided	Y (N)
Bars (%)	∅
pH	—
O_2(ppm)	—
Water Temp.(°C)	11
Turb.(cm)	—
Cond.(25°C)	—

OBSTRUCTIONS: C | Ht(m) | Type | Loc'n

DISCHARGE

Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC 87

SITE 7

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Hilda Creek	(local)		Access	Method
Watershed Code		Reach No.		Length(km)	
Location	site #7	Map		Length Surv.(m)	100
		U.T.M.		Fish Card Y N	Field ☐ Hist. ☐
Date Y.M.D.	95 07 17	Time	1230	Agency / Crew	MG/DH
Photos		Air Photos			

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	Ave.Chan.Width (m)	5	GE	
	Ave.Wet.Width (m)	3		
	Ave.Max.Riffle Depth (cm)	10		
	Ave.Max.Pool Depth (cm)	50	↓	
	Gradient %	5	CL	
	% Pool 20 Riffle 60 Run 20 Other		GE	
	Side Chan.%	5		
	Debris Area%	5		
	Stable %	90	↓	
	COVER: Total %	30		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
	30	20			30	20

Crown Closure %: 20 | Aspect:

BED MATERIAL		%
Fines	clay, silt, sand (<2mm)	
Gravel	small (2–16mm)	
	large (16–64mm)	
Cobble	sm.cobble (64–128mm)	
Large	lge.cobble (128–256mm)	
	boulder (>256mm)	
Bedrock		

D_{90}(cm): | Compaction: L (M) H

BANKS	
Height(m)	.5
%Unstable	10
Texture	F (G) L R
Confinement	EN CO (FC) OC UC N/A
Valley: Channel Ratio	0–2 2–5 5–10 10+ (N/A)
Stage	Dry (L) M H Flood
Flood Signs Ht(m)	1.5
Braided	(Y) N
Bars (%)	25
pH	—
O_2(ppm)	—
Water Temp.(°C)	9
Turb.(cm)	
Cond.(25°C)	—

OBSTRUCTIONS: C | Ht(m) | Type | Loc'n

DISCHARGE

Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC 87

SITE #5

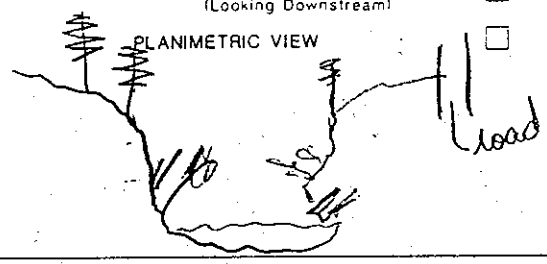
FISH SUMMARY

C	Species	No.	Size Range(mm)	Life Phase	Use	Method/Ref.
	trout	2	60-80	you 1-2		

STREAM/VALLEY CROSS-SECTION ☐
(Looking Downstream)

L R

PLANIMETRIC VIEW ☐



COMMENTS

Channel Stability ☐ Debris ☐ Management Concerns ☐ Obstructions ☐ Riparian Zone ☐ Valley Wall Processes ☐ Etc.

- excellent fish habitat at site #5 through the bedrock canyon confined portion of the channel
- [illegible] old hanging bedrock banks
- [illegible] abundant

Edited by:
Date Y M D:

SITE #7

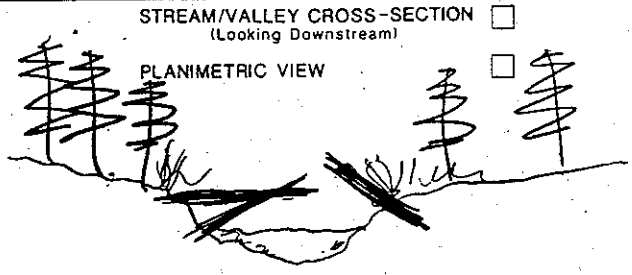
FISH SUMMARY

C	Species	No.	Size Range(mm)	Life Phase	Use	Method/Ref.

STREAM/VALLEY CROSS-SECTION ☐
(Looking Downstream)

L R

PLANIMETRIC VIEW ☐



COMMENTS

Channel Stability ☐ Debris ☐ Management Concerns ☐ Obstructions ☐ Riparian Zone ☐ Valley Wall Processes ☐ Etc.

- no fish observed.
- the [illegible] at site #7 is currently passing 100% of the flow to little
- moderate fish habitat [illegible] rearing

Edited by:
Date Y M D:

Beaver Pond

DFO / MOE
STREAM SURVEY FORM

Field	Value
Stream Name (gaz.)	Hilda Creek
(local)	
Watershed Code	
Location	beaver pond
U.T.M.	
Date Y M D	95 07 17
Time	1630
Agency	
Crew	MG/DH
Photos	
Air Photos	
Access	
Length (km)	
Fish Cards	Y N
Field / Hist.	

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	Ave.Chan.Width (m)	20-30		
	Ave.Wet.Width (m)	20-30		
	Ave.Max.Riffle Depth (cm)	2		at outflow of dam
	Ave.Max.Pool Depth (cm)	200		
	Gradient %	0		
	Pool % / Riffle % / Run %	10 / 90		
	Debris Area %	5		
	Debris Stable %	100		
	COVER: Total %	30		
	Comp. sum 100%: Dp Pool / L.O.D. / Boulder / In Veg / Over Veg / Cutbank	5 / 15 / / 30 / 30 /		
	Crown Closure %	Ø		
	Aspect			

BED MATERIAL	%
clay, silt, sand (<2mm)	
small (2-16mm)	
large (16-64mm)	
sm.cobble (64-128mm)	
lge.cobble (128-256mm)	
boulder (>256mm)	
Bedrock (R)	
D_{90}(cm)	
Compaction	L (circled) M H

BANKS	
Height (m)	.5
% Unstable	Ø
Texture	F (circled) G L R
Confinement	EN CO FC OC UC N/A (circled)
Valley: Channel Ratio	0-2 2-5 5-10 10+ N/A (circled)
Stage	Dry L M (circled) H Flood
Flood Signs Ht (m)	
Braided	Y N (circled)
Bars (%)	—
pH	—
O_2 ppm	—
Water Temp. (°C)	16
Turb. (cm)	—
Cond. (25°C)	—

OBSTRUCTIONS: C | Ht(m) | Type | Loc'n

DISCHARGE Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)
(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC. 87 SS187

Site #2

DFO / MOE
STREAM SURVEY FORM

Field	Value
Stream Name (gaz.)	Hilda Creek
(local)	
Watershed Code	
Location	site #2 d/s of beaver dams
U.T.M.	
Date Y M D	95 07 17
Time	1500
Agency	
Crew	MG/DH
Photos	
Air Photos	
Access	
Length (km)	
Fish Cards	Y N
Hist.	

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	Ave.Chan.Width (m)	4		
	Ave.Wet.Width (m)	3		
	Ave.Max.Riffle Depth (cm)	10		
	Ave.Max.Pool Depth (cm)	50		
	Gradient %	2		
	Pool % / Riffle % / Run %	30 / 20 / 50		
	Debris Area %	10		
	Debris Stable %	90		
	COVER: Total %	30		
	Comp. sum 100%: Dp Pool / L.O.D. / Boulder / In Veg / Over Veg / Cutbank	30 / 10 / / / 40 / 20		
	Crown Closure %			
	Aspect			

BED MATERIAL	%
clay, silt, sand (<2mm)	
small (2-16mm)	
large (16-64mm)	
sm.cobble (64-128mm)	
lge.cobble (128-256mm)	
boulder (>256mm)	
Bedrock (R)	
D_{90}(cm)	
Compaction	L (circled) M H

BANKS	
Height (m)	1
% Unstable	10
Texture	F G (circled) L R
Confinement	EN CO FC (circled) OC UC N/A
Valley: Channel Ratio	0-2 2-5 5-10 10+ N/A (circled)
Stage	Dry L (circled) M H Flood
Flood Signs Ht (m)	
Braided	Y N (circled)
Bars (%)	10
pH	—
O_2 ppm	—
Water Temp. (°C)	16
Turb. (cm)	—
Cond. (25°C)	—

OBSTRUCTIONS: C | Ht(m) | Type | Loc'n

DISCHARGE Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)
(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC. 87 SS187

Beaver Pond

FISH SUMMARY

C	Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.
	CT	6	200	2-3		angl.
	CT	20	80-200	1-3		vis

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

L R

PLANIMETRIC VIEW ☐

COMMENTS

Channel Stability ☐; Debris ☐; Management Concerns ☐; Obstructions ☐; Riparian Zone ☐; Valley Wall Processes ☐; Etc.

16°C at the outflow
beaver pond is ~ 300 cm deep in the middle.
- excellent fish habitat in the ponds created by 1 BD
= CT

Edited by:
Date Y M D:

SITE #2

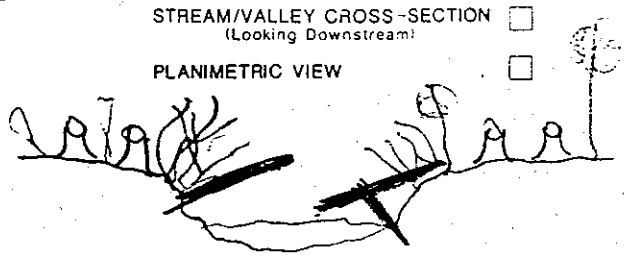
FISH SUMMARY

C	Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.
	CT	6	80-140	1-2		vis

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

L R

PLANIMETRIC VIEW ☐



COMMENTS

Channel Stability ☐; Debris ☐; Management Concerns ☐; Obstructions ☐; Riparian Zone ☐; Valley Wall Processes ☐; Etc.

- excellent fish habitat d/s from BD's
- abundant small - medium gravels

Edited by:
Date Y M D:

APPENDIX D

Belgo Creek
Stream Information File

Photograph 1. Debris jam at Belgo Creek Site #2 (downstream view).

Photograph 2. Debris jam with 1 m deep pool on upstream side at Belgo Creek Site #16. Note scattered LWD on banks.

