Prince George Fisheries Sensitive Watershed Review

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EXECUTIVE SUMMARY

The Ministry of the Environment, Omineca Region (MoE) has initiated a process to identify Fisheries Sensitive Watersheds (FSW) in the Upper Fraser Basin area. The Government Actions Regulations, section 14 (GAR sec 14) defines a fisheries sensitive watershed as an area of land in a watershed that has significant downstream ***fisheries values*** and significant ***watershed sensitivity***. This report provides a detailed description of the fish values and the sensitivity for five individual watersheds located in the Upper Fraser River basin that will be proposed as candidates for FSW designation. In summary, the results are as follows:

Seebach Creek watershed

Seebach Creek watershed has a significant population of bull trout (a species that is particularly sensitive to land-use disturbances) and the watershed has been highly disturbed through forest harvesting activities in the past. This watershed has a sensitive stream channel type that shows evidence of channel de-stabilization from these past land-use activities. This watershed currently exhibits signs of recovery. In order to promote this watershed recovery and protect the high fisheries values therein, it is recommended that this watershed be designated as a FSW and provided with special management objectives to protect fish. Specific objectives and recommendations have been provided to protect this watershed, the main being to maintain the Equivalent Clearuct Area (ECA) below 25% for the Seebach watershed as a whole

Framstead Creek Watershed

Framstead Creek watershed has an important population of bull trout distributed throughout the watershed. Although the mainstem reaches of this watershed are not particularly sensitive to the intensity of land-use activities that are likely to occur in this watershed, numerous tributary streams and sub-watersheds have been identified as very sensitive (65 stream reaches and 10 sub-basins). In order to protect the high fisheries values in these sub-basins and sensitive stream reaches, it is recommended that this watershed be designated as a Fisheries Sensitive Watershed. Special management objectives have been provided for this watershed and include: 1) Maintain a minimum of 90% of the forest stand located within 15m of the stream bank, for all identified sensitive stream reaches, 2) maintain the FREP WQEE score below specified threshold values for all road crossings that cross sensitive stream reaches, 3) use open-bottom structures for all crossings of sensitive streams if they contain fish, maintain an ECA of 25% or less for all sub-basins identified as sensitive.

Milk River

The situation in the Milk River watershed is very similar to that described for the Framstead watershed. It has a very important population of bull trout and also has Chinook salmon. A total of 20 sensitive stream reaches and 10 tributary sub-basins have been identified as particularly sensitive. In order to protect the high fisheries values in these sub-basins and sensitive stream reaches, it is recommended that the Milk River watershed be designated as a Fisheries Sensitive Watershed. The special management objectives that have been provided for this watershed are the same as those provided for the Framstead and include: 1) maintain a minimum of 90% of the forest stand located within 15m of the stream bank, for all identified sensitive stream reaches, 2)

maintain the FREP WQEE score below specified threshold values for all road crossings that cross sensitive stream reaches, 3) use open-bottom structures for all crossings of sensitive streams if they contain fish, maintain an ECA of 25% or less for all sub-basins identified as sensitive.

Upper Goat River

The Upper Goat River also has important bull trout and Chinook salmon populations and numerous sensitive sites and tributary sub-basins. Although the Upper Goat River watershed has had minimal land-use disturbance to date, Carrier Lumber is considering operations there in the near future. A total of 19 sensitive stream reaches and 9 tributary sub-basins have been identified as particularly sensitive. In order to protect the high fisheries values in these sub-basins and sensitive stream reaches, it is recommended that the Upper Goat River watershed be designated as a Fisheries Sensitive Watershed. The special management objectives that have been provided for this watershed are the same as those provided for the Framstead and include: 1) maintain a minimum of 90% of the forest stand located within 15m of the stream bank, for all identified sensitive stream reaches, 2) maintain the FREP WQEE score below specified threshold values for all road crossings that cross sensitive stream reaches, 3) use open-bottom structures for all crossings of sensitive streams if they contain fish, maintain an ECA of 25% or less for all sub-basins identified as sensitive.

Chehischic Creek

This watershed supports a large variety of fish species, including rainbow trout, mountain whitefish and burbot. The fish sampling also suggests an extensive use of the lower reaches by Chinook salmon. Consequently, this watershed is considered to have a significant fisheries value. This is a low elevation watershed with very limited topography, which means that the whole watershed is accessible for land-use activities. There has been a very large amount of forest harvesting activity distributed throughout the watershed and a significant amount of range use along the lower reaches. These lower stream reaches, which have been classified as sensitive to disturbance, show clear sign of streambank de-stabilization and associated reduction or loss in fish habitat. In order to protect the high fisheries values in this watershed from further stream channel destabilization it is recommended that this watershed be designated as a Fisheries Sensitive Watershed and that special management be implemented to protect fish. The report provides the following recommendations to protect fish: 1) maintain an ECA of 25% or less across the entire Chehischic Creek watershed, 2) retain at least 90% of the forest stand located within 15m of the edge of all fish streams that are more than 0.5m in width 3) implement strict grazing controls along all lower reaches of Chehischic Creek 3) ensure that sediment production at "active" road crossings on fish streams is kept to a minimum (specific FREP WQEE thresholds are provided in the report), 4) maintain fish passage by using open bottomed structures.

1. Introduction

The Ministry of the Environment, Omineca Region (MoE) has initiated a process to identify Fisheries Sensitive Watersheds (FSW) in the Upper Fraser Basin area. The Government Actions Regulations, section 14 (GAR sec 14) defines a fisheries sensitive watershed as an area of land in a watershed that has significant downstream ***fisheries values*** and significant ***watershed sensitivity***. This report provides a detailed description of the fish values and the sensitivity for five individual watersheds located in the Upper Fraser River basin that will be proposed as candidates for FSWs designation. The report also provides specific objectives and land-use recommendations for each of the watersheds in an effort to:

a. Conserve the natural hydrological conditions, natural stream bed dynamics and stream channel integrity in each candidate watershed,
b. Conserve the quality, quantity and timing of water flow in each candidate watershed,
c. Prevent cumulative hydrological effects that would have material adverse effect on fish in each candidate watershed.

2 Project Objectives

a. Identify the specific fish resources in each candidate watershed and describe why the watershed has "significant fisheries values".

b. Describe in detail the physical characteristics of each of the candidate watersheds and why each one should be considered as "sensitive"

c. Provide detailed objectives and recommendations for land-use management within each of the candidate watersheds in order to maintain hydrological integrity and prevent cumulative effects. This could be considered as the "special management to protect fish" referred to in GAR sec 14.

3 Physical Setting

3.1 General Location of Candidate FSW Watersheds

The five watersheds selected as candidates for FSW designation in the Upper Fraser are identified in Figure 1. These five candidate watersheds represent a broad mix of watersheds types and intensity of land-use disturbance (Table 1). This is very desirable as it provides a wide variety of examples and possible templates from which to draw upon when designating FSW watersheds in other parts of the MoE Omineca Region.

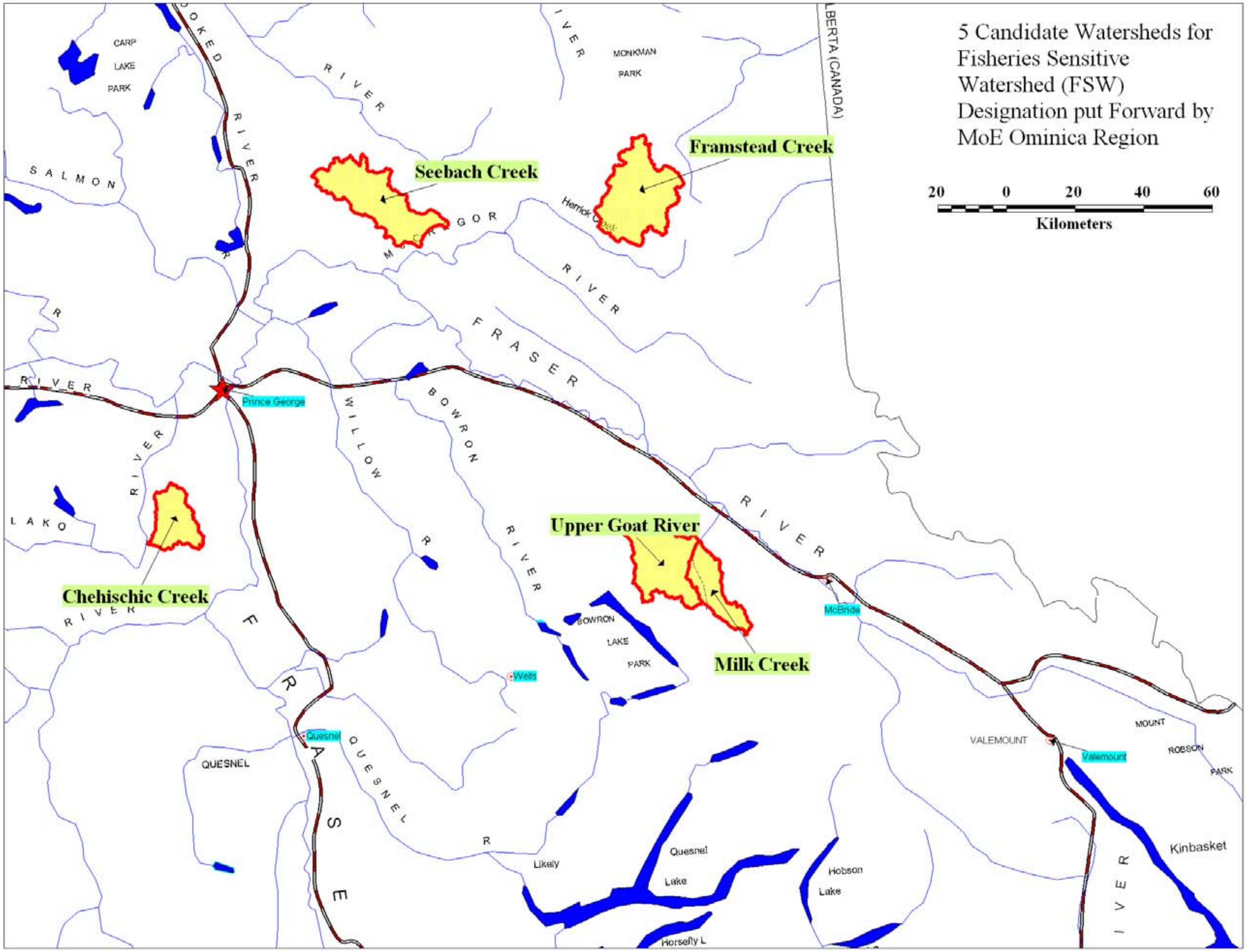

Figure 1. General location of the five candidate Fisheries Sensitive Watersheds (FSW) located in the "Upper Fraser" portion of the Omineca MoE region

Table 1. Candidate watersheds for FSW designation in the Upper Fraser area.

Watershed name	General watershed type	Level of land-use activity	Main Biogeoclimatic sub-zones
Chehischic	Flat topography	Heavily disturbed by both recent and past land-use activities, including agriculture and range	SBSdw3
Seebach	Flat and rolling topography	Heavily harvested in the past, currently in a hydrological recovery stage	SBSvk SBSwk1
Framstead	U-shaped valley and steep topography	A moderate amount of recent road building and forest harvesting	SBSvk ESSFwk2 AT
Milk	U-shaped valley and steep topography	Moderate amount of forest harvesting	ESSFwk1 AT
Upper Goat	U-shaped valley and steep topography	Virtually untouched by forest harvesting activities	ESSFwk1 AT

4 Project Methodology

4.1 General

The assessment of the potential for cumulative impacts in each of the 5 watersheds considered in this report was completed based on: 1) the biophysical characteristics of the watershed 2) the sensitivity of the mainstem channel and its tributary channels to increased peak flows, and 3) the land-use related hazard indicators in each of the watersheds.

4.2 Assessment of Watershed Hazards

The hazard indicators considered in this watershed review included the following:

1. <u>The history of disturbance in each watershed</u>. The Equivalent Clearcut Area (ECA) was used as the disturbance indicator, which quantifies both the extent of disturbance and the level of hydrological recovery.