MISSION CREEK STREAM ASSESSMENT

STREAM: BELGO CREEK
DATE: October 22, 1994
TAPE: WRP Tape 8

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	West
1		▸ mouth of the stream	00:20	49.29.05	119.09.12
2	Fs/Q-C-Hw-2	▸ bridge for Hwy 33 across the mouth	00:36	49.51.73	119.09.31
3	Fb/Q-D-U-1	▸ LWD in the channel	02:05	49.51.73*	119.08.74
4	Fb/Q-D-U-1	▸ large log jam	02:47		119.08.65
5	Fs/Q-S-N-3	▸ eroding banks on the left side and LWD	03:12		119.08.63
6	Fb/Q-C-F-2	▸ road crossing, wooden bridge	04:00		119.08.46
7	Fs/Q-S-N-3	▸ debris torrents from the hill on the left	04:55		119.08.23
8	Fs/Q-F-F-3	▸ old rail beside the stream on the flood plain	06:11		119.08.23
9	Q-F-F-3	▸ road on the left ~200-300m from the channel @ ~3300' elevation	08:26		119.07.16
10	Fs/Q-F-F-3	▸ old road now 50m from the channel on the left side	10:24		119.06.26
11	Fs/Q-F-F-2	▸ bank slump ~ 10m. from the old road appears not to have impacted the stream	10:41		119.06.15
12	Fs/Q-D-F-2 Fb/Q-D-U-1	▸ large amount of LWD in the channel & continues u/s for some distance	12:08		119.05.44
13	Fb/Q-D-U-1	▸ log jams blocking the channel, one small and one large jam	14:29		119.04.78
14	Fb/Q-D-F/N-1 Fb/Q-D-U-1	▸ large log jam @ ~3900' elevation	15:33		119.04.70
15	Q-S-F-3	▸ cutblock on the left (~10 years regen.)	16:49		119.04.21
16	Fb/Q-D-F/N-1 Fb/Q-D-U-1	▸ large log jam blocking the channel	17:14		119.04.60
17	Q-F-F-2	▸ some selective logging on the flood plain adjacent to the stream, the road comes within a few metres of the stream	17:28		119.04.19
18	Q-F-F-2	▸ recent cutblock on the right side with the road within 20m of the stream	18:30		119.04.13
19	Fs/Q-D-N/F-2 Fb/Q-D-U-1	▸ two large log jams in the stream	18:56		119.04.35
20	Fs/Q-C-F-1	▸ bridge @ ~4200' elevation	19:08		119.04.36

STREAM: BELGO CREEK
DATE: October 22, 1994
TAPE: WRP Tape 8

LOCATION SYMBOL		CODE	COMMENTS	TIME	COORDINATES North	West
24/11/94	21	Q-S-F-1	▸ cutblock on the left side comes within 10m of the stream, logging now very extensive on both sides coming within 20m of the stream	20:46		119.04.40
	22	Fb/Q-D-N-2	▸ beaver dam	21:17	49.51.73*	119.04.34
24/11/94*	23 ✓	Fs/Q-D-F-1	▸ cutblock with less than 5m buffer in some areas with some windfall & harvesting to streamside	21:53		119.04.46
24/11/94*	24 ✓	Fs/Q-C-F-1	▸ old log bridge	23:18		119.04.39
24/11/94*	25 ✓	Fs/Q-C-F-1	▸ road crossing (bridge?) @ ~4300' elevation	23:54		119.04.66
	26	Fb-C-R-1	▸ dam, *Ideal Lake*, road on the right side @ ~4500' elevation	25:40		119.05.77
	27		▸ headwaters	28:13		119.05.80

* GPS Coordinate for latitude stuck
NOTE: 1-19 Map 82 E/14 1:50,000
20-27 Map 82 L/3 1:50,000

Sites #3-4

DFO/MOEP
STREAM SURVEY FORM

Stream Name (gaz.)	Belgo Creek	(local)		Access		Method
Watershed Code			Reach No.		Length(km)		
Location	btwn site #3 & 4	Map #	Site No.		Chan.Lgth(m)	300	
		U.T.M.	Fish Card	Y (N)		Field	File
Date Y/M/D	94/11/04	Time 12[10]	Agency	Crew MCG/BTG/	Photos	Air Photos	

PARAMETER	VALUE	METH.	SPECIFIC DATA
Ave. Chan. Width (m)			10
Ave. Wet Width (m)			4
Ave.Max.Riffle Depth (cm)			
Ave.Max.Pool Depth (cm)			
Gradient %	3		
Pool 20 / Riffle 40 / Glide 40			
Side Channels 20	☑		
Debris 10	☑		
Stable %	80		
COVER: Total %	60		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
		80		10	50	20

Crown Closure % | Aspect

OBSTRUCTIONS

	H(m)	Type	Loc'n

BED MATERIAL

BED MATERIAL		%
Fines	clay,silt,sand (<2mm)	10
Gravels	small (2-16mm)	[illegible]
	large (16-64mm)	[illegible]
Cobbles	sm.cobble (64-128mm)	[illegible]
	lge.cobble (128-256mm)	[illegible]
	boulder (>256mm)	[illegible]
Bedrock (%)		0

D_{90}(cm) 20 | Compaction L (M) H

BANKS

Height(m)	1	%Unstable	50
Texture	(F G L) R		
Confinement	EN CO FC OC UC N/A		
Valley: Channel Ratio	0-2 2-5 (5-10) 10+ N/A		
Stage	Dry (L) M H Flood		
Flood Signs Ht(m)		Braided	(Y) N
Bars (%)		pH		O_2(ppm)	
Water Temp.(°C)		Turb.(cm)		Cond.(25°C)	

DISCHARGE

Parameter	Value	Method	Specific Data
Wetted Width (m)			4
Mean Depth (m)			.10
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL
(Fish)

(Width,Valley:Channel,Slope) (Bed Material)

REVISED DEC. 87 SS187

SITES #3-4

FISH SUMMARY					
Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref

STREAM/VALLEY CROSS-SECTION ☐
(Looking Downstream)

L R

PLANIMETRIC VIEW ☐

COMMENTS

Channel Stability ☐, Debris ☐, Management Concerns ☐, Obstructions ☐, Riparian Zone ☐, Valley Wall Processes ☐, Etc.

- actively undercutting banks,

- some evidence of [illegible] logging along the right bank but does not appear to have impacted the stream (appears to be all cedar stumps)

- the culvert of [illegible] flows on the main road [illegible] runs [illegible] right down to the stream

Edited by:

Date Y M D:

SITES #12-14

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Delgo Creek	(local)	Access:	Method:
Watershed Code		Reach No.	Length(km)
Location	Site #14 / Site #12	Map	Site No.	Length surv.(m) 100
		U.T.M.	Fish Card: Y N	C Field ☐ Hist. ☐
Date Y M D 95 07 19	Time 1200	Agency	Crew MG/HH/	Photos	Air Photos

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	Ave.Chan.Width (m)	10		
	Ave.Wet.Width (m)	8		
	Ave.Max.Riffle Depth (cm)	10		
	Ave.Max.Pool Depth (cm)	50		
	Gradient %	3		
	% Pool 20 / Riffle 40 / Run 40 / Other			
	Side Chan. %	40		
	Debris Area %	10		
	Debris Stable %	90		
	COVER: Total %	30		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
	20	10	10		40	20

Crown Closure % 10 | C | Aspect 5

Bed Material (%): clay, silt, sand (<2mm); small (2-16mm); large (16-64mm); sm.cobble (64-128mm); lge.cobble (128-256mm); boulder (>256mm); Bedrock; D_{90}(cm); Compaction L (M) H

BANKS: Height(m) 1 | %Unstable 10 | Texture (F) (G) L R

Confinement	EN	CO	FC	OC	UC	N/A
Valley: Channel Ratio	0-2	2-5	(5-10)	10+	N/A	
Stage	Dry	(L)	M	H	Flood	
Flood Signs Ht(m) 1.5	Braided (Y) N					
Bars (%) 10	pH —	O_2(ppm) —				
Water Temp.(°C) 10	Turb.(cm) —	Cond.(25°C) —				

OBSTRUCTIONS: C | Ht(m) | Type | Loc'n

DISCHARGE Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width,Valley:Channel,Slope) (Bed Material)

REVISED DEC. 87 SS187

SITE #19

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Delgo Creek	(local)	Access	Method
Watershed Code		Reach No.	Length(km)
Location	site #19	Map	Site No.	Length surv.(m) 80
		U.T.M.	Fish Card: Y N	C Field ☐ Hist.
Date Y M D 95 07 19	Time 1400	Agency	Crew MG/HH/	Photos	Air Photos

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
C1	Ave.Chan.Width (m)	10	GE	
	Ave.Wet.Width (m)	8	↓	
	Ave.Max.Riffle Depth (cm)	10	↓	
	Ave.Max.Pool Depth (cm)	75	↓	
	Gradient %	2	CL	
	% Pool 40 / Riffle 20 / Run 40 / Other		GE	
	Side Chan. % 40: 0☐ 0-10☐ 10-40☑ >40☐		↓	
	Debris Area % 15: 0☐ 0-5☐ 5-15☑ >15☐		↓	
	Debris Stable %	70	↓	
	COVER: Total %	20		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
	35	30	10		35	10

Crown Closure % 10 | C | Aspect 5

Bed Material (%): clay, silt, sand (<2mm); small (2-16mm); large (16-64mm); sm.cobble (64-128mm); lge.cobble (128-256mm) 20; boulder (>256mm); Bedrock 10; D_{90}(cm); Compaction L (M) H

BANKS: Height(m) 1 | %Unstable 40 | Texture F (G) L R

Confinement	EN	CO	FC	OC	UC	N/A
Valley: Channel Ratio	0-2	(2-5)	5-10	10+	N/A	
Stage	Dry	(L)	M	H	Flood	
Flood Signs Ht(m)	Braided (Y) N					
Bars (%) 20	pH —	O_2(ppm) —				
Water Temp.(°C) 8	Turb.(cm) —	Cond.(25°C)				

OBSTRUCTIONS: C | Ht(m) | Type | Loc'n

DISCHARGE Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width,Valley:Channel,Slope) (Bed Material)

REVISED DEC. 87 SS187

SITES #12-14

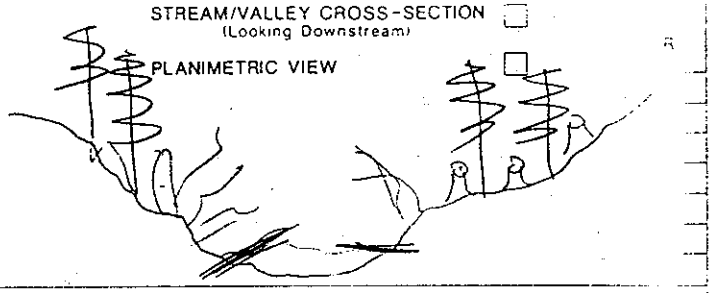
FISH SUMMARY

C	Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.
	Trout	3	100	1-2		

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

L R

PLANIMETRIC VIEW ☐



COMMENTS

Channel Stability ☐, Debris ☐, Management Concerns ☐, Obstructions ☐, Riparian Zone ☐, Valley Wall Processes ☐, Etc.

- excellent fish habitat at site #14 & #12
- very similar to u/s site #16
- [illegible] and accum. of LWD in this reach are potential barriers to fish migration

Edited by:

Date Y M D:

SITE #19

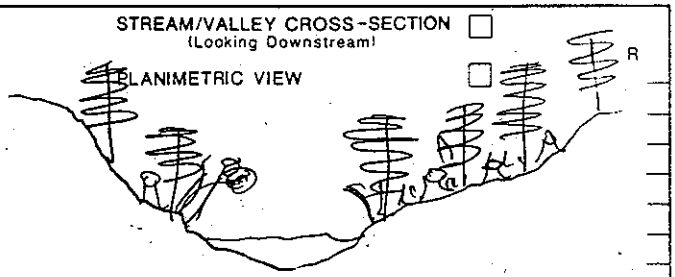
FISH SUMMARY

C	Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.
	Trout	6	50-100			

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

L R

PLANIMETRIC VIEW ☐



COMMENTS

Channel Stability ☐, Debris ☐, Management Concerns ☐, Obstructions ☐, Riparian Zone ☐, Valley Wall Processes ☐, Etc.

- at site #19 numerous side channels are present in the ~30m wide flood plain
- the banks are actively undercutting
- excellent fish habitat for both rearing & spawning
- abundance of spawning size gravels
- the debris jam LWD at site #16 is a barrier to fish migration

Edited by:

Date Y M D:

APPENDIX E

Pearson Creek
Stream Information File

Photograph 1. Erosion and deposition at culvert outlet: Pearson Creek Site #6.