2. <u>The identification of potential sediment sources caused by stream crossings.</u> The inventory of stream crossings, for each of the watersheds, was provided by the Ministry of the Environment. The MoE stream crossing database is a GIS modelling exercise and is not the direct result of field assessment.

3. The extent of riparian disturbance. This was assessed directly on the ortho-photo. In most cases it could be easily determined if the riparian forest had been removed and thereby decreasing riparian functions. This indicator was assessed individually for both the mainstem and the tributaries.

4.3 Assessment of Watershed Sensitivity

The computation of the watershed sensitivity, relative to the potential for increases in peak flows (PFs), was computed as follows:

PFs= Rs * TOP * DEf *VERT*CLIM*SYNC* NDTf

Where:

1. **Rs** = The Rosgen stream channel sensitivity score, applied to the lower reaches of the watershed (Rosgen 1996, 2006). This is the most important component of the sensitivity score. Figure 2 (from Rosgen 2006) provides the probability of channel destabilization for different stream channel types based on the amount of disturbance in the watershed (indexed by ECA).

2. **TOP** = The watershed topography factor. This is related to generally topography of the watershed and the connectivity of the hillslopes to the stream network

3. **DEf** = The drainage efficiency factor of the watershed (related to the number, size and location of lakes and wetlands in the watershed)

4. **VERT =** This is the typology factor which considers general soils and bedrock types and their effect on the conductivity of water through the soil , i.e. the proportion of shallow horizontal flow (fast) vs deep bedrock flow (slow).

5. **CLIM =** The influence of climate type (as indexed by Biogeoclimatic subzones) on potential for increases in peak flows cause by land disturbance. For example a rain-on-snow zone will be much more sensitive then a dry desert type.

6. **SYNC =** The flow synchronization factor. This factor considers the distribution of elevation zones in the watershed and how flows may potentially be desynchronized with a greater distribution of elevation bands. For example a flat watershed , where most of the area generates peak flows at a similar time (i.e. flows are synchronized) will be more sensitive to extensive land-use disturbances then will be a steeper watershed.

7. **NDTf** = The dominant natural disturbance type in the watershed. (NDTf). The assumption here is that a lower sensitivity rating will be given to those watersheds where large natural disturbances are frequent and the biological communities may be better adapted to frequent natural changes caused by large disturbances (e.g. wildfires, insect infestations and possibly clearcutting).

The computation of the overall watershed sensitivity ((PFs) is based on the sensitivity rating classes and scores provided in the following seven tables (Table 2 to Table 8).

Table 2. Rosgen channel sensitivity rating table (Rs).

Rosgen Stream Type	Stream Sensitivity Class	Channel Sensitivity Score (Rs)
A3 to A6 F3 to F6, G3 to G6	Very High	5
C3 to C6 and D3 to D6	High	4
E3 to E6	Moderate	3
C1 and C2 and B3 to B6	Low	2
A1, A2, B1, B2, F1, F2, G1, G2	Very Low	1

Table 3. Watershed topography rating table (TOP).

Description of the watershed	Topography Factor (TOP)
Gently rolling with very wide uncoupled floodplains	0.9
Hilly, gentle mountains, generally uncoupled with wide valley flats	0.95
Mountainous with localized steepness	1.0
Generally steep and coupled	1.05
Very steep and tightly coupled	1.10

Table 4. Watershed drainage efficiency rating table (DEf).

Description of Watershed Characteristics relative to abundance of lakes and wetlands	Drainage efficiency and lateral connectivity (Topology) (DEf)
Numerous lakes, or one big lake, near outlet (big reduction in sensitivity) low drainage density	0.8
Numerous lakes that are scattered throughout watershed, low to moderate drainage density	0.9
Moderate amount of lakes scattered throughout watershed with moderate to high drainage density.	1.0
Few lakes/swamps that are scattered throughout watershed with high drainage density	1.05
No lakes, very high drainage density	1.1

Table 5. Watershed typology rating table (VERT).

Description of the watershed	Typology Factor Soils and bedrock relative to vertical vs horizontal drainage (VERT)
Very deep porous soils with fractured bedrock	0.9
Deep porous soils with fractured bedrock	0.95
Shallow soils with fractured bedrock or deep soils with solid bedrock	1.0
Moderately shallow soils with solid bedrock	1.05
Very shallow soils and solid bedrock	1.10

Table 6. Watershed flow synchronization rating table (SYNC).

% of watershed in "Low Elevation (i.e. less than 300 m above outlet)	Flow Synchronization Factor (SYNC)
<10	0.9
10-30	0.95
30-60	1.0
60-90	1.05
90-100	1.10

Table 7. Watershed natural disturbance type rating table (NDTf).

Dominant NDT Type in watershed	Natural Disturbance factor (NDTf)
NDT 5 - Alpine tundra and subalpine park land (less sensitive because better adapted to being disturbed)	0.93
NDT 4 - Frequent stand maintaining fires, (less sensitive because better adapted to frequent disturbance)	0.96
NDT 3 - Frequent stand initiating fires, (a bit less sensitive)	1.0
NDT 2 - Infrequent stand-initiating events (minor increase in sensitivity)	1.05
NDT 1 - Rare stand initiating events (increase in sensitivity)	1.08

Table 8. Watershed climate type rating table (CLIM).

BEC Zone	**Weight for BEC Peak Flow Generation Index**		**Justification for Peak Flow Generation Weight Selection**
	Rank **1**= Logging in this zone generates the biggest increases in peak flows **14**= Logging in this zones causes the least effect on increases in peak flows	**Score (CLIM)** (Score is scaled from 0 to 1, where 1 is biggest impact and 0 would be no impact at all)	
MH	High	1.1	Deepest snowpack and rain on snow zones
ICH	High	1.1	Wet climate with potentially lots of snow, not that much different than MH
ESSF	High	1.1	Deep snowpacks and thus the effect of logging on snow accumulation and melt can be significant. Not that much different than ICH and ESSF
MS	High	1.1	Climate is wet and snowy (less than ESSF, but more than SBS)
SBS	High	1.1	Not a huge annual precipitation, but significant snowpack
CWH	Moderate	1.0	Lots of rain, but not much snow. Thus effects of tree removal are less, but still significant
CDF	Moderate	1.0	Lots of rain, but virtually no snow
SWB	Moderate	1.0	Although winters are long, snowpacks are not that deep.
BWBS	Low-Mod	0.85	Although winters are long, snowpacks are not that deep.
SBPS	Low	0.65	Very dry and low snowpack, but completely forested.
IDF	Low	0.65	Most of the zone is relatively dry with generally more rain than snow.
PP	Very Low	0.30	Very dry and low snowpack, not much logging potential in PP
BG	Very Low	0.30	Minimal logging in this zone
AT	Very Low	0.30	No logging in this zone

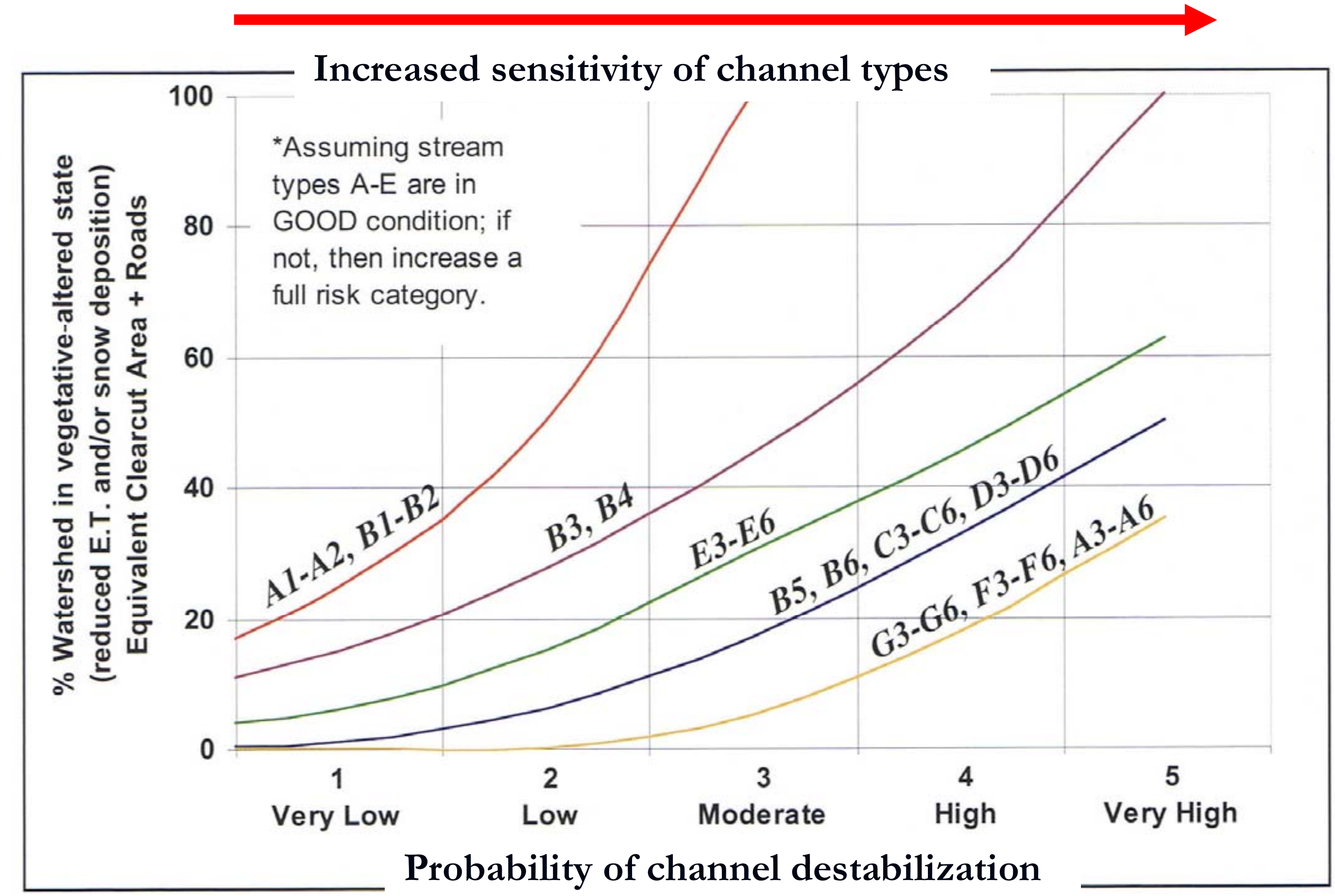

Figure 2. Probability of stream channel destabilzation and accelerated bank erosion associated with increases in equivalent clearcut area, for different Rosgen stream types (adapted from Rosgen 2006).

4.4 Objectives and Recommendations

For each of the five (5) watersheds reviewed, a series of objectives and operational recommendations have been provided in order to maintain the hydrological integrity of the watershed. The recommendations address issues of rate of cut, sediment production, riparian management, range management and fish passage. The specific recommendations (or thresholds) for rate of cut were based on the inherent sensitivity of the stream channel and the watershed to increased peakflows and the assumption that a moderate level of risk is acceptable in order to not unduly impact timber supply. Table 9 provides the recommended ECA thresholds for different watershed sensitivities and different risk levels. This table was used to provide the specific ECA recommendations for each of the watersheds reviewed.

Table 9. Recommended ECA levels, for watersheds of different sensitivities in order to maintain an acceptable risk level ("acceptable risk level" is defined by management objectives).

Watershed Risk Ratings		**Equivalent Clearcut Area (ECA) (% of Watershed)**						
		<20%	**20 to 25%**	**25 to 30%**	**30 to 40%**	**40 to 50%**	**50 to 60%**	**>60%**
Sensitivity of Watershed to Large Scale Disturbance	Very Low	**Very Low**	**Very Low**	**Very Low**	**Very Low**	**Low**	**Moderate**	**High**
	Low	**Very Low**	**Very Low**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
	Moderate	**Very Low**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Very High**
	High	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Very High**	**Very High**
	Very High	**Low**	**Moderate**	**High**	**Very High**	**Very High**	**Very High**	**Very High**
	Extreme	**Moderate**	**High**	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**

5 Seebach Creek Watershed

5.1.1 Biophysical Characteristics of Seebach Creek Watershed

Table 10. Summary Information – Watershed Characteristics – Seebach Creek Watershed

Size (km^2)	Dominant BEC Zones	Domin-ant NDT	Elevation Range (m)	Stream Density (km/km^2)	% of watershed that is in "low elevation"[1]	Distribution of slope gradients within the watershed (% of watershed)			
						<10% slope	10 to 30% slope	30 to 60% slope	>60% slope
413	SBSvk SBSwk1	NDT3	635-1701	1105/413 =2.7	56.6	53	38	8	1

[1]"low elevation" is defined as the part of the watershed that is less than 300 metres in elevation above the elevation of the watershed outlet. The greater the % of the watershed in "low elevation", the greater will likely be the effect of forest harvesting on increased peak flows due to the theoretical concept of "synchronization"

Table 11. Rating of "Sensitivity" of Watershed to Increased Peak Flow – Seebach Creek

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type =unstable C4 Score =5.0	0.95	1.05	0.95	1.1	1.0	1.0	Score = 5.2 Rating =**Very High**

[1]Sensitivity of stream channel refers to the lower reaches of the watershed in question. Rating is on a scale of 1 to 5 where 1 = Very low sensitivity and 5 = very high sensitivity, according to Rosgen 1996 and 2006.
[2]Steeper topography is more sensitive (see section 4.3 for scoring details)
[3]Low stream density and lots of lakes and wetlands is less sensitive (see section 4.3 for scoring details)
[4]Deep soils with fractured bedrock is less sensitive than shallow soils with unfractured bedrock (see section 4.3 for details)
[5]Dry climates less sensitive than wetter climates with lots of snow and rain-on-snow (see section 4.3)
[6]Frequent disturbance type less sensitive than infrequent type (see section 4.3 for scoring details)

Table 12. Rating of "Sensitivity" of Watershed to Increased Peak Flow – Upper Seebach Creek

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type = stable C4 Score =4.0	0.95	1.05	0.95	1.1	1.0	1.0	Score = 4.2 Rating = **High**

Table 13. Rating of "Sensitivity" of Watershed to Increased Peak Flow – East Seebach Creek

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type = stable C4 Score =4.0	0.95	1.05	0.95	1.1	1.0	1.0	Score = 4.2 Rating = **High**

5.1.2 Description of Land Disturbance History within Seebach Creek Watershed

Table 14. Seebach watershed - % disturbance by elevation band

Elevation band	Area of elevation band (km^2)	Area of disturbance (km^2)	% disturbance of each of the individual elevation bands	% of the entire watershed in that elevation band
635-735	55.82	20.38	36.51	13.8
735-835	92.22	33.03	35.82	23.3
835-935	80.58	30.13	37.39	19.5
935-1035	92.67	30.97	33.42	22.7
1035-1135	48.81	15.30	31.35	11.9
1135-1235	17.15	3.70	21.57	4.3
1235-1335	8.7	0.47	5.40	2
>1325	5.2	0.19	3.65	1.2
Total Watershed	401.15	140	34.9	

Table 15. Seebach watershed – Equivalent Clearcut Area (ECA) by elevation band

Elevation band	Area of elevation band (km^2)	ECA for that elevation band (km^2)	ECA of each of the individual elevation bands	% of the entire watershed in that elevation band
635-735	55.82	17.75	2.82	13.8
735-835	92.22	25.18	4.00	23.3
835-935	80.58	22.36	3.55	19.5
635-935	228.62	65.29	10.37	56.6
935-1035	92.67	21.12	3.35	22.7
1035-1135	48.81	10.42	1.65	11.9
1135-1235	17.15	1.99	0.32	4.3
1235-1335	8.7	0.17	0.03	2
>1325	5.2	0.05	0.01	1.2
Total Watershed	629.77	164.33	15.73	100

Table 16. Seebach watershed – Equivalent Clearcut Area (ECA) by major sub-basin

Watershed ID	ECA (km^2)	Watershed area	ECA (%)
East Seebach (see Figure 4)	32.48	157.3	20.65
Upper Seebach (Figure 4)	39.03	147.2	26.51
Total Seebach (Figure 5)	104.1	413	25.21

Table 17. Seebach watershed – Extent of Riparian Harvest by Reach

Reach Number	Reach Length (m)	Ave reach gradient (%)	Rosgen Stream Type	Inherent sensitivity to increased peak flows	% riparian logged	Apparent stability
1	1046	0.5	C5	High	100	Severe localised instability
2	1524	0.5	C5	High	100	Severe localised instability
3	5954	0.5	C5	High	6	Frequent localised instability
4	6290	0.5	C5	High	0	Frequent localised instability
5	2258	0.5	C4	High	0	Frequent localised instability
All other reaches	No riparian logging in any of the other mainstem reaches					

Table 18. Seebach watershed Stream crossing data (note that many of these crossing are de-actived) (data provided by Min of the Environment)

	Watershed Size (km^2)	# of x-ings	#of fish bearing X-ings	#of non-fish bearing X-ings	density of x-ings	Density of fish bearing X-ings	Density of non-fish bearing X-ings
Entire Seebach Creek Watershed	413	456	435	21	1.10	1.05	0.05

5.1.3 Information that will support the decision to identify the Seebach Creek watershed as a "Fisheries Sensitive Watershed".

What makes this watershed "fisheries sensitive"?

1. Based on the results of the MoE telemetry project, it is very likely that there are bull trout distributed throughout the Seebach Creek watershed, as there are no major barriers along any of the mainstems (Figure 3). Thus this watershed has significant downstream fisheries values.
2. The Seebach Creek watershed was divided into three individual watersheds and a sensitivity analysis was completed for each of theses. The three watersheds include the Upper and East Seebach sub-basins (Figure 4) and the "entire" Seebach Creek watershed (Figure 5). The sensitivity analysis suggest that all three watersheds are sensitive, with a High sensitivity rating for both the Upper and East Seebach (Table 12 and Table 13) and a Very High rating for the entire Seebach Creek watershed (Table 11). The lower stream reaches of the Seebach are especially sensitive to the potential for increased peak flows as they have been de-stabilized by riparian disturbances in the past. The lower reaches of each of the three watersheds flow through easily de-stabilized alluvium deposited over deep fine textured lacustrine (Figure 6 and Figure 7).
3. Given the amount and distribution of past disturbances in this watershed (Table 14 to Table 16), there is a high probability that peakflows have been increased and could increase even further if there was a significant amount of additional harvesting throughout the watershed.
4. Although it is difficult to determine if bank erosion and localized instability, observed along the lower reaches have been caused by increased peak flows, the fact remains that this stream channel type is highly sensitive to increased peak flows and has been directly disturbed by riparian harvesting (Table 17).
5. There are relatively few occurrences of logging related mass wasting directly connected to the stream network in this watershed. Thus accelerated mass wasting and delivery of coarse sediment to the stream channel is likely not the cause of streambank instability.
6. Localized stream bank instability has likely been caused by a combination of high flows (possibly increased by forest harvesting) and localized riparian harvesting.
7. It is thus important to protect bull trout habitat in this watershed so that further possible increases in peak flows are minimized, at least until the stream stabilizes from past events.
8. In the 1998 TFL-30 sediment source inventory there was evidence of forestry related mass wasting on the fine textured flat over steep terrain (Beaudry et al. 1998). The frequency of this process may have increased over the last decade as the tree roots have decayed.
9. Despite the high level of disturbance in this watershed, and some minor occurrences of logging related mass wasting, this watershed is not "falling apart" in any significant way, at least not at this time. Consequently, it is a good candidate for protection as a fisheries sensitive watershed so that stream stability does not deteriorate any further and fish habitat is thus protected. This, in my opinion, is a better strategy than waiting until the channel de-stabilizes further, before protection measures are implemented and then having to implement a very expensive program of channel rehabilitation with dubious chances of success.

10. A channel stability analysis completed by Dr Gottesfeld in 1997 suggested that the lower reaches of the Seebach Creek are in the process of becoming more stable. Over the 30 year study period, the stream channel has reduced in average width and channel area, and has increased in channel length. These are recognized indicators of a reduction in both sediment supply and water supply to the stream channel and an increase in stream channel stability (Knighton 1998). Thus, the designation of a Fisheries Sensitive Watershed could be used to ensure that logging activities in this watershed are carried out in such a way as to ensure that the "healing process" of the stream channel continues and that further increases in stability continue to occur.
11. Thus in summary, the three watersheds shown in Figure 4 and Figure 5 have: a) significant downstream fisheries values and b) significant watershed sensitivity and they require special management to protect fish, including bull trout (salvelinus confluentus), which has been classified by the Ministry of the Environment as being very sensitive to land-use disturbances. Section 5.1.4 provides a list of special management objectives that are recommended to be applied specifically to these three watersheds in order to protect fish.

5.1.4 Suggested "Special Management" objectives for the Seebach Creek watershed for the maintenance of Fish Habitat, as a Fisheries Sensitive Watershed.

1. Given the sensitivity of these watersheds and especially the lower reaches of each watershed, the ECA should be maintained below 30% for the Upper and East Seebach watersheds and below 25% for the Entire Seebach watershed, in order to maintain a "moderate" risk level for fish habitat (Table 9) Current ECA levels for each of these watersheds are provided in Table 16. The maintenance at or below the recommended ECA thresholds should ensure that natural recovery of the stream channel continues to occur.

2. S4 streams and S6 streams that flow directly into fish bearing streams and are greater than 0.5 m in width, should be managed to retain both a short and long term supply of large woody debris to the stream system and enough shade should be retained to maintain stream temperatures within historical ranges. In order to achieve this objective it is recommended that at least 90% of the forest stand located within 15m of the edge of the stream channel be retained. This recommendation is based on the results of the Prince George Small Streams research project (http://www.for.gov.bc.ca/hre/ffip/PGSSP.htm)

3. Ensure that sediment production at "active" road crossings on fish streams is kept to a minimum. This objective can be achieved by maintaining the FREP WQEE score at or below the following thresholds:

    - 0.2 for fish streams less than 1.5 m in width
    - 1.0 for fish streams less than 5 m in width
    - 5.0 for fish streams less than 20 m in width
    - 20 for fish streams equal to or greater than 20 m in width

The details of the FREP WQEE procedure can be downloaded from the following site (http://www.for.gov.bc.ca/hfp/frep/site_files/indicators/Indicators-WaterQuality-Protocol-2008.pdf)

4. There are a few occurrences of "flat over steep" type of slope failures (Beaudry et al 1998). Avoid these landscape features when designing and locating cutblocks in the future.

5. It is the combination of stream channel types, surficial materials and past riparian disturbances that makes these watersheds "sensitive". The lower reaches of each of the watersheds are most sensitive to the possibility of increased peakflows and riparian logging. Consequently, the control of the rate of cut (or ECA) is the key management objective for this watershed.

6. For fish streams with the following characteristics, ensure fish passage is maintained by utilizing open bottom structures:

    - Fish streams that are 1 m in width and greater

    - Fish streams that have 200 m or more of usable fish habitat upstream of the crossing.