MISSION CREEK STREAM ASSESSMENT

STREAM: PEARSON CREEK
DATE: October 22, 1994
TAPE: WRP Tape 8

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	COORDINATES West
1		▸ mouth of the stream	49:07	49.51.73*	119.03.73
2	Q-S-F-2	▸ cutblocks on both sides on the terrace at the mouth of the stream	49:44		119.03.37
3 ✓	~~Fs/Q-S-U-1~~ Q-S-F-3	▸ slide into the stream on the left	50:04		119.03.17
4	Q-S-F-3	▸ old cutblock high above the stream on the left side	51:12		119.02.33
5 ✓	~~Fb/Q-D-U-1~~ Fb/Q-D-N/F-2	▸ large log jam @ ~4000' elevation	54:53	49° 54.297'	119° 00.655 ~~119.00.92~~
6 ✓	~~Q-S-F-1~~ Fs/Q-C-F-1	▸ recent cutblock on the right & road visible on the left (cutblock also on the left) ▸ the block on the right continues u/s for some distance	55:13	49° 54.215'	~~119.00.76~~ 119° 00.530'
7 ✓	~~Fb/Q-D-U-1~~ Fs/Q-D-F-2	▸ two small log jams	56:47	49° 54.409'	119° 00.537' ~~119.00.31~~
8 ✓	~~Fb/Q-D-U-1~~ Fs/Q-D-N-1	▸ log jam	58:38	49° 55 105'	118° 59.401' ~~118.59.39~~
9	Q-S-F-2	▸ landing/end of road on the left ~20m from the stream	59:15	49° 55.147'	118° 59.013' ~~118.58.99~~
10	Fs/Q-S-N-3	▸ historic slides on the left (natural)	59:41		118.58.69
11		▸ confluence with *Stevenson Creek* @ ~4500' elevation	1:00:12		118.58.26
12	Fb-W-N-2	▸ rapids/falls	1:01:18		118.58.15
13	Q-F-F-2	▸ road on the left ~50m from the stream @ ~5100' elevation	1:01:06		118.57.90
14	Q-F-F-2	▸ landing/road on the left ~50m from the stream @ ~5300' elevation	1:03:03		118.57.71
15	Fb-W-N-2	▸ falls/rapids	1:03:25		118.57.56
16	Fb-W-N-2	▸ large waterfall	1:04:04		118.57.09
17	Q-F-F-2	▸ old road accessing swamp area @ ~6000' elevation	1:05:04		118.56.28
18	Q-F-F-2	▸ new road, cabins on the left side	1:05:50		118.56.06
19	Q-F-F-2	▸ road directly ahead, cabin on the right	1:08:38		118.54.9

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	West
20		▸ road directly ahead, cabin on the right ▸ headwaters @ ~6300' elevation - *Long Lake* & *St. Margaret Lake* visible	1:09:35		118.55.49

* GPS coordinate for latiitude stuck

NOTE: 1-18: Map 82 E/14 1:50,000
19&20: Map 82 E/14 1:50,000

SITES #5-7

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Pearson Creek	(local)	
Watershed Code		Reach No.	R3
Location	u/s from site #5 (site #5,6,7)	Map	
U.T.M.		Site No.	
Access		Method	
Length(km)		Linsurvey(m)	500
Fish Card	Y N	Field / Hist.	
Date Y M D	95 07 16	Time	1630
Agency		Crew	NG DH /
Photos		Air Photos	

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	Ave.Chan.Width (m)	4	GE	3 channels 2,4,6 m wide
	Ave.Wet Width (m)	3.5		" " 2,3,5
	Ave.Max.Riffle Depth (cm)	20		
	Ave.Max.Pool Depth (cm)	100		
	Gradient %	5	CL	
	%Pool 3 — Riffle 50 Run 20 Other		GE	
	Side Chan.%	50 (0, 0-10, 10-40, >40 ☒)		
	Debris Area%	15 (0, 0-5, 5-15 ☒, >15)		
	Debris Stable %	70		
	COVER: Total %	30		
	Comp. sum 100%	Dp Pool 0, L.O.D. 0, Boulder 0, In Veg —, Over Veg 50, Cutbank 10		
	Crown Closure %	10		Aspect

Bed Material	%
Fines: clay,silt,sand (<2mm)	
Gravels: small (2-16mm)	
Gravels: large (16-64mm)	
Larges: sm.cobble (64-128mm)	
Larges: lge.cobble (128-256mm)	70
Larges: boulder (>256mm)	
Bedrock (R)	
D_{90}(cm)	
Compaction	L (M) H

BANKS	
Height(m)	1
%Unstable	10
Texture	(F G) L R
Confinement	EN CO FC (OC) UC N/A
Valley: Channel Ratio	0-2 2-5 (5-10) 10+ N/A
Stage	Dry (L) M H Flood
Flood Signs Ht(m)	
Braided	(Y) N
Bars (%)	30
pH	—
O_2(ppm)	—
Water Temp.(°C)	10
Turb.(cm)	—
Cond.(25°C)	—

OBSTRUCTIONS			
C	Ht(m)	Type	Loc'n

DISCHARGE			
Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width,Valley:Channel,Slope) (Bed Material)

REVISED DEC. 87 SS:87

D/S SITE #5

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Pearson Creek	(local)	
Watershed Code		Reach No.	R2
Location	d/s from site #5	Map	
U.T.M.		Site No.	
Access		Method	
Length(km)		Linsurvey(m)	500
Fish Card	Y N	Field / Hist.	
Date Y M D	95 07 16	Time	1600
Agency		Crew	NG/DH /
Photos		Air Photos	

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	Ave.Chan.Width (m)	10	GE	
	Ave.Wet Width (m)	8		
	Ave.Max.Riffle Depth (cm)	10		
	Ave.Max.Pool Depth (cm)	75		
	Gradient %	7	CL	
	%Pool 20 Riffle 70 Run 10 Other		GE	
	Side Chan.%	5 (0, 0-10 ☒, 10-40, >40)		
	Debris Area%	10 (0, 0-5, 5-15 ☒, >15)		
	Debris Stable %	70		
	COVER: Total %	30		
	Comp. sum 100%	Dp Pool 30, L.O.D. 10, Boulder 20, In Veg —, Over Veg 40, Cutbank —		
	Crown Closure %	20		Aspect

Bed Material	%
clay,silt,sand (<2mm)	
small (2-16mm)	
large (16-64mm)	
sm.cobble (64-128mm)	
lge.cobble (128-256mm)	
boulder (>256mm)	
D_{90}(cm)	
Compaction	L (H)

BANKS	
Height(m)	1-2
%Unstable	10
Texture	F (G L) R
Confinement	EN CO (FC) OC UC N/A
Valley: Channel Ratio	0-2 (2-5) 5-10 10+ N/A
Stage	Dry (L) M H Flood
Flood Signs Ht(m)	
Braided	Y (N)
Bars (%)	5
pH	—
O_2(ppm)	—
Water Temp.(°C)	12
Turb.(cm)	—
Cond.(25°C)	—

OBSTRUCTIONS			
C	Ht(m)	Type	Loc'n

DISCHARGE			
Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width,Valley:Channel,Slope) (Bed Material)

REVISED DEC. 87 SS:87

SITES #5-7

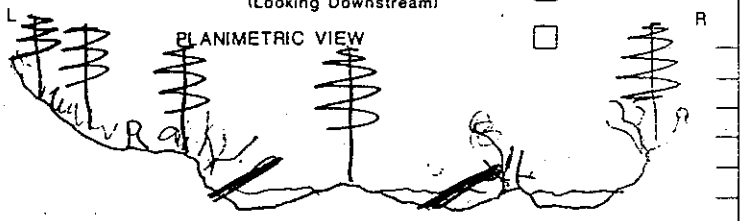
FISH SUMMARY

C	Species	No.	Size Range(mm)	Life Phase	Use	Method/Ref.
	Hcut	20	50-70	fry		
	"	10	130-140	juv		

STREAM/VALLEY CROSS-SECTION (Looking Downstream) ☐

PLANIMETRIC VIEW ☐

L R



COMMENTS

Channel Stability ☐, Debris ☐, Management Concerns ☐, Obstructions ☐, Riparian Zone ☐, Valley Wall Processes ☐, Etc.

- excellent fish habitat in this reach
- [illegible] riffles, runs, pools, deep pools, LWD, side channels [illegible] very
- also very abundant aquatic insects & periphyton

Edited by:

Date Y M D:

D/S SITE #5

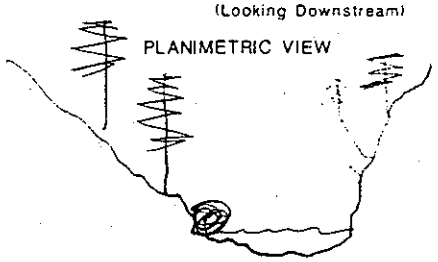
FISH SUMMARY

C	Species	No.	Size Range(mm)	Life Phase	Use	Method/Ref.
	[illegible]		50-120	juv 2-3y		

STREAM/VALLEY CROSS-SECTION (Looking Downstream) ☐

PLANIMETRIC VIEW ☐

L R



COMMENTS

Channel [illegible] Debris Management Concerns ☐, Obstructions ☐, Riparian Zone ☐, Valley Wall Processes ☐, Etc.

[illegible] mostly confined by bedrock

- many deep pools (2-3m)
- good rearing habitat
- [illegible]

Edited by:

Date Y M D:

APPENDIX F

Joe Rich Creek
Stream Information File

MISSION CREEK

STREAM: JOE RICH CREEK
DATE: October 22, 1994
TAPE: WRP Tape 8

Read 50's Aerial Review
re: #8 (could possibly be F-1)

LOCATION SYMBOL	CODE		COMMENTS	TIME	COORDINATES North	West
1		▸	mouth of the stream	1:13:07	49.51.73*	119.08.99
2	Q-S-A/R-2	▸	agricultural fields, fences, road crossings & cattle in the stream on the old terrace area of the lower reaches & bank erosion	1:14:29		119.07.51
3	Fb/Q-C-Hw-1	▸	Hwy 33 crosses over the stream through 2 culverts	1:16:09		119.05.78
4	Fs/Q-C-F-2	▸	old bridge crossing for gravel road on the left side	1:16:33		119.05.38
5	Q-S-F-2	▸	cutblock on the left side above the channel ~10-15m from the stream	1:16:56		119.05.23
6	Q-F-F-2	▸	gravel road on the right side ~5-10m from the streams	1:17:57		119.05.00
7	Fs/Q-F-F-1	▸	road failure from an old road on the left ~5-10m from the stream	1:19:22	49.48.48	119.04.982
8	Fs/Q-S-N-3	▸	historic eroding bank on the left	1:19:42		119.05.01
9	Fs/Q-S-Hw-2	▸	several road-bed failures from Hwy 33 on the right entering the stream	1:20:16		119.05.19
10	Q-S-F-2	▸	old road on the right side @ ~4500' elevation	1:22:23		119.04.14
11	Fb/Q-C-F-1 ~~Fs/Q-D-F-1~~	▸	Road crossing with a log culvert. ~~cutblock logged across the channel with a~~ road ~~crossing, (culvert?) @~4700' elevation~~	1:22:37	49°48.463'	119°04.090' ~~119.04.17~~
11A	Fb/Q-D-F-1	▸	cutblock logged across channel		49°48.463'	119° 04.090'
12	Q-S-F-2	▸	recent cutblock on the right	1:23:26		119.03.89
13	~~Fb/Q-C-F-1~~ Fs/Q-C-F-3	▸	road crossing, wooden box culvert @ ~4900' elevation	1:24:08	49°49.297'	~~119.03.78~~ 119° 03.673
14	Q-S-F-2	▸	cutblock on the left with a buffer of ~20-30m	1:24:38		119.03.70
15		▸	headwaters	1:26:42		119.03.02

* GPS Coordinate for latitude stuck
NOTE: 1-15: Map 82 E/14 1:50,000

SITE 13

DFO / MOE
STREAM SURVEY FORM

Field	Entry
Stream Name (gaz.)	Joe Rich
(local)	
Watershed Code	
Location	Side# 13
Reach No.	R3
Access	
Length(km)	
Method	100
U.T.M.	
Date Y.M.D	95 07 16
Time	1200
Agency	
Crew	MG/DH/
Photos	
Air Photos	
Field / Hist.	

PARAMETER	VALUE	METH.	SPECIFIC DATA
Ave.Chan.Width (m)	2.8		3.3 u/s, 2.4 d/s from culvert
Ave.Wet.Width (m)	2		
Ave.Max.Riffle Depth (cm)	5		
Ave.Max.Pool Depth (cm)	30		
Gradient %	1-2		
Pool 30 / Riffle 10 / Run 60 / Other			
Side Chan %	10		
Debris Area %	10		
Stable %	90		
COVER: Total %	20		

Comp. sum 100%	Op Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
	30	10		10	20	30

Crown Closure % 10 · Aspect

BED MATERIAL	%
Fines: clay, silt, sand (<2mm)	
small (2-16mm)	20
large (16-64mm)	80
sm.cobble (64-128mm)	80
Large: lge. cobble (128-256mm)	20
boulder (>256mm)	/
Bedrock (R)	
D_{90}(cm)	
Compaction	L (M) H

BANKS	
Height(m)	.5
%Unstable	
Texture	(F G) L R
Confinement	EN CO (FC) OC UC N/A
Valley: Channel Ratio	0-2 2-5 5-10 10+ (N/A)
Stage	Dry (L) M H Flood
Flood Signs Ht(m)	
Braided	Y (N)
Bars (%)	5
pH	—
O_2(ppm)	
Water Temp.(°C)	12
Turb.(cm)	—
Cond.(25°C)	

OBSTRUCTIONS: Ht(m) · Type · Loc'n

DISCHARGE Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC 87 SS1 87

SITE 11

DFO / MOE
STREAM SURVEY FORM

Field	Entry
Stream Name (gaz.)	Joe Rich
(local)	
Watershed Code	
Location	Side# 11
Reach No.	R2
Access	
Length(km)	
Method	
U.T.M.	
Field Card	Y N
Date Y.M.D	95 07 16
Time	1030
Agency	
Crew	MG/DH/
Photos	
Air Photos	
Field / Hist.	

PARAMETER	VALUE	METH.	SPECIFIC DATA
Ave.Chan.Width (m)	4	GE	
Ave.Wet.Width (m)	2.5	↓	
Ave.Max.Riffle Depth (cm)	5	↓	
Ave.Max.Pool Depth (cm)	30	↓	
Gradient %	7	CL	
Pool 30 / Riffle 50 / Run 20 / Other		GE	
Side Chan %	10	↓	
Debris Area %	20	↓	
Stable %	80	V	
COVER: Total %	50		

Comp. sum 100%	Op Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
	30	20	10		30	20

Crown Closure % 20 · Aspect SW

BED MATERIAL	%
Fines: clay, silt, sand (<2mm)	
Gravels: small (2-16mm)	40
large (16-64mm)	60
sm.cobble (64-128mm)	30
Larges: lge. cobble (128-256mm)	20
boulder (>256mm)	10
Bedrock (R)	
D_{90}(cm)	
Compaction	L (M) H

BANKS	
Height(m)	0.5
%Unstable	10
Texture	(F G) L R
Confinement	EN CO (FC) OC UC N/A
Valley: Channel Ratio	0-2 2-5 (5-10) 10+ N/A
Stage	Dry (L) M H Flood
Flood Signs Ht(m)	
Braided	(Y) N
Bars (%)	15
pH	—
O_2ppm	
Water Temp (°C)	10
Turb.(cm)	—
Cond (25°C)	

OBSTRUCTIONS: C · Ht(m) · Type · Loc'n

DISCHARGE Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC 87 SS1 87

SITE 13

FISH SUMMARY

Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.
Trout	2	80-120	2-3		

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

L R

PLANIMETRIC VIEW ☐

COMMENTS

Channel Stability ☐; Debris ☐; Management Concerns ☐; Obstructions ☐; Riparian Zone ☐; Valley Wall Processes ☐; Etc.

- excellent fish habitat for both spawning & rearing in this reach
- [illegible] at site 13 a sequence of 4 pools/riffles have [illegible]
- [illegible] with ~1/3 of the culvert

Edited by:

Date Y M D:

SITE 11

FISH SUMMARY

Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.
Trout	2	80-120	2-3		

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

L R

PLANIMETRIC VIEW ☐

COMMENTS

Channel Stability ☐; Debris ☐; Management Concerns ☐; Obstructions ☐; Riparian Zone ☐; Valley Wall Processes ☐; Etc.

excellent fish habitat in this reach for both spawning & rearing resident fish

- many small accum. of spawning size gravel, abundant overhanging veg, undercut banks, LWD & pools

Edited by:

Date Y M D:

APPENDIX G

Hydraulic Creek
Stream Information File

Photograph 1. Windfall across stream adjacent to cutblock at Hydraulic Creek Site #15.

MISSION CREEK STREAM ASSESSMENT

STREAM: HYDRAULIC CREEK
DATE: October 22, 1994
TAPE: WRP Tape 9

sites to visit (✱ visited)

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	West
1		mouth of the stream	28:46	49.50.81	119.21.21
2	Fb-W-N-2	small falls/chutes ~300m u/s of the confluence with Mission Creek	29:24	49.50.54	119.20.62
3	Fs/Q-F-F-2	roads up both sides of the stream within the valley	29:38	49.50.48	119.20.45
4	Fb-C-F-2	road crossing through a large culvert	30:06	49.50.42	119.20.13
5	Q-F-F-2	road now parallel to the stream on the left in the valley bottom, a gate is blocking the road (road is within 5m of the stream)	30:31	49.50.34	119.19.91
6	Fb-C-R-3	dam with a headpond ~50m across	31:35	49.50.01	119.19.32
7	Fb-C-R-3	rock weir with a gate structure	32:03	49.49.89	119.19.23
8	Q-F-F-3	road still immediately adjacent to the stream & possibly a pipeline also or a penstock	32:44	49.49.75	119.18.80
9	Fb-C-R-2	weir structure @ ~2600′ elevation	33:52	49.49.58	119.18.25
10	Fb-D-R-2	footbridge & a man-made pond on the right side of the stream	35:18	49.49.32	119.17.47
11	Q-S-F-2	old lumber mill site with large piles of wood on the left side	37:05	49.49.25	119.16.29
12	Q-S-F-3	cutblock (20 years regen.) ~200m from the stream on the left & wood waste piles ~500m uphill	38:07	49.49.11	119.15.58
13	Q-D-R-3	building of some sort (white roof) in the channel	39:19	49.49.02	119.14.64
14	Q-S-F-3	large old cutblock on the left	40:42	49.48.86	119.13.60
2/11/94 ✱ 15	Fb/Q-D-F-1	recent cutblock on the right with no buffer with several log jams & LWD	41:23	49.48.65	119.13.19
2/11/94 ✱ 16	Fb/Q-D-F-1	log jam blocking the channel	42.40	49.48.08	119.12.52
17	Q-F-F-3	road on the left side ~50m from the stream	43:22	49.47.85	119.12.10
2/11/94 ✱ 18	Fb-C-R-2	road crossing with a large concrete culvert	43:36	49.47.752 ~~49.47.73~~	119.12.04C ~~119.12.10~~
19	Q-C-R-3	footbridge, old farm fields @ *McCulloch* (some sheep on the fields)	44:00	49.47.69	119.11.03

STREAM: HYDRAULIC CREEK
DATE: October 22, 1994
TAPE: WRP Tape 9

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	COORDINATES West
20	Fb-C-R-3	▸ dam, *Hydraulic Lake*	45:04	49.47.12	119.11.17
21	Fb-D-N-3	▸ series of ~6 beaver dams	48:25	49.45.82	119.12.92
22	Fs/Q-S-F-2	▸ cutblock & road on the left side with no buffer	48:44	49.45.61	119.12.95
23	Fb/Q-C-F-2	▸ road crossing (culvert or bridge?) with a cement weir ~100m u/s & road surface erosion visible	49:15	49.45.36	119.13.13
24	Fb-C-F-2	▸ road crossing through a culvert	49:48	49.45.06	119.12.99
25	Fs/Q-S-R-2	▸ engineered channel (diversion channel with a dyke) ▸ the whole area has been logged around the stream for quite a distance	50:19	49.44.78	119.13.03
26	Fb-C-R-2	▸ road crossing, culvert @ ~4500' elevation	51:17	49.44.25	119.13.06
27	Fb-C/D-F-2	▸ road crossing, culvert ▸ a lot of blowdown along the stream u/s of this crossing	51:41	49.44.01	119.13.10
28	Q-S-F-3	▸ cutblock on the left ~100m from the channel	53:46	49.43.90	119.14.27
29	Q-S-F-3	▸ road parallel to the stream on the left and an old cutblock ~50m buffer	55.32	49.43.86	119.15.00
30		▸ headwaters ~5200' elevation	56:29	49.43.92	119.15.79

NOTE: 1-24: Map 82 E/14 1:50,000
25-30: Map 82 E/11 1:50,000

APPENDIX H

Pooley Creek
Stream Information File

MISSION CREEK STREAM ASSESSMENT

STREAM: POOLEY CREEK
DATE: October 22, 1994
TAPE: WRP Tape 8

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	COORDINATES West
1		▸ mouth of the stream @ ~3500' elevation	1:47:55	49.51.73*	119.18.97
2		▸ KVR crossing above the stream on the right and directly ahead @ ~4100' elevation	1:49:35		119.19.46
3	Fb-C-R-2	▸ KVR steel tressle crossing	1:50:00		119.19.67
July 15/95 DH/MG 4	~~Fs-Q-F-F-1~~ Q-S-R-2	▸ new road on the left with the fill-slope entering the stream	1:52:41	49° 45.234'	119° 20.192' ~~119.20.29~~
July 15/95 DH/MG 5	~~Fb-C-U-1~~ Fb-W-R-1	▸ weir structure across the stream and the road end to control the flow @ ~5100' elevation	1:52:59	49° 45.095'	119° 20.196 ~~119.20.29~~
6		▸ flying directly towards *Little White Mountain*	1:54:24		119.20.42
7	Q-S-F-2	▸ old cutblock on the right @ ~6100' elevation	1:57:14		119.20.64
8		▸ headwaters @ ~6100' elevation	1:57:30		119.20.69

*GPS Coordinate for latitude stuck
NOTES: 1-3: 82 E/14 1:50,000
4-8: 82 E/11 1:50,000

SITES #4-5

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.) Pooley Creek	(local)	Access	Method
Watershed code		Length(km)	
Site #4			
#5	U.T.M.	Y N	
Date 95 07 15	Time 1230	MG/DH	Photos	Air Photos

PARAMETER	VALUE	METH.	SPECIFIC DATA
Channel Width (m)	10	GE	
Wetted Width (m)	4	↓	
Ave.Max.Riffle Depth (cm)	20	↓	
Ave.Max.Pool Depth (cm)	50	↓	
Gradient %	6	CL	
Pool 20 Riffle 40 Run 40 Other		GE	
Stable %	90	↓	
COVER: Total %	30		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
	20	10	10		50	10