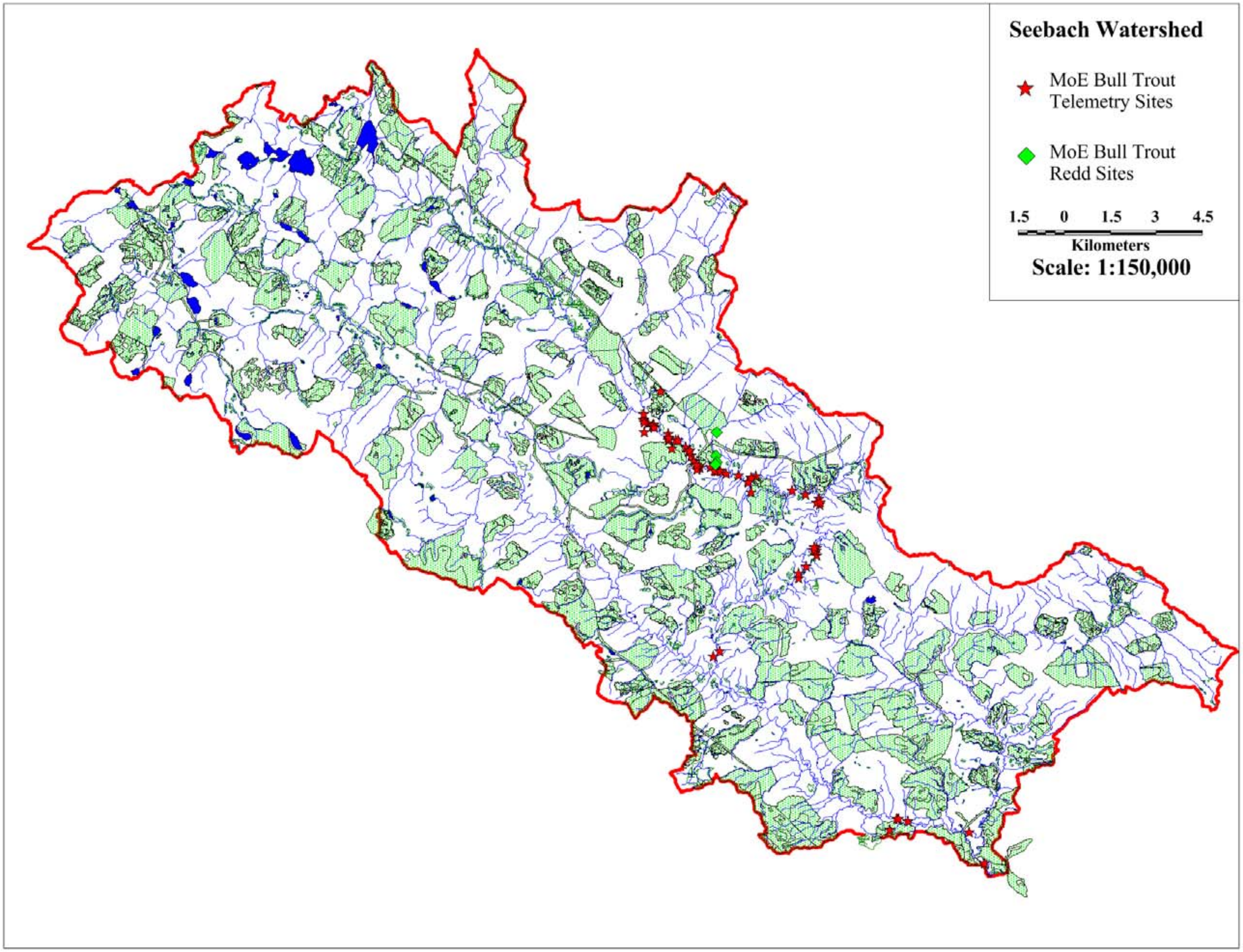

Figure 3. Distribution of tagged bull trout collected during a MoE Telemetry project.

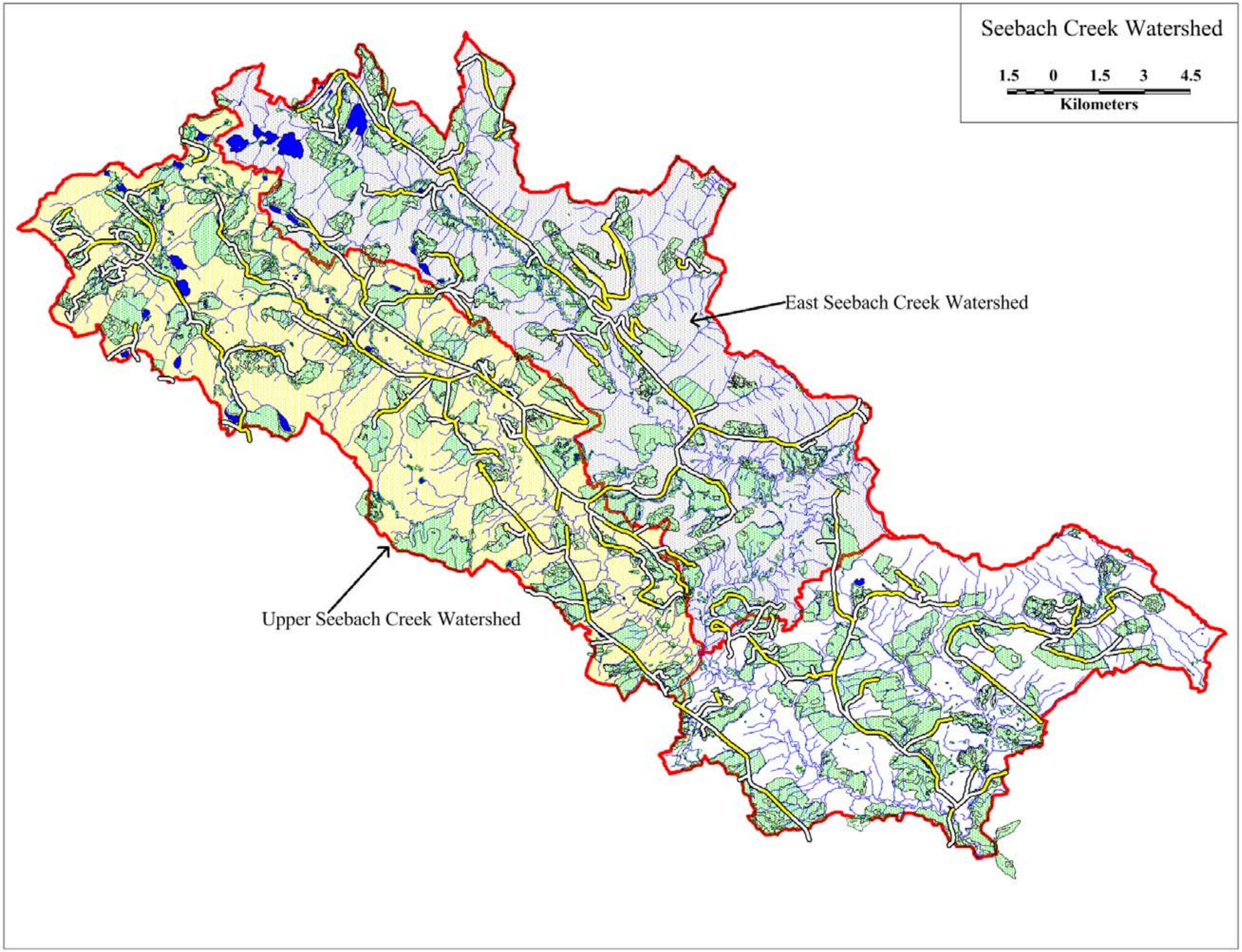

Figure 4. Two major sub-basins of the Seebach Creek watershed, each one considered as an independent watershed.

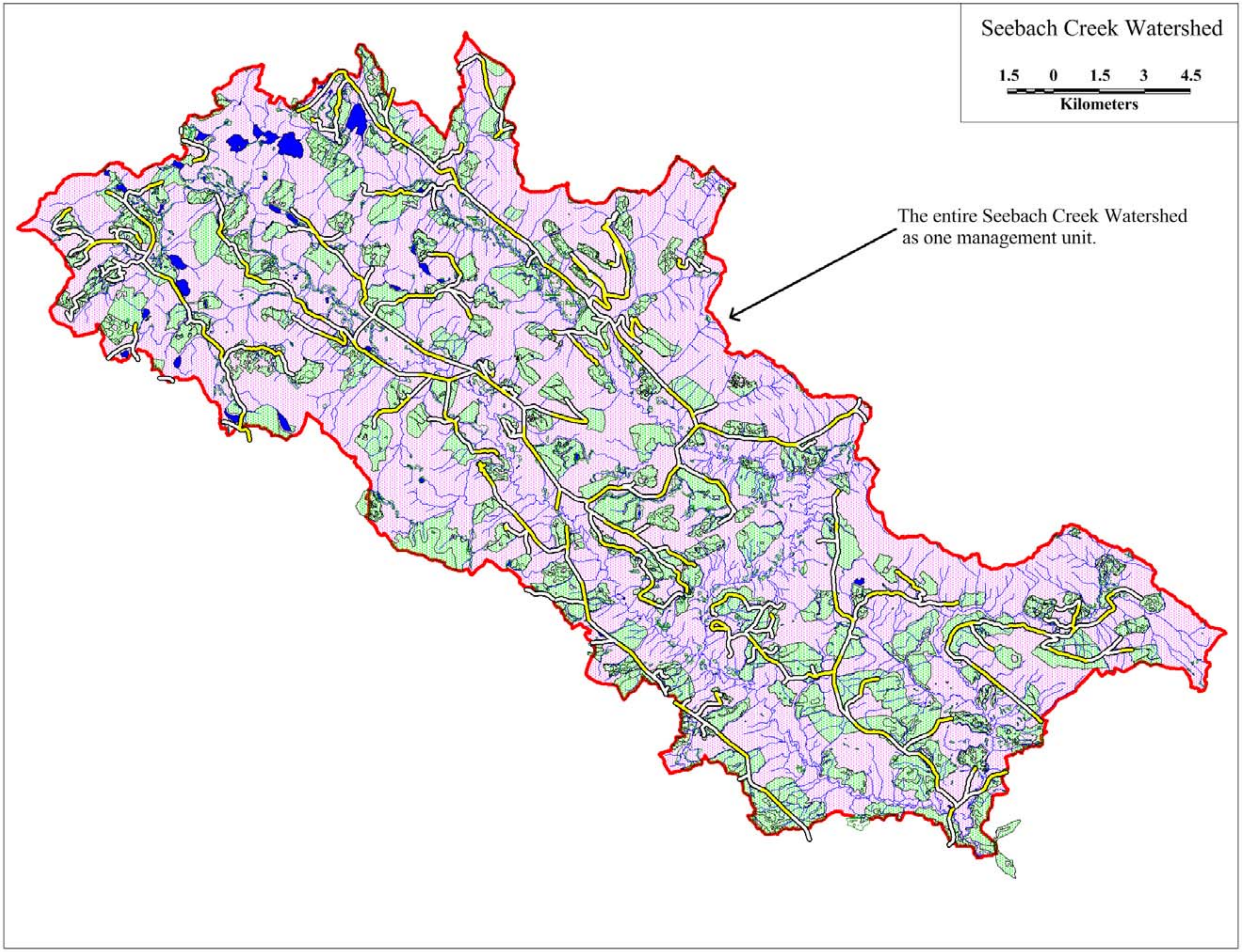

Figure 5. The entire Seebach Creek watershed as one management unit or watershed. .

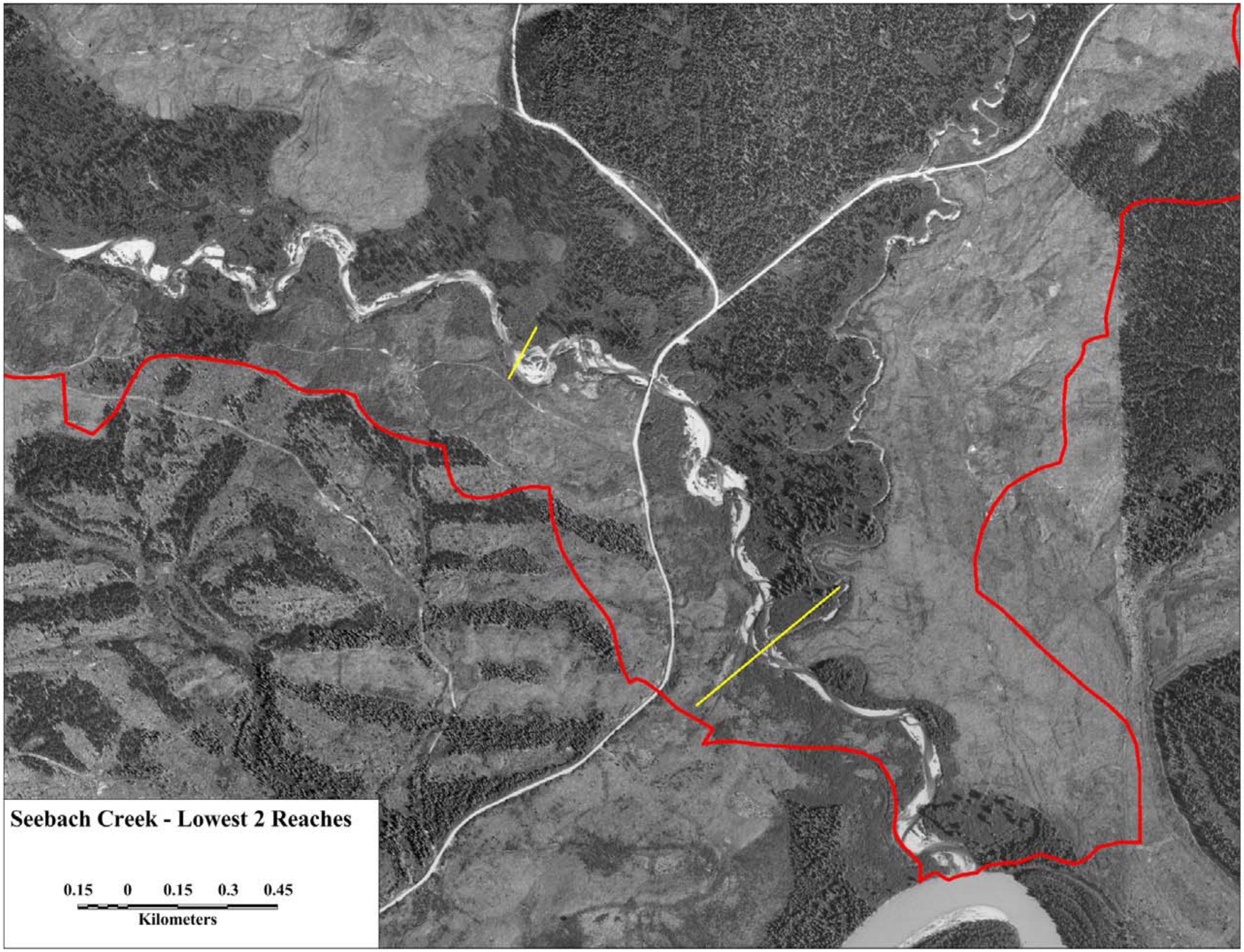

Figure 6. Example of a stretch of Seebach Creek where there has been an extensive amount of riparian forest removal which has likely resulted in accelerated stream channel erosion.

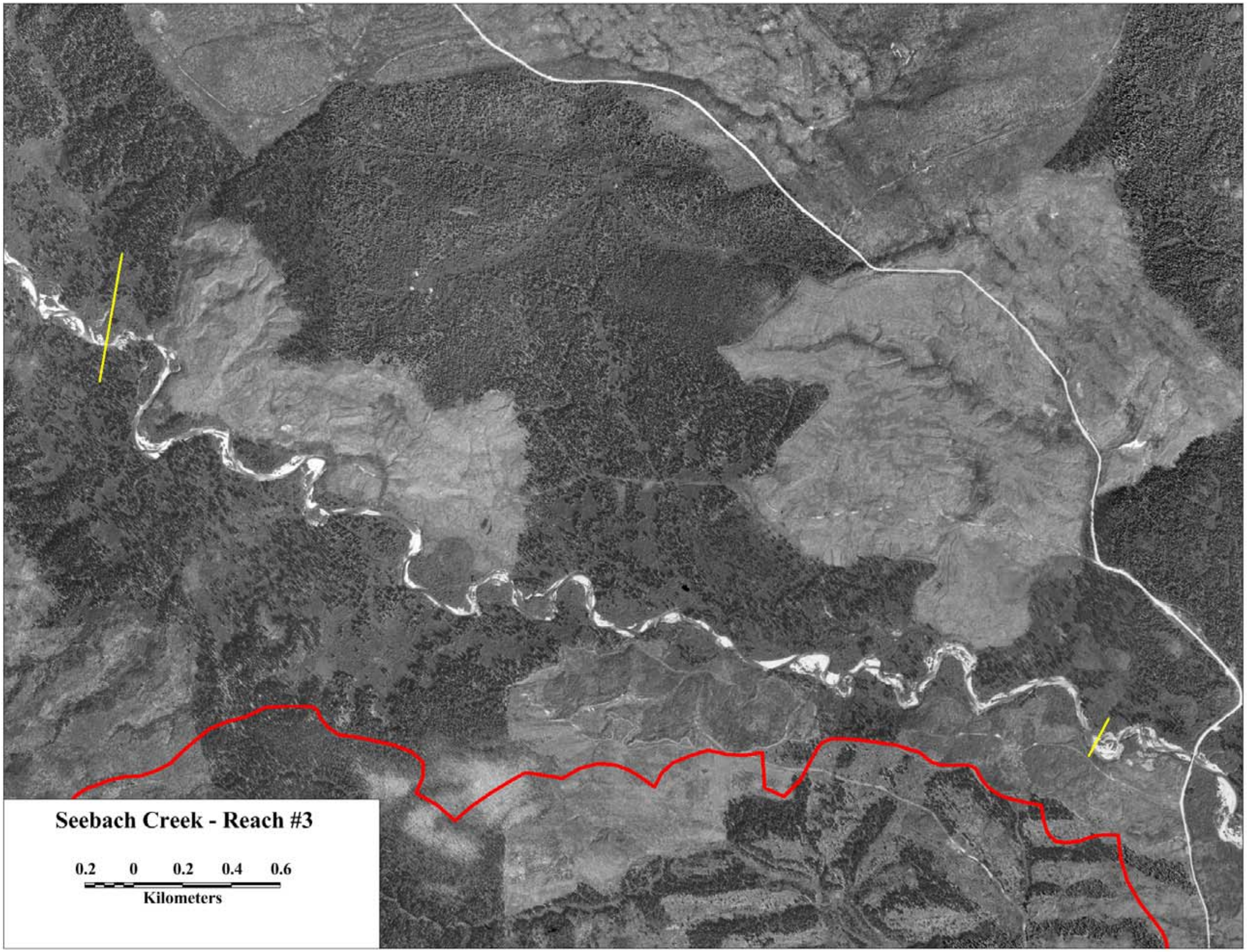

Figure 7. Reach #3 of Seebach Creek, where the stream shows signs of local instability.

6 Framstead Creek Watershed

6.1.1 Biophysical Characteristics of Framstead Creek Watershed

Table 19. Summary Information – Watershed Characteristics – Framstead Creek Watershed

Size (km^2)	Dominant BEC Zones	Dominant NDT	Elevation Range (m)	Stream Density (km/km^2)	% of watershed that is in "low elevation"[1]	Distribution of slope gradients within the watershed (% of watershed)			
						<10% slope	10 to 30% slope	30 to 60% slope	>60% slope
463.5	SBSvk ESSFwk2 AT	NT2, NDT1	849-2644 (1795m)	3.1	26	13	31	40	16

[1]"low elevation" is defined as the part of the watershed that is less than 300 metres in elevation above the elevation of the watershed outlet. The greater the % of the watershed in "low elevation", the greater will likely be the effect of forest harvesting on increased peak flows due to the theoretical concept of "synchronization"

Table 20. Rating of "Sensitivity" of Entire Watershed to Increased Peak Flow – Framstead Creek

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type =B4 Score =2	1.05	1.1	1.1	1.1	0.95	1.05	Score = 2.8 Rating = **Mod**

[1]Sensitivity of stream channel refers to the lower reaches of the watershed in question. Rating is on a scale of 1 to 5 where 1 = Very low sensitivity and 5 = very high sensitivity, according to Rosgen 1996 and 2006.
[2]Steeper topography is more sensitive (see section 4.3 for scoring details)
[3]Low stream density and lots of lakes and wetlands is less sensitive (see section 4.3 for scoring details)
[4]Deep soils with fractured bedrock is less sensitive than shallow soils with unfractured bedrock (see section 4.3 for details)
[5]Dry climates less sensitive than wetter climates with lots of snow and rain-on-snow (see section 4.3)
[6]Frequent disturbance type less sensitive than infrequent type (see section 4.3 for scoring details)

Table 21. Rating of "Sensitivity" of Watershed to Increased Peak Flow – West Framstead Creek Sub-basin

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type =B4 Score =2	1.1	1.1	1.1	1.1	0.95	1.05	Score = 2.9 Rating = **Mod**

Table 22. Rating of "Sensitivity" of Watershed to Increased Peak Flow – East Framstead Creek Sub-basin

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type =B4 Score =2	1.05	1.1	1.1	1.1	0.95	1.05	Score = 2.9 Rating = **Mod**

Table 23. Sensitivity Rating of typical small Sensitive Sub-basins in the Framstead Watershed

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchronization potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type =A4 &G4 Score =5	1.1	1.1	1.1	1	1.05	1	Score = 7 Rating = **Extreme**

6.1.2 Description of Land Disturbance History in the Framstead Creek Watershed

Table 24. Forest harvesting and sediment source hazards – Framstead Creek Watershed

Total area Disturbed in 2007 (% of watershed)	Current ECA (% of watershed)	# of x-ings	#of fish bearing X-ings	#of non-fish bearing X-ings	density of x-ings	Density of fish bearing X-ings	Density of non-fish bearing X-ings
4.6	4.6	189	165	24	0.41	0.36	0.05

[1]Note: The information on stream crossings was provided by MoE and was generated by a GIS model, not fieldwork.

Table 25. Framstead Creek watershed – Equivalent Clearcut Area (ECA) by major sub-basin

Watershed ID	ECA (km^2)	Watershed area	ECA (%)
West Framstead (Figure 9)	16.5	134.6	12.2
East Framstead (Figure 9)	3.89	323.3	1.2
Total Framstead (Figure 8)	21.45	463.5	4.6

Table 26. Framstead Creek watershed – Extent of Riparian Harvest by Reach

Reach Number	Reach Length (m)	Ave reach gradient (%)	Rosgen Stream Type	Inherent sensitivity to increased peak flows	% riparian logged	Apparent stability
1	1611	<0.5	B4-B5	Moderate to Low	0	Stable
2	3413	<0.5	B4-B5	Moderate to Low	0	Stable
3	3327	<0.5	B4-B5	Moderate to Low	0	Stable
4	1306	<0.5	B4-B5	Moderate to Low	0	Stable
5	2169	1	B3-B4	Low	0	Stable
6	1105	1	B3-B4	Low	0	Stable
7	4192	1	B3-B4	Low	0	Local instability
8						
All other reaches	No riparian logging in any of the other mainstem reaches					

[1]Note: The only orthos available for the lower reaches of Framstead Creek are about 12 years old and were taken before forest harvesting began in this watershed. Consequently, I could not measure the extent of riparian harvest to any degree of accuracy. The Google Earth images, which are much more recent, suggest that there has been no riparian logging along the mainstem of the Framstead Creek, but they are not of very good quality.

Table 27. Identified sensitive stream reaches (or stream sections) in the Framstead Creek Watershed (refer to Figure 13)

Stream Reach ID	Description of Sensitivity	Stream Reach ID	Description of Sensitivity
1	Sensitive off-channel floodplain habitat	33	BT habitat
2	Sensitive off-channel floodplain habitat	34	Sensitive off-channel floodplain habitat
3	BT present	35	BT present
4	Bt present - sensitive unstable stream	36	BT habitat
5	Sensitive off-channel floodplain habitat	37	BT habitat
6	Sensitive - unstable stream - BT likely	38	Off-channel floodplain habitat & BT present
7	Sensitive - unstable stream - BT likely	39	BT present
8	Sensitive off-channel floodplain habitat	40	BT present
9	Sensitive off-channel floodplain habitat	41	BT present
10	Sensitive off-channel floodplain habitat	42	BT present
11	Sensitive off-channel floodplain habitat	43	BT present and off channel floodplain habitat
12	Sensitive off-channel floodplain habitat	44	BT present
13	BT Present	45	BT present and off-channel floodplain habitat
14	Sensitive off-channel floodplain habitat	46	BT present and off-channel floodplain habitat
15	Sensitive off-channel floodplain habitat	47	BT present
16	Sensitive stream - BT likely	48	BT present and off-channel floodplain habitat
17	BT Present	49	Sensitive off-channel floodplain habitat
18	BT present	50	BT present
19	BT Present	51	Bt present
20	Bt Present	52	BT present
21	BT present	53	BT present
22	BT Present	54	Sensitive off-channel floodplain habitat
23	BT Present	55	Sensitive stream BT present
24	BT Present	56	BT present
25	BT Present	57	BT present
26	BT present	58	BT present
27	BT present	59	BT present
28	BT Present	60	Colluvian fan
29	BT Present	61	Off - channel floodplain habitat
30	BT Present	62	Sensitive fan - bull trout likely
31	BT present	63	Sensitive stream - unstable fan - BT likley
32	BT present	64	BT present
		65	BT present

Table 28. Identified sensitive sub-basins in the Framstead Creek Watershed (refer to Figure 14)

ID	Description of watershed sensitivity
Basin #1	BT likely, senstive stream type
Basin #2	BT present, sensitive stream type
Basin #3	BT Present, alluvial fan
Basin #4	BT present, sensitive stream type, fan
Basin #5	BT present, sensitive stream
Basin #6	BT present, sensitive stream type
Basin #7	BT present, sensitive stream type
Basin #8	BT present, sensitive and unstable stream
Basin #9	BT present, sensitive and unstable stream
Basin #10	BT likely, unstable and sensitive stream

6.1.3 Information that will support the decision to identify the Framstead Creek watershed as a "Fisheries Sensitive Watershed".