Crown Closure % 20 | Aspect

BED MATERIAL	%
clay,silt,sand (<2mm)	
small (2-16mm)	20
large (16-64mm)	80
sm.cobble (64-128mm)	
lge.cobble (128-256mm)	
boulder (>256mm)	
Bedrock	
D_{90}(cm)	Compaction L (M) H

BANKS	
Height(m) 1	%Unstable 10
Texture	F (G) L R
Confinement	EN (CO) FC OC UC N/A
Valley: Channel Ratio	(0-2) 2-5 5-10 10- N/A
Dry	(L) M H Flood
Flood Signs Ht(m)	Braided Y N
Bars (%) 20	pH —	O_2(ppm)
Water Temp.(°C) 9	Turb.(cm) —	Cond.(25°C)

OBSTRUCTIONS	Type	Loc'n
2	weir	

DISCHARGE Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

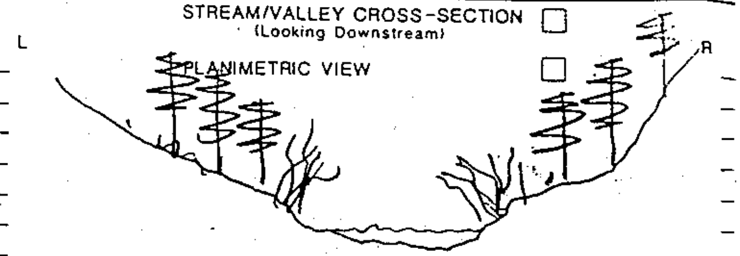
(Width,Valley:Channel,Slope) (Bed Material)

REVISED DEC 87

FISH SUMMARY Species	No.	Size Range(mm)	Life Phase	Use	Method/Ref.
trout	6	80-100	juv.		vis.

STREAM/VALLEY CROSS-SECTION (Looking Downstream) ☐

PLANIMETRIC VIEW ☐



COMMENTS

Channel Stability ☐, Debris ☐, Management Concerns ☐, Obstructions ☐, Riparian Zone ☐, Valley Wall Processes ☐, Etc.

- this reach is delineated by the weir at site #5 that diverts 100% of the flow (at the time of the survey) into a ditch that drains into Hydraulic Lake
- the fish observed at this site have probably come from Hydraulic Lake
- moderate fish habitat u/s of the weir for fish rearing
- excellent spawning habitat in the ditch d/s of the weir

Edited by:

Date Y M D:

APPENDIX I

KLO Creek
Stream Information File

Photograph 1. Water pipeline crossing KLO Creek at Site #4.

Photograph 2. Box culvert in very poor condition with eroding road bed: KLO Creek Site #14A.

MISSION CREEK STREAM ASSESSMENT

STREAM: KLO CREEK
DATE: October 22, 1994
TAPE: WRP Tape 8

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	West
1		mouth of the stream	1:29:18	49.51.73*	119.21.83
2	Fb/Q-C-R-1	roads on both sides of the stream & weir in the stream	1:30:27		119.22.08
2a	Q-C-F/R-3	Bridge across the channel		49°49.672'	119° 21.827'
3	~~Fb/Q-C-F-1~~ Q.C.R.3	gravel extraction operation on the left & a road crossing (bridge or culvert?) - gravel operation is on both sides	1:30:47	49.49.561	~~119.22.10~~ 119.21.751
4	~~Fb/Q-D-R-1~~ no code ~~Q-D-N-2~~ HH 23/11/95	large steel pipe along the left side of the stream & crosses over to the right side	1:31:27		119.22.00
5	Fs/Q-S-N-3	exposed eroding bank on the left	1:33:38		119.21.10
6	Fs/Q-S-N-3	eroding bank on the left	1:34:42		119.20.44
7	Q-F-F-2	old road adjacent to the stream on the left @ ~3200' elevation	1:35:57		119.19.70
8		Kettle Valley Railway (KVR) above & on the left @ ~3700' elevation	1:38:25		119.18.90
9	Fb-C-R-2	directly over steel railway bridge	1:39:58		119.18.47
10	~~Fs/Q-D-F-1~~ N/A	cutblock logged across the stream	1:40:33	49°46.472'	119°18.114' ~~119.18.10~~
11	~~Fs/Q-C-F-T~~ Q-C-F-3	bridge	1:41:01	49°46.341'	~~119.17.97~~ 119°18.018'
12	Q-S-F-2	cutblock on the left within 20-30m of the stream	1:42:05		119.17.34
13	Q-S-F-2	evidence of an old cutblock right on the flood plain	1:43:14		119.16.78
14	Fb-D-U-2	dam/weirs in the channel & several road crossing & an u/s log weir filled in with sediment	1:44:05		119.16.61
14A	Q-C-F-1	Culvert collapsing across channel.		49°45.668'	119°16.477'
15		headwaters @ ~5350' elevation	1:45:41		119.15.98

Field check: @4 pipe is 2' Ø. Water supply
no GPS coordinates from field unit
MG has notes & measurements, modified code → Ø
@3 Scour on left abutment, undermining
modified code → Q.C.R.3
(old trailer or KVR access)

*GPS coordinate for latitude stuck
NOTES: 1-15: Map 82E/4 1:50,000

Site #3

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.) Klo Creek (local)		Access	Method
Watershed Code	Reach No. 2	Length (km)	
Location 49°49.561 SITE #3	Map NTS 82E/14	Site No. 4,3	Channel (m) 400
119° 21.951	U.T.M.	Fish Card Y (N)	Field [ ] Hist [ ]
Date Y/M/D 94 11 02 Time 1000 Agency [illegible] Crew MCG/BTG/	Photos	Air Photos	

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	[illegible]			10.8
	[illegible]			3.0, 3.1, 3.6
	Ave.Max.Riffle Depth (cm)			10, 5
	Ave.Max.Pool Depth (cm)			40, 20
	Gradient %	5		
	[illegible] 30 [illegible] 40 [illegible] 30 [illegible]			
	[illegible] 10 [ ] [✓] [ ] [ ]			
	[illegible] 5 [ ] [✓] [ ] [ ]			
	Stable %	95		
	COVER: Total %	40		
	Comp. sum 100%: Dp Pool — ; L.O.D. 5 ; Boulder 10 ; In Veg — ; Over Veg 80 ; Cutbank 5			
	Crown Closure %		Aspect	

C	BED MATERIAL		%
	Fines	clay, silt, sand (<2mm)	5
	Gravel	small (2-16mm)	10
		large (16-64mm)	90
	[illegible]	sm.cobble (64-128mm)	20
		lge.cobble (128-256mm)	60
		boulder (>256mm)	30
	Bedrock		10
	D_{90} (cm)	Compaction	L M (H)

C	BANKS		
	Height (m) 1	%Unstable 10	
	Texture	F G (C R)	
	Confinement	EN CO FC (OC) UC N/A	
	Valley: Channel Ratio	0-2 2-5 (5-10) 10+ N/A	
	Stage	Dry (L) M H Flood	
	Flood Signs Ht(m) 1	Braided	Y (N)
	Bars (%)	pH	O_2 (ppm)
	Water Temp. (°C)	Turb. (cm)	Cond. (25°C)

OBSTRUCTIONS			
C	[illegible]	Type	Loc'n

DISCHARGE			
Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC 87 SS1 87

SITE #3

FISH SUMMARY

C	Species	No.	Size Range (mm)	Life Phase	Use	Method Ref.

STREAM/VALLEY CROSS-SECTION ☐
(Looking Downstream)

L R

PLANIMETRIC VIEW ☐

COMMENTS

Channel Stability ☐ Debris ☐ Management Concerns ☐ Obstructions ☐ Riparian Zone ☐ Valley Wall Processes ☐ Etc.

- no obstructions to fish access were noted in this reach, good distribution of pools
- very little organic material in the channel

Edited by:

Date Y M D:

SITE 14A

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Klo Creek	(local)		Access	Method
Watershed Code		Reach No.		Length (km)	
Location	site NA 49°45.668	Map		Site No. / Lngth. (m)	50
	119°16.477	U.T.M.		Fish Card Y N	Field ☐ Hist. ☐
Date Y M D	95 07 15	Time 1015	Agency	Crew MG/DH /	Photos / Air Photos

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	Ave. Chan. Width (m)	1-2	GE	
	Ave. Wet Width (m)	0.4	↓	
	Ave. Max. Riffle Depth (cm)	5	↓	
	Ave. Max. Pool Depth (cm)	20	↓	
	Gradient %	2	CL	
	% Pool 5 Riffle 10 Run 85 Other		GE	
	Side Chan. % 0		↓	
	Debris Area % 10		↓	
	Stable %	100	↓	
	COVER: Total %	60		
	Comp. sum 100%: Dp Pool 10, L.O.D. 20, Boulder –, In Veg –, Over Veg 60, Cutbank 10			
	Crown Closure %	60		Aspect

BED MATERIAL		%
Fines	clay, silt, sand (<2mm)	
Gravels	small (2-16mm)	50
	large (16-64mm)	50
Cobbles	sm. cobble (64-128mm)	90
	lge. cobble (128-256mm)	10
Larges	boulder (>256mm)	
D_{90} (cm)		Compaction L M (H)

BANKS						
Height (m) .5	%Unstable					
Texture	(F)	(G)	L	R		
Confinement	EN	(CO)	FC	OC	UC	N/A
Valley: Channel Ratio	0-2	2-5	5-10	10+	(N/A)	
Stage	Dry	(L)	M	H	Flood	
Flood Signs Ht(m)	.3	Braided	Y	(N)		
Bars (%)	Ø	pH	—	O_2 (ppm)	—	
Water Temp. (°C)	10	Turb. (cm)	—	Cond. (25°C)	—	

OBSTRUCTIONS			
C	Ht(m)	Type	Loc'n

DISCHARGE

Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC 87 SS-87

SITES #10-11

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Klo Creek	(local)		Access	Method
Watershed Code		Reach No.		Length (km)	
Location	site #11	Map		Site No. / Lngth. (m)	100
	site #10 (on a gully 50 m to the north)	U.T.M.		Fish Card Y (N)	Field ☐ Hist. ☐
Date Y M D	95 07 15	Time 0830	Agency	Crew MG/DH /	Photos / Air Photos

C	PARAMETER	VALUE	METH.	SPECIFIC DATA
	Ave. Chan. Width (m)	5.5	GE	
	Ave. Wet Width (m)	2.2	↓	
	Ave. Max. Riffle Depth (cm)	5	↓	
	Ave. Max. Pool Depth (cm)	20	↓	
	Gradient %	.4	CL	
	% Pool 20 Riffle 20 Run 60 Other		GE	
	Side Chan. % ☐0 ☒0-10 ☐10-40 ☐>40		↓	
	Debris Area % 10 ☐0 ☐0-5 ☒5-15 ☐>15		↓	
	Stable %	70	↓	
	COVER: Total %	60		
	Comp. sum 100%: Dp Pool 10, L.O.D. 10, Boulder 10, In Veg –, Over Veg 50, Cutbank 20			
	Crown Closure %	40		Aspect W

BED MATERIAL		%
Fines	clay, silt, sand (<2mm)	
Gravels	small (2-16mm)	30
	large (16-64mm)	70
Cobbles	sm. cobble (64-128mm)	60
	lge. cobble (128-256mm)	20
Larges	boulder (>256mm)	20
D_{90} (cm)		Compaction L (M) H

BANKS						
Height (m) .75	%Unstable 30					
Texture	F	(G)	(L)	R		
Confinement	EN	(CO)	FC	OC	UC	N/A
Valley: Channel Ratio	0-2	2-5	5-10	10+	(N/A)	
Stage	Dry	(L)	M	H	Flood	
Flood Signs Ht(m)	.75	Braided	Y	(N)		
Bars (%)	Ø	pH	—	O_2 (ppm)	—	
Water Temp. (°C)	8	Turb. (cm)	—	Cond. (25°C)	—	

OBSTRUCTIONS			
C	Ht(m)	Type	Loc'n

DISCHARGE

Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC 87 SS-87

SITE #14A

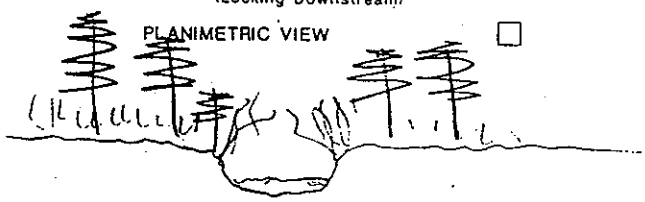
FISH SUMMARY

Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

PLANIMETRIC VIEW ☐

L R



COMMENTS

Channel Stability ☐; Debris ☐; Management Concerns ☐; Obstructions ☐; Riparian Zone ☐; Valley Wall Processes ☐; Etc.

- [illegible] on the plateau
- [illegible] high conc. of fines contained to create [illegible] habitat
- the water temp. at site #14A is 2°C higher than that at site #11

Edited by:

Date Y M D:

SITES #10-11

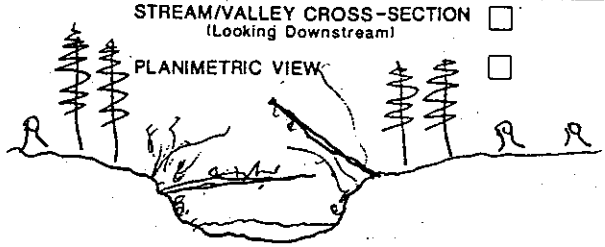
FISH SUMMARY

Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

PLANIMETRIC VIEW ☐

L R



COMMENTS

Channel Stability ☐; Debris ☐; Management Concerns ☐; Obstructions ☐; Riparian Zone ☐; Valley Wall Processes ☐; Etc.

- the stream in this reach is on the plateau but 300m d/s enters an incised canyon where the gradient is >25%
- moderate rearing habitat, however very low flow at the times of the survey
- abundance of stoneflies on the channel substrate

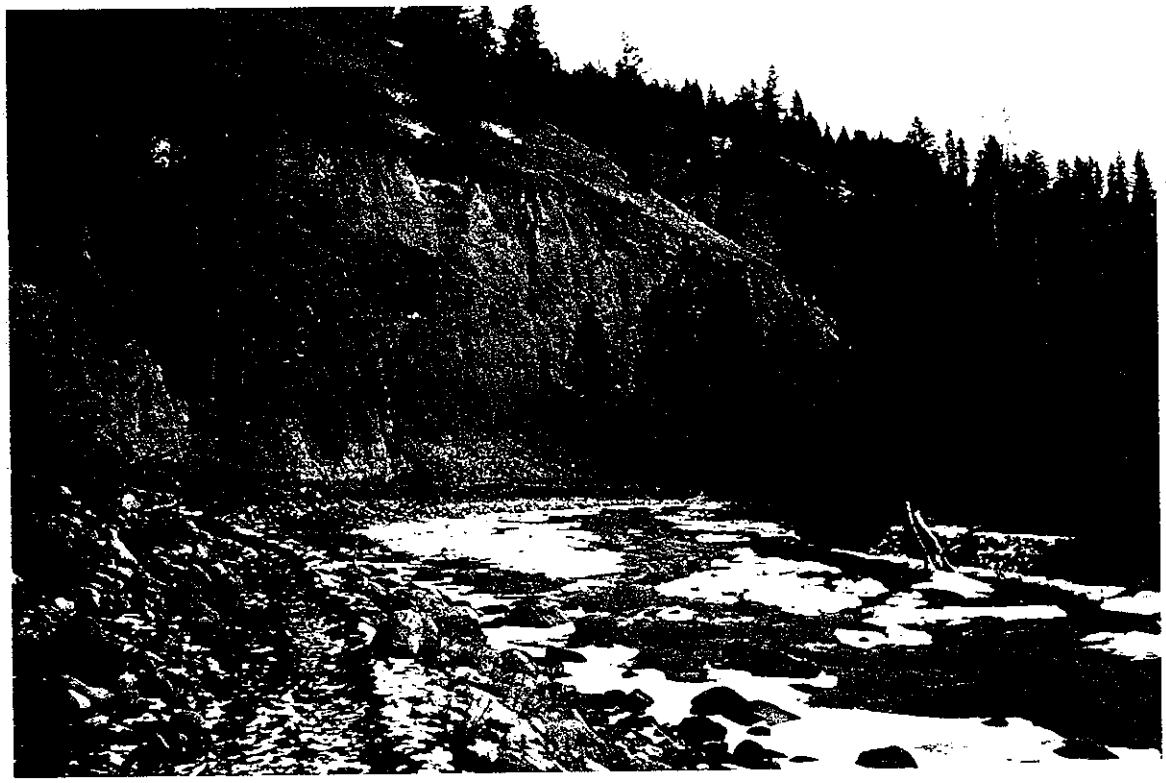
Edited by:

Date Y M D:

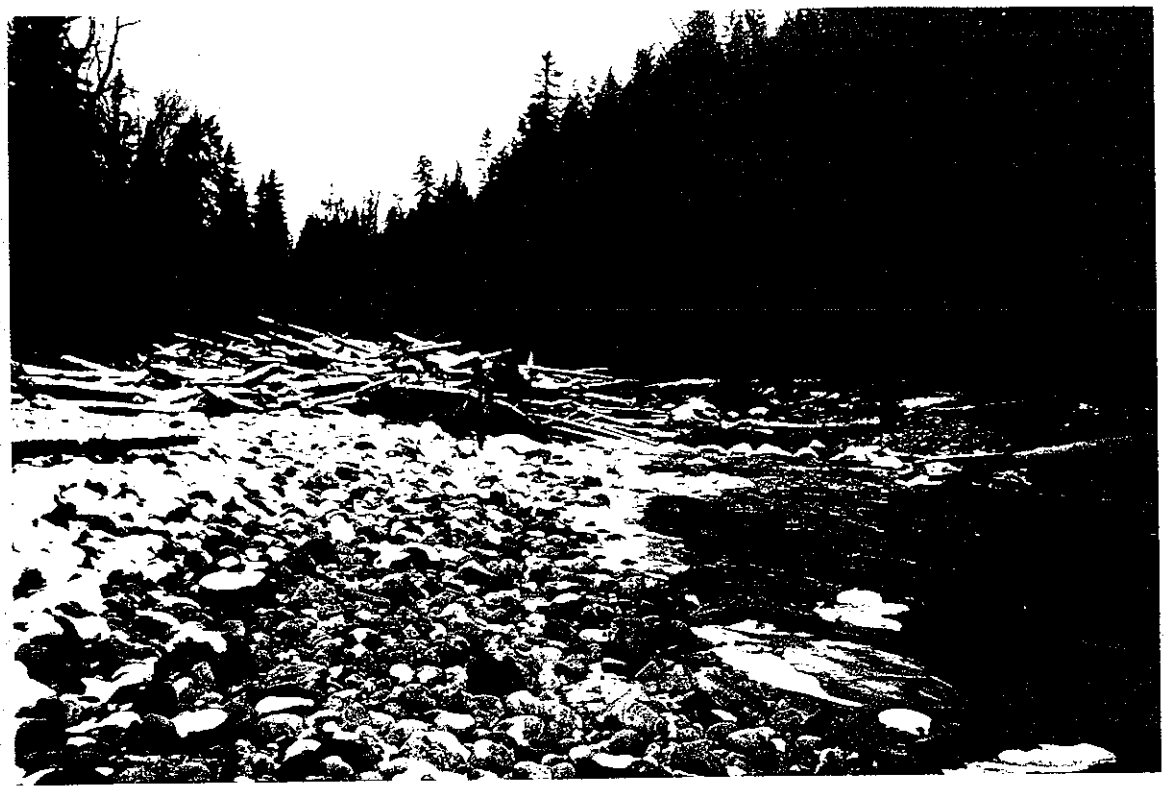
APPENDIX J

Mission Creek
Stream Information File

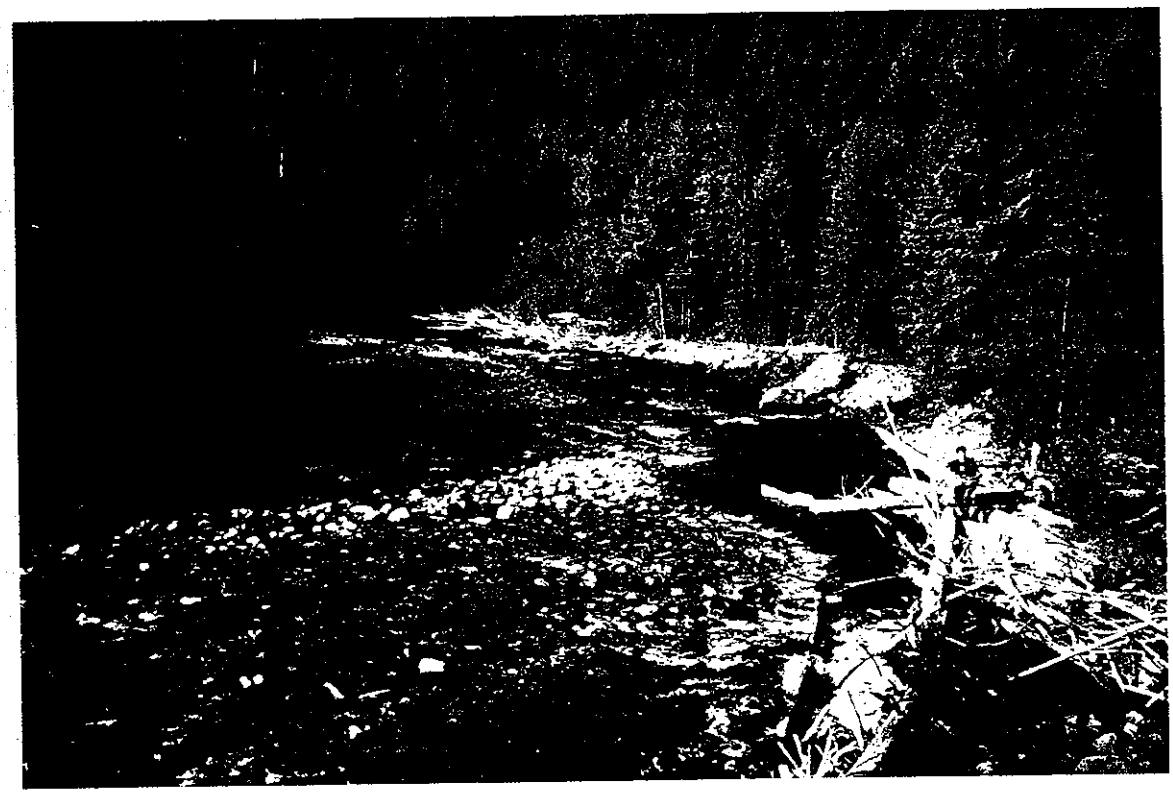
Photograph 1. Water falls at Mission Creek Sites #23/24.