<u>What makes this watershed "fisheries sensitive"?</u>

1) Fisheries values in this watershed are very high as the presence of bull trout has been identified throughout much of the watershed (Figure 10). Bull trout have been sampled in both the mainstem and tributary streams.
2) Unlike the Seebach watershed, the potential problems in this watershed are not associated with the "quantity" of disturbance and its impacts on peak flows, but rather the quality of operations and their specific locations relative to sensitive stream reaches (e.g. roads or cutblocks on fans).
3) The current ECA is very low in the Framstead watershed and in both of its main tributaries (i.e. the east and west branches) (Table 25) (Figure 9). Consequently increases in peak flows in the mainstem channels are very unlikely to occur. The main Framstead stream channel itself is not particularly sensitive to increased peakflows (Table 20). It is a large stable channel with lots of evidence of natural mass wasting (Figure 11). However, there are numerous small sub-basins and tributary streams that are highly sensitive and could be impacted by inadequately managed stream crossings and/or excessive rates of cut (i.e. ECA) (Table 23 and Figure 12).
4) Thus, in summary, the high sensitivity of the Framstead watershed is a result of the very high sensitivity of many of the smaller sub-basins and the impact that forest harvesting activities (both stream crossings and ECA) could have on these small tributary streams. These small streams are much more physically vulnerable to disturbances than are the mainstem stream reaches in the Framstead watershed. If these small streams are significantly disturbed, through increases in peak flows and sediment supply, the stream channel may become destabilized and accelerated bank erosion could result. Such accelerated bank erosion could cause not only reduced habitat quality in the tributary stream, but an increase in sediment supply to the mainstem reach immediately below the disturbance. Since the bull trout appear to use most of the mainstem river, the increased input of fine and coarse sediment, delivered from a disturbed tributary stream, could potentially cause habitat degradation. In summary, this watershed has both well documented high fisheries values and high sensitivity to watershed disturbances that could cause significant degradation of fish habitat.
5) The following section of this report (Section 6.1.4) provides a list of suggested management objectives that could be used to protect fish habitat in this watershed, if it was designated as "fisheries sensitive".

6.1.4 Suggested "Special Management Objectives" for the Framstead Creek watershed for the maintenance of Fish Habitat, under FSW legislation.

1. I have identified sixty-five (65) individual tributary streams in the Framstead watershed that could be classed as particularly sensitive (Figure 13). These stream sections have been classified as such based on one or several of the following factors.
   a) The presence of bull trout has been identified in this stream
   b) The bottom reach of the stream flows through an alluvial or colluvial fan
   c) It is an off-channel floodplain habitat, which is very sensitive to disturbance
   d) It is a sensitive channel type that could potential have bull trout

   Table 27 provides a listing of each of these sensitive stream reaches (or sensitive sites) and provides a short description of why each of these sites is considered sensitive.

   Any forest harvesting or forest management activities in proximity to these tributary streams should be done with great care and attention to prevent disturbance to the aquatic ecosystem. This includes insuring that an adequate supply of both long and short term inputs of large woody debris to the stream and that adequate shade is provided. All stream crossings that cross these sensitive streams should be built to ensure that: 1) fish passage is maintained and 2) erosion and sediment delivery to the stream network is prevented. In order to achieve these objectives, the following recommendations are provided:

   i. A minimum of 90% of the forest stand located within 15m of the edge of the stream channel should be retained. This recommendation is based on the results of the Prince George Small Streams research project (http://www.for.gov.bc.ca/hre/ffip/PGSSP.htm)

   ii. Maintain the FREP WQEE score at or below the following thresholds:

      a. 0.2 for fish streams less than 1.5 m in width

      b. 1.0 for fish streams less than 5 m in width

      c. 5.0 for fish streams less than 20 m in width

      d. 20 for fish streams equal to or greater than 20 m in width

   The details of the FREP WQEE procedure can be downloaded from the following site (http://www.for.gov.bc.ca/hfp/frep/site_files/indicators/Indicators-WaterQuality-Protocol-2008.pdf)

   iii. Use open-bottomed structures when crossing any fish stream that is 1 m in width or greater and has 200 m or more of useable fish habitat upstream of the crossing

2. In addition to the identification of the 65 individual sensitive stream sites, I have also identified 10 particularly sensitive small sub-basins in the Framstead watershed (Figure 14). These sub-basins have been identified as sensitive for one or several of the following reasons

   a) Bull trout have been identified in these watersheds
   b) The lower reaches of the mainstem stream in these watersheds appears to be sensitive to increased peak flows.
   c) The sub-basins are large enough to be reasonably managed at the watershed level.

Table 28 provides a listing of each of the sensitive sub-basins identified in Figure 14 and provides a short description of why each of these sub-basins is considered sensitive to land-use disturbances.

Given that these small basins have a sensitivity rating of Very High, or even Extreme (Table 23), and it is assumed that a Moderate level of risk to fish and their habitat is acceptable, the ECA for each sub-basin should be maintained below 25% (Table 9). Since many of these watersheds have steep terrain, any land-management disturbances on these terrain types should be done with the utmost care, in order to prevent slope failures, whether that be cutblock or road related. Currently there is only one identified sub-basin that has any significant amount of forest harvesting in it and that is Basin #5 (Figure 14). The ECA for that sub-basin is currently at (2.03 km^2/7.96)*100= 25.5 %. Thus, for the protection of this fisheries sensitive watershed, there should be no further forest harvesting in Sub-basin #5, until the older cut-blocks reach hydrological recovery.

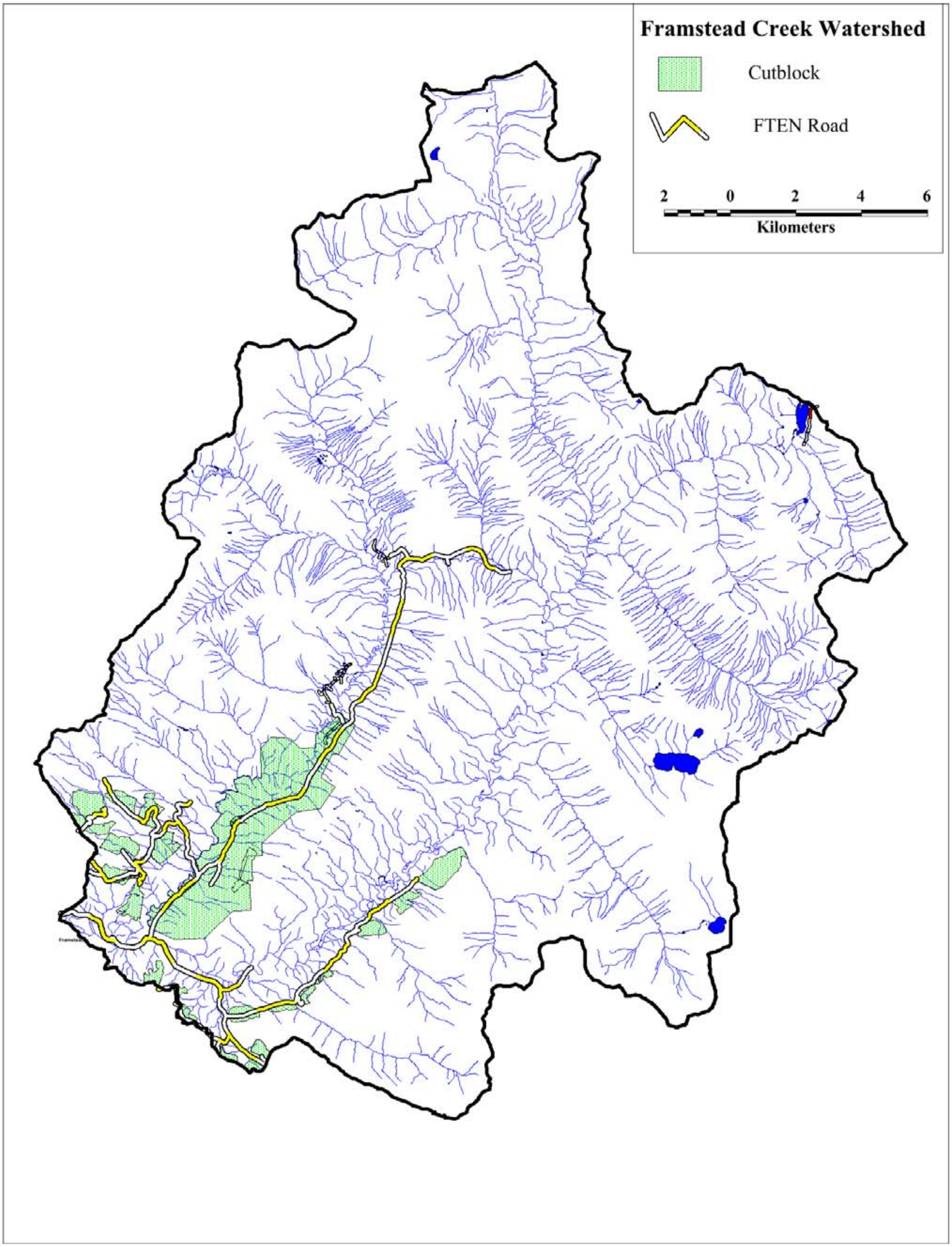

Figure 8. Land-use disturbances in the Framstead watershed and the watershed boundary of the “entire” Framstead watershed.

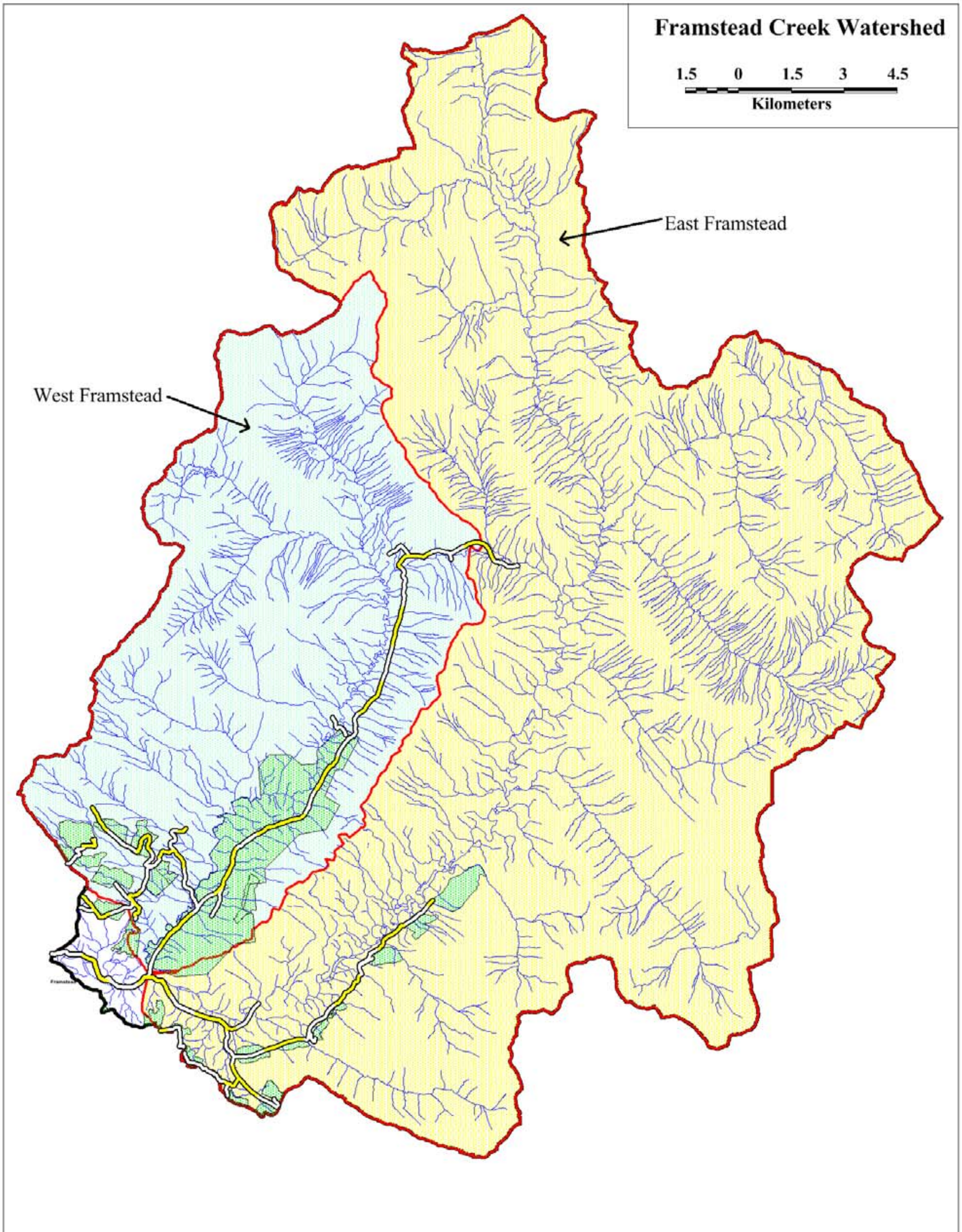

Figure 9. Major sub-basins in the Framstead watershed

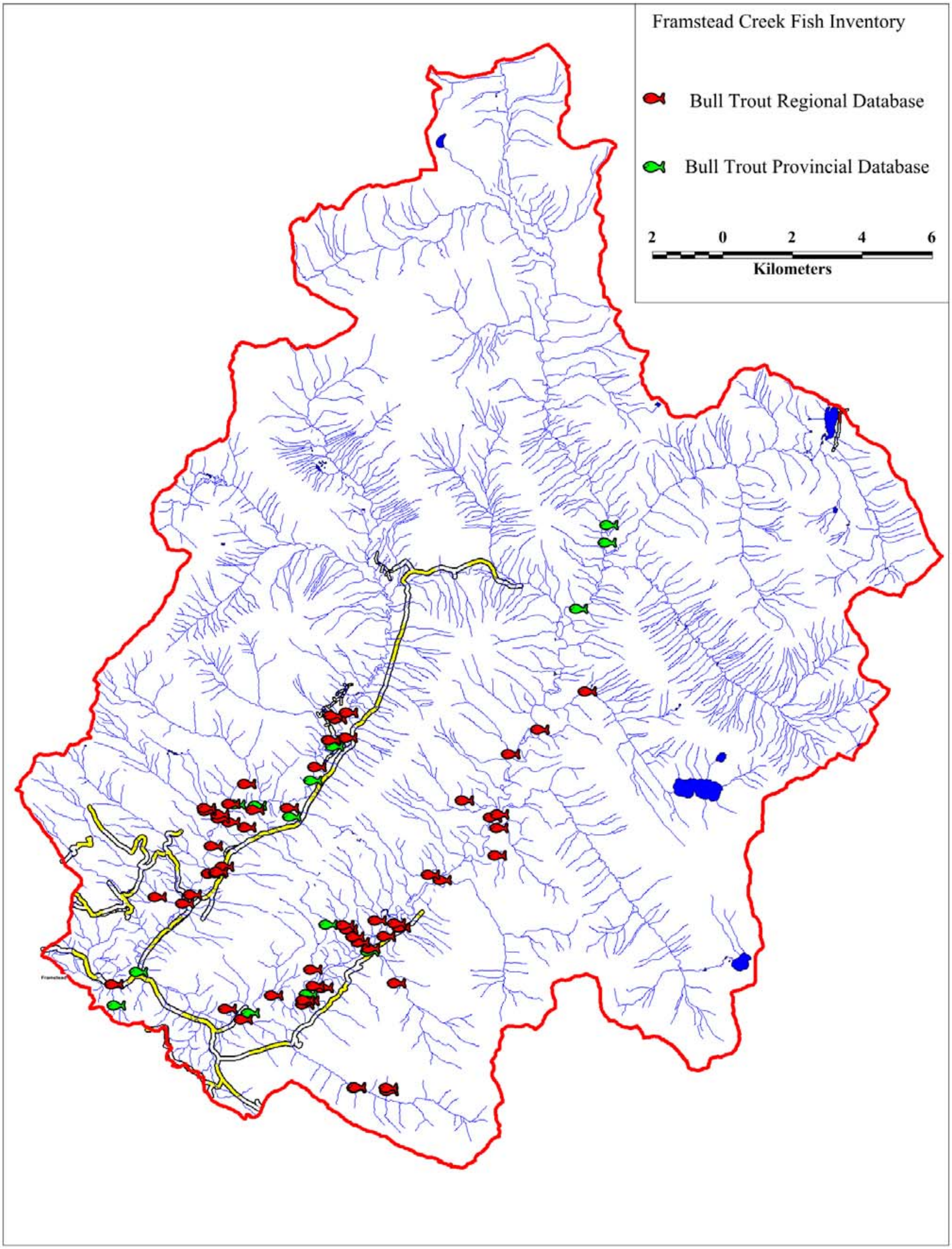

Figure 10. Location of sampling sites were bull trout were identified in the Framstead watershed

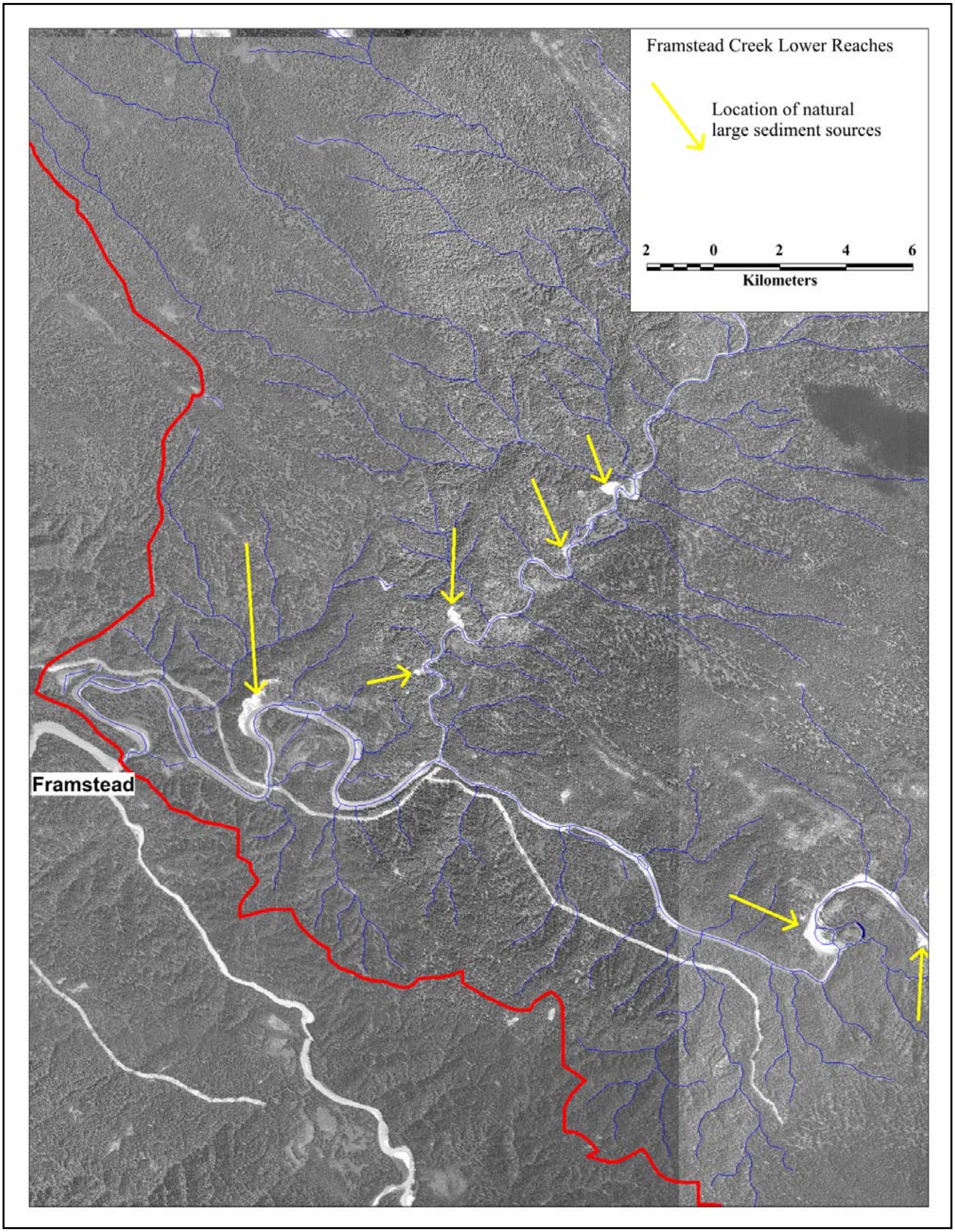

Figure 11. Lower reaches of Framstead Creek and location of some of the large natural sediment sources

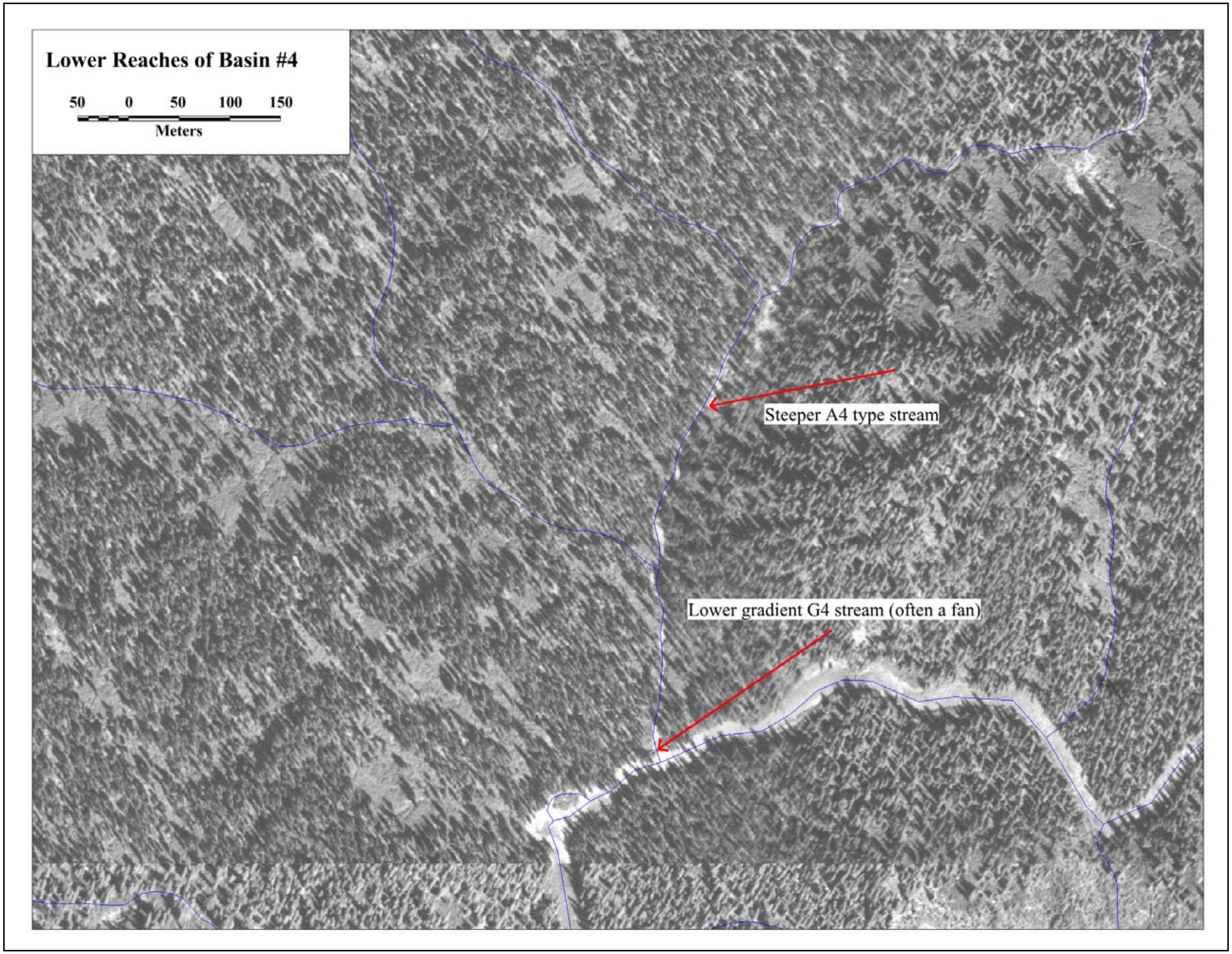

Figure 12. Typical stream types of sub-basins identified as "sensitive". This particular example is Basin #4

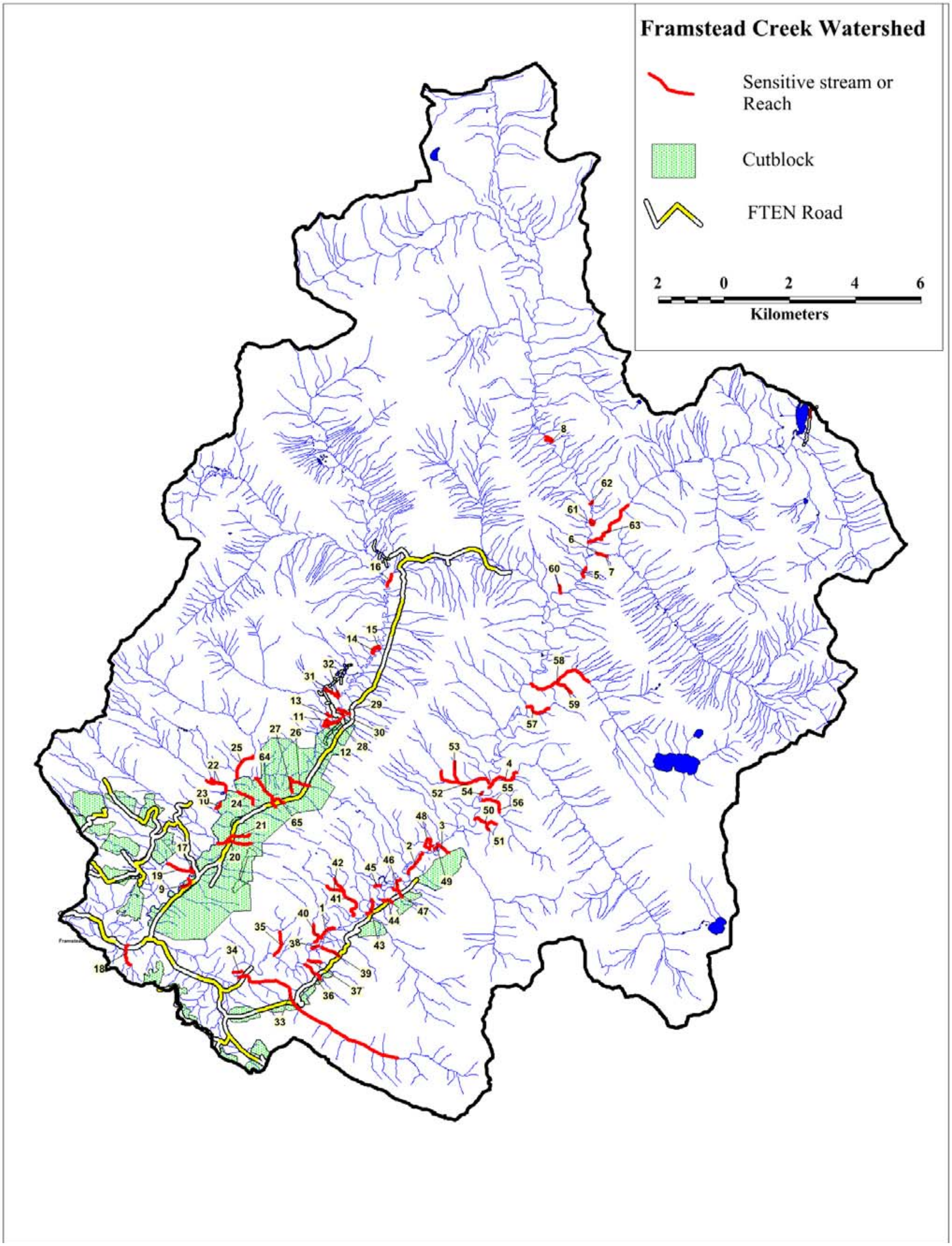

Figure 13. Location and identification of streams or stream reaches identified as "sensitive" in the Framstead watershed.

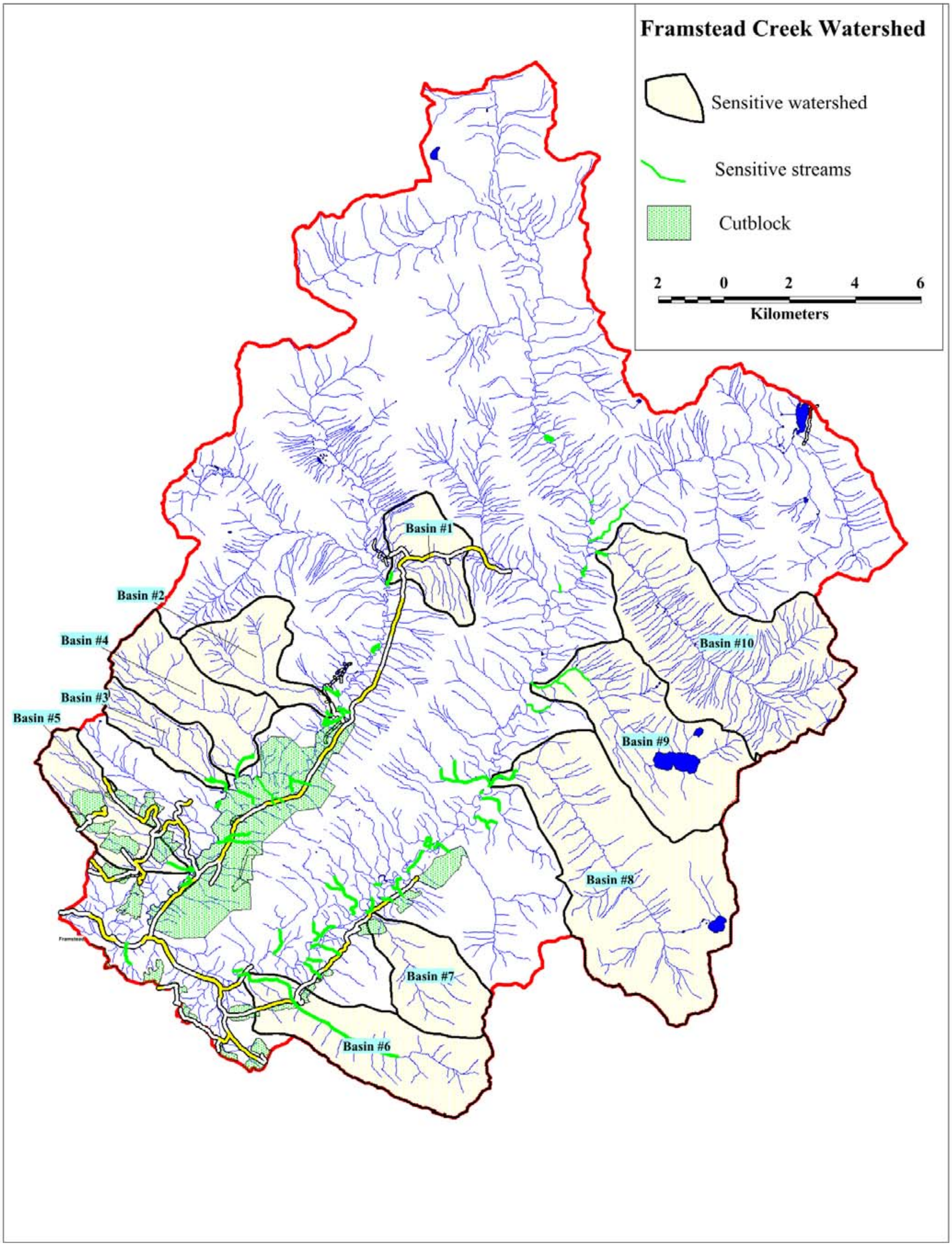

Figure 14. Location of sub-basins identified as "sensitive" in the Framstead watershed

7 Milk River Watershed

7.1.1 Biophysical Characteristics of Milk River Watershed

Table 29. Summary Information – Watershed Characteristics – Milk River Watershed

Size (km^2)	Dominant BEC Zones	Dominant NDT	Elevation Range (m)	Stream Density (km/km^2)	% of watershed that is in "low elevation"[1]	Distribution of slope gradients within the watershed (% of watershed)			
						<10% slope	10 to 30% slope	30 to 60% slope	>60% slope
188.8	ESSFwk1 AT	NDT 1 and 2	835-2731 (1896)	2.25	2.8	4	18	59	19

[1]"low elevation" is defined as the part of the watershed that is less than 300 metres in elevation above the elevation of the watershed outlet. The greater the % of the watershed in "low elevation", the greater will likely be the effect of forest harvesting on increased peak flows due to the theoretical concept of "synchronization"

Table 30. Rating of Sensitivity of mainstem of Milk River to Increased Peak Flows

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type =B4 Score =2	1.05	1.1	1.05	1.1	0.9	1.05	Score = 2.5 Rating = **Mod**

[1]Sensitivity of stream channel refers to the lower reaches of the watershed in question. Rating is on a scale of 1 to 5 where 1 = Very low sensitivity and 5 = very high sensitivity, according to Rosgen 1996 and 2006.
[2]Steeper topography is more sensitive (see section 4.3 for scoring details)
[3]Low stream density and lots of lakes and wetlands is less sensitive (see section 4.3 for scoring details)
[4]Deep soils with fractured bedrock is less sensitive than shallow soils with unfractured bedrock (see section 4.3 for details)
[5]Dry climates less sensitive than wetter climates with lots of snow and rain-on-snow (see section 4.3)
[6]Frequent disturbance type less sensitive than infrequent type (see section 4.3 for scoring details)

Table 31. Sensitivity Rating of typical sensitive small sub-basins of the Milk River to Increased Peak Flow

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows (1= Very Low, 5 = Very High)
Type =A4 &C4 Score =4.5	1.1	1.1	1.1	1.1	0.9	1.05	Score = 6.2 Rating = **Extreme**

[1]Sensitivity of stream channel refers to the lower reaches of the watershed in question. Rating is on a scale of 1 to 5 where 1 = Very low sensitivity and 5 = very high sensitivity, according to Rosgen 1996 and 2006.
[2]Steeper topography is more sensitive (see section 4.3 for scoring details)
[3]Low stream density and lots of lakes and wetlands is less sensitive (see section 4.3 for scoring details)
[4]Deep soils with fractured bedrock is less sensitive than shallow soils with unfractured bedrock (see section 4.3 for details)
[5]Dry climates less sensitive than wetter climates with lots of snow and rain-on-snow (see section 4.3)
[6]Frequent disturbance type less sensitive than infrequent type (see section 4.3 for scoring details)

7.1.2 Description of Land Disturbance History in the Milk River Watershed

Table 32. Forest harvesting and sediment source hazards – Milk River Watershed

Total area Disturbed in 2007 (% of watershed)	Current ECA (% of watershed)	# of x-ings	#of fish bearing X-ings	#of non-fish bearing X-ings	density of x-ings (#/km^2)	Density of fish bearing X-ings (#/km^2)	Density of non-fish bearing X-ings (#/km^2)
12.8	10.9	181	101	80	0.95	0.53	0.42

[1]Note: The information on stream crossings was provided