Photograph 2. Naturally eroding bank at Mission Creek Site #27 (view looking upstream).



Photograph 3. Large debris jam at Mission Creek Sites #29.



Photograph 4. Debris jams blocking access to side channels at Mission Creek Site #31.

MISSION CREEK STREAM ASSESSMENT

STREAM: MISSION CREEK
DATE: October 22, 1994
TAPE: WRP Tape 9

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	COORDINATES West
1		mouth of the stream	1:00:15	49.50.63	119.29.01
2	Q-C-Hw-3	large concrete bridge	1:01:12	49.50.53	119.28.64
3	Fs/Q-S-R-3	golf course on the left side, <10m from the channel	1:02:39	49.51.09	119.27.40
4	Fb-D-R-1	large gravel weir almost completely across the channel	1:03:08	49.51.36	119.27.08
5	Q-C-Hw-3	large concrete bridge	1:03:37	49.51.56	119.26.70
6	Fs/Q-S-R-3	footbridge & dykes/roads on both sides of the channel	1:05:09	49.52.53	119.26.01
7	Fs/Fr-C-R-3	large side channel with a culvert on the u/s end on the right side	1:05:52	49.52.76	119.25.34
8	Fb/Q-D-R-1	series of 2 or 3 weirs for 200-300m in the channel	1:06:24	49.52.68	119.24.87
9	Fb/Q-P-R-3	channel reinforced with large amounts of riprap on the left side	1:07:51	49.52.16	119.23.65
10	Q-C-Hw-3	large concrete bridge	1:08:21	49.52.07	119.23.61
11	Fs/Q-S-R-3	from the mouth up to this point both sides of the stream banks were reinforced, agricultural fields, residential, industrial, golf courses, etc.	1:08:46	49.51.72	119.23.44
12	Fs/Q-S-N-3	eroding bank on the left side & a gravel operation d/s on the right side	1:08:55	49.51.63	119.23.36
13	Q-S-R-3	*Gallager Golf Course* on the right side	1:09:49	49.51.06	119.23.03
14	Fb-D-R-1	weir across the stream creating a large pool	1:10:01	49.50.94	119.2.89
15	Fs/Q-S-N-3	high eroding banks on the left for several hundred metres u/s	1:10:29	49.50.94	119.22.63
16		confluence with *KLO Creek*, coincides with a change from high eroding terraces to bedrock cliffs/canyon	1:11:11	49.50.86	119.22.14
17	Fb-D-R-1	weir or small dam structure extending from the right side into the stream	1:11:47	49.50.63	119.21.66
18		confluence with *Hydraulic Creek*	1:12:30	49.50.56	119.21.01

STREAM: MISSION CREEK
DATE: October 22, 1994
TAPE: WRP Tape 9

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	West
19	Q-F-F-2	roads now on both sides of the channel	1:12:39	49.50.63	119.20.92
20	Fs/Q-S-R-2	residence within 5m of the channel, coincides with a bank failure	1:14:03	49.51.33	119.19.87
21	Fb-W-N-1	falls/chutes for 300-500m u/s @ ~18---2000' elevation	1:14:19	49.51.32	119.19.65
22	Q-C-U-3	road on the right side, old cement bridge abutments on both sides of the channel	1:14:56	49.51.30	119.19.14
* 23	Fb-W/D-N/U-1	large falls & series of small falls/chutes with a debris jam on the d/s end of the large falls	1:16:33	49.51.23	119.18.31
24	Q-C-R-3	large intake/settling pond structure on the left ~20m from the channel (completely dry with no water at the intake)	1:17:11	49.51.23	119.17.75
25	Q-C-R-3	second reservoir on the left full of water - stream can flow around to the right	1:18:13	49.51.15	119.16.82
26	Fb-D-R-1	rock weir to divert flow into the reservoir	1:18:40	49.51.12	119.16.43
* 27	Fs/Q-S-N-3	high eroding bank on the left	1:19:38	49.51.31	119.15.62
28	Fs/Q-S-N-3	historic hill slump on the left which apparently completely blocked the stream	1:20:41	49.51.38	119.14.72
* 29	~~Fb-D-F-1~~ QD. N/F - 1	large log jam on the right side with some pieces showing saw-cuts	1:21:03	49.51.46	119.14.40
30	Fb-D-N-3	beaver dams in a side channel on the left side, the side channel is blocked on the u/s end by LWD	1:21:52	49.51.58	119.13.76
nb 7/16/95 * 31	Fb-D-U-1 Fb/Q-D-N/F-1	large island with the channel on the right blocked by debris	1:22:46	49°51.657' ~~49.51.62~~	119° 12.87 ~~119.12.94~~
32	Fs/Q-S-N-3	high eroding bank on the left	1:23:25	49.51.65	119.12.42
33		pumphouse adjacent to the channel	1:23:46	49.51.57	119.12.13
34	Fb-D-N-3	side channel on the left with several beaver dams	1:25:00	49.51.66	119.11.05
35	Fs/Q-S-N-3	high eroding bank on the right	1:25:07	49.51.64	119.10.96
36	Q-S-F-2	historic logging on the flood plain	1:25:49	49.51.78	119.10.34
37	Q-S-R-3	farm on the left with cattle in the stream	1:26:00	49.51.74	119.10.15

STREAM: MISSION CREEK
DATE: October 22, 1994
TAPE: WRP Tape 9

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	West
38	Fb-C-U-2	▸ old wooden bridge	1:26:14	49.51.79	119.09.03
39	Fb-D-R-2	▸ confluence with *Belgo Creek*, several rock weirs in the channel to create large pools	1:26:51	49.51.98	119.09.37
40	Q-C-F-2	▸ confluence with *Joe Rich Creek*, large bridge crossing	1:27:11	49.51.92	119.09.00
41	Fb-D-R-2	▸ large island with 2 weirs in the channel on the left creating large pools	1:28:15	49.51.98	119.07.83
42	Fs/Q-S-N-3	▸ eroding sand/gravel bank on the left ~5m high	1:28:48	49.52.05	119.07.26
11/94 * 43	Fb-D-U-1	▸ intricate rock structures/weirs in the channel & large amounts of LWD	1:29:08	49.52.05	119.06.92
44		▸ pumphouse adjacent to the channel	1:29:43	49.52.22	119.06.38
* 45	Q-D-F-1	▸ LWD (stumps) in the channel with saw-cuts	1:30:43	49.52.39	119.05.73
46	Fb-D-N-3	▸ beaver dam in a side channel on the left	1:30:51	49.52.30	119.05.63
3/11/94 * 47	Fb-D-U-1	▸ large debris jam in the channel on the right	1:32:25	49.52.69	119.04.55
48	Fs-D-F-3	▸ large steel culvert pipe laying across the channel	1:32:55	49.52.89	119.04.32
49	Q-S-F-3	▸ cutblock on the right in the valley flat adjacent to the stream ~10-20m buffer	1:33:08	49.52.98	119.04.22
50	Q-S-F-3	▸ cutblock on a terrace on the left	1:33:28	49.53.11	119.-03.98
at on field notes) 20/03/95 * 51	Fb-C-F-2	▸ log bridge	1:33:45	49.53.25	119.03.83
3/11/94 * 52	Fb/Q-D-F-1	▸ recent logging right on the flood plain on the left within 1m of the channel with felled trees laying in the stream	1:34:05	49.53.45	119.03.72
53	Q-S-F-3	▸ road on the right ~80m from the channel	1:36:11	49.54.66	119.03.41
54	Q-S-F-3	▸ road on the left ~100m from the channel	1:37:21	49.55.31	119.03.28
55	Fb-D-U-2	▸ log jam in the channel on the left around an island	1:39:05	49.56.15	119.02.85
04/11/94 * 56	Fb/Q-D-U-1	▸ large accumulation of debris causing sediment/gravel to accumulate on the right side	1:40:43	49.56.94	119.02.56
57	Q-S-F-3	▸ cutblock (10-15 years old) on the hillslope on the left	1:41:20	49.57.32	119.02.34

LOCATION SYMBOL	CODE	COMMENTS	TIME	COORDINATES North	West
58	Q-S-F-3	▸ another cutblock on the left @ ~4200' elevation	1:43:41	49.58.53	119.01.01
59	Fb/Q-D-F-2	▸ tributary entering from the left runs through the cutblock on the left & is scoured down to bedrock & has large amounts of LWD in the channel	1:46:34	49.59.45	118.59.96
60	Fs/Q-S-N-3	▸ large eroding/slumping bank on the left @ ~4500' elevation	1:46:54	49.59.54	118.58.71
61	Fs/Q-S-N-3	▸ large active eroding bank on the left @ ~4600' elevation	1:48:02	49.59.62	118.57.81
62	Fb/Q-D-U-2	▸ large log jam across the channel @ ~4800' elevation	1:49:08	49.59.70	118.57.01
63	Fb/Q-D-U-2	▸ substantial amounts of LWD	1:50:04	49.59.85	118.56.25
64	Fs/Q-S-N-3	▸ large eroding bank on the left @ ~5000' elevation	1:50:24	49.59.76	118.55.94
65	Fb-W-N-3	▸ series of small falls/chutes	1:51:23	49.59.80	118.55.08
66		▸ just u/s of confluence with *Stanley Creek* took branch of the stream to the right	1:51:52	49.59.79	118.54.77
67	Fb-W-N-3	▸ series of falls/pools	1:52:21	49.59.69	118.54.41
68	Fb/Q-C-F-2	▸ landing & road crossing over a bridge & old culvert pipes on top of the road @ ~6000' elevation	1:55:33	50.00.05	118.52.09
69		▸ *Mission Lake* in the distance & the headwaters	1:57:58	50.00.09	118.50.43

NOTE: 1-58: Map 82 E/14 1:50,000
59-67: Map 82 E/15 1:50,000
68&69 Map 82 L/2 1:50,000

SITE #31

DFO/MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Mission Creek	(local)	
Watershed Code			
Location	site #31 49°51.657 119°12.875		
U.T.M.			
Date Y M D	95 07 16	Time 0745	Crew MG/DH
Photos		Air Photos	
Access		Method	
Length (km)			
Length (m)	200		
Y (N)		Hist.	

PARAMETER	VALUE	METH.	SPECIFIC DATA
[illegible] Width (m)	20	GE	20 (main) 8-10 (side channels)
[illegible] Width (m)	15		15 (main) 2 (side channels) [illegible] due to seepage
Ave.Max.Riffle Depth (cm)	20		
Ave.Max.Pool Depth (cm)	150		
Gradient %	2	CL	
[illegible] 20 [illegible] 46 [illegible] 40 [illegible]		GE	
[illegible] 30			
[illegible] 15			
Stable %	80		
COVER: Total %	10 (60, 10)		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
	20	20	10		30	20

Crown Closure % 5 | Aspect SW

BED MATERIAL	%
clay, silt, sand (<2mm)	
small (2-16mm)	30
large (16-64mm)	20
sm.cobble (64-128mm)	60
lge.cobble (128-256mm)	30
boulder (>256mm)	15

D_{90} (cm) | Compaction L (M) H

BANKS	
Height (m)	2-3
% Unstable	40
Texture	F (G L) R
Confinement	EN CO FC (OC) UC N/A
Valley: Channel Ratio	0-2 2-5 (5-10) 10+ N/A
[illegible]	Dry L (M) H Flood
Flood Signs Ht (m)	2
Braided	(Y) N
Bars (%)	30
pH	—
O_2 (ppm)	—
Water Temp. (°C)	
Turb. (cm)	—
Cond. (25°C)	—

OBSTRUCTIONS

[illegible]	Type	Loc'n

DISCHARGE

Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

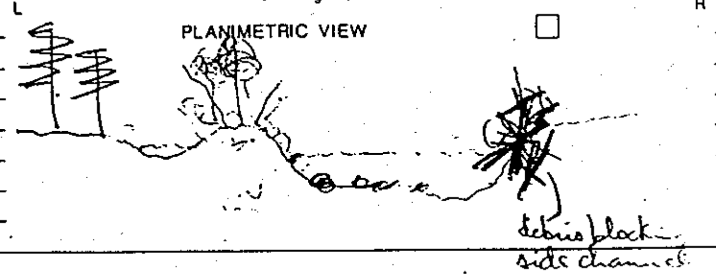
REVISED DEC 87 SS18

FISH SUMMARY

Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.

STREAM/VALLEY CROSS-SECTION (Looking Downstream) ☐

PLANIMETRIC VIEW ☐



COMMENTS

Channel Stability ☐; Debris ☐; Management Concerns ☐; Obstructions ☐; Riparian Zone ☐; Valley Wall Processes ☐; Etc.

- the cover on the main channel is 10%, 60% on the 1st side channel & 10% on the 2nd
- moderate fish habitat in the main channel & the potential for excellent habitat in the side channels if flow is reintroduced by removal of debris jams blocking the u/s end.
- no fish observed
- many aquatic insects present in the pools of the side channels

Edited by:

Date Y M D:

DFO / MOE
STREAM SURVEY FORM

Stream Name (gaz.)	Mission	(local)	
Watershed Code		Reach No.	
Location	lat 49 51.337 up to 49 51.521 / 119 18.110 119 14.179	Map #	
		U.T.M.	
Date Y M D	94 11 09	Time	0900
Agency		Crew	MCG/BTG/
Photos		Air Photos	
Site No.	23-29	Fish Card	Y (N) circled
Access		Method	
Length (km)			
Ch.Length (m)	400		

PARAMETER	VALUE	METH.	SPECIFIC DATA
Ave. Chan. Width (m)			15, 20
Ave. Wet Width (m)			5, 7, 10
Ave. Max. Riffle Depth (cm)			10-15, 20
Ave. Max. Pool Depth (cm)			200-300, 100
Gradient %	2.5-3.5		
Pool 30 / Riffle 40 / Run 20 / Other 10			
Stable %	50		
COVER: Total %	30		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
		10	10		70	10

Crown Closure % | Aspect

OBSTRUCTIONS

Ht (m)	Type	Loc'n
3-5	water fall	

BED MATERIAL		%
Fines	clay, silt, sand (<2mm)	15
Gravels	small (2-16mm)	15
	large (16-64mm)	10
Larges	sm. cobble (64-128mm)	
	lge. cobble (128-256mm)	30
	boulder (>256mm)	
Bedrock (R)		20

D_{90} (cm) | Compaction L (M) H

BANKS			
Height (m)	1-2	% Unstable	40
Texture	F (G L R)		
Confinement	(EN CO) FC OC UC N/A		
Valley: Channel Ratio	0-2 (2-5) 5-10 10+ N/A		
Stage	Dry (L) M H Flood		
Flood Signs Ht (m)	3	Braided	Y (N)
Bars (%)	10	pH	
Water Temp. (°C)	0.5	Turb. (cm)	
O_2 (ppm)		Cond. (25°C)	

DISCHARGE

Parameter	Value	Method	Specific Data
Wetted Width (m)			7.5
Mean Depth (m)			~~0.2~~ 0.15
Mean Velocity (m/s)			0.5
Discharge (m^3/s)			0.35 ?

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC 87 SS187

FISH SUMMARY

Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

PLANIMETRIC VIEW ☐

L R

COMMENTS

Channel Stability ☐; Debris ☐; Management Concerns ☐; Obstructions ☐; Riparian Zone ☐; Valley Wall Processes ☐; Etc.

- 50m d/s from this location the canyon begins & a series of falls/chutes impedes fish migration
- a beaver resides in an old debris flow and has recently felled trees across the channel
- no spawning size gravel in this section mostly bedrock/cobble
- some undercut banks
- also surveyed down of the stream @ site #27

Edited by:

Date Y M D:

DFO / MOEP
STREAM SURVEY FORM

Stream Name (gaz.)	Mission Creek	(local)	Access:	Method
Watershed Code		Reach No.	Length (km)
Location	lat 49 52 050 / 119 06 903	Map	Site No.	Elevation: 400 - 600
		U.T.M.	Fish Card: Y (N)
Date Y M D: 94 11 03	Time: 0945	Agency	Crew: MCG, BTG /	Photos: 1, 2	Air Photos

PARAMETER	VALUE	METH.	SPECIFIC DATA
Ave. Channel Width (m)	20		20
Ave. Wetted Width (m)	10		7-12
Ave. Max. Riffle Depth (cm)			20-30, 10, 15
Ave. Max. Pool Depth (cm)			60-70, 200, 100
Gradient %	1.25		
[illegible]	20 / 50 / 30		
Stable %	95		
COVER: Total %	20		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
		20	10	10	50	10

Crown Closure % | Aspect

BED MATERIAL		%
Fines	clay, silt, sand (<2mm)	5
Gravels	small (2-16mm)	10
	large (16-64mm)	20
Cobbles	sm. cobble (64-128mm)	40
	lge. cobble (128-256mm)	10
	boulder (>256mm)	10
Bedrock		5

D_{90}(cm): 30 | Compaction: L (M) H

BANKS			
Height (m): 1-2	% Unstable: 50		
Texture: F (G) (L) R			
Confinement: EN (CO) FC OC UC N/A			
Valley: Channel Ratio: 0-2 (2-5) 5-10 10+ N/A			
Stage: Dry (L) M H Flood			
Flood Signs Ht (m): 2	Braided: (Y) N		
Bars (%): 50	pH	O_2 (ppm)	
Water Temp. (°C): 0.5	Turb. (cm)	Cond. (25°C)	

OBSTRUCTIONS: Type | Loc'n

DISCHARGE

Parameter	Value	Method	Specific Data
Wetted Width (m)			10
Mean Depth (m)			.1
Mean Velocity (m/s)			0.3
Discharge (m^3/s)			0.3

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

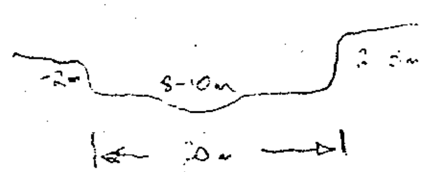
REVISED DEC. 87 SS187

FISH SUMMARY: Species	No.	Size Range (mm)	Life Phase	Use	Method/Ref.

STREAM/VALLEY CROSS-SECTION (Looking Downstream) ☐

PLANIMETRIC VIEW ☐

L R



anastomosing channel

COMMENTS

Channel Stability ☐; Debris ☐; Management Concerns ☐; Obstructions ☐; Riparian Zone ☐; Valley Wall Processes ☐; Etc.

- thalweg - 1m
- [illegible] pool [illegible]
- some undercut banks -> [illegible]
- no [illegible] seen but [illegible] 70% [illegible] is [illegible] by snow
- LOD in the channel appears to be natural in origin at this point
- debris on the bar/island appears natural & relatively stable with some instream veg. d/s
- [illegible] to lat 49°52 105 long 119 08.771

Edited by:

Date Y M D:

DFO / MOEP
STREAM SURVEY FORM

Field	Value
Stream Name (gaz.)	Mission
(local)	
Watershed Code	
Location	lat. 49 53.519 / 119 03.637 — SITE 52
Map #	
U.T.M.	
Date/Time	94 11 03 — Time 1500
Agency	
Crew	KG/BTG/
Photos	
Reach No.	
Site No.	
Fish Data	Y (N) circled
Field / Hist	☐ / ☐
Access	
Length (km)	
Chainage	200
Air Photos	
Method	

PARAMETER	VALUE	METH.	SPECIFIC DATA
Ave. Chan. Width (m)			25-30 m
Ave. Wet. Width (m)			8-10 main, 2-3 side channels
Ave. Max. Riffle Depth (cm)			20
Ave. Max. Pool Depth (cm)			50, 75
Gradient	1.5		
Pattern	10 / 60 / 30		
Side Chan.	10		
Stable %	50		
COVER: Total %	20		

Comp. sum 100%	Dp Pool	L.O.D.	Boulder	In Veg	Over Veg	Cutbank
		20	10	20	40	10

Crown Closure %		Aspect	

BED MATERIAL		%
Fines	clay, silt, sand (<2mm)	10
Gravels	small (2-16mm)	20
	large (16-64mm)	80
Cobbles	sm. cobble (64-128mm)	40
	lge. cobble (128-256mm)	30
	boulder (>256mm)	30
Dominant By		
D_{90} (cm)	25	Compaction: L (M) H — M circled

BANKS	
Height (m)	2
% Unstable	50
Texture	F (G L) R — G, L circled
Confinement	EN CO FC OC UC N/A
Valley: Channel Ratio	0-2 2-5 5-10 (10+) N/A — 10+ circled
Stage	Dry (L) M H Flood — L circled
Flood Signs Ht (m)	
Braided	(Y) N — Y circled
Bars (%)	50
pH	
O_2 (ppm)	
Water Temp. (°C)	
Turb. (cm)	
Cond. (25°C)	

OBSTRUCTIONS		
Dist.	Type	Loc'n

DISCHARGE

Parameter	Value	Method	Specific Data
Wetted Width (m)			
Mean Depth (m)			
Mean Velocity (m/s)			
Discharge (m^3/s)			

REACH SYMBOL (Fish)

(Width, Valley:Channel, Slope) (Bed Material)

REVISED DEC. 87 SS187

FISH SUMMARY

Species	No.	Size Range (mm)	Life Phase	Use	Method Ref.

STREAM/VALLEY CROSS-SECTION ☐ (Looking Downstream)

PLANIMETRIC VIEW ☐

L R

COMMENTS

Channel Stability ☐, Debris ☐, Management Concerns ☐, Obstructions ☐, Riparian Zone ☐, Valley Wall Processes ☐, Etc.

- this reach is probably the same as the reach at site # 43 except if there is a major gradient change somewhere in between
  → check map / air photos
- some areas look scouring and gravel.
- recent logging debris with [illegible] bank may cause [illegible] future [illegible] bank instability (? trees in total)
- there is some older LWD in the middle of the channel which appears stable.

Edited by:

Date Y M D:

APPENDIX K

Key to Biogeoclimatic Zone Codes

Appendix K

Key to Biogeoclimatic Zone, Subzone and Variant Unit Symbols in the Mission Creek Watershed.

Biogeoclimatic unit symbols are arranged by zone/subzone/variant/phase. For example, IDFxh1a indicates:

Zone	Interior Douglas fir
Subzone dry (= xeric)	(precipitation) hot (temperature)
Variant	1 (Okanagan Highland)
Phase	a (grassland)

Zones

PP	Ponderosa pine
IDF	Interior Douglas fir
MS	Montane spruce
ESSF	Engelmann Spruce - Subalpine fir

Subzones

Precipitation

x	very dry
d	dry
m	moist

Temperature

h	hot
w	warm
m	mild
k	cool
c	cold

Variants

1	Okanagan Highlands
2	Thompson Plateau

Phases (recognized)

a	Grassland

Source: B.C. Ministry of Forests Biogeoclimatic Units maps. Kamloops Forest Region. January 1989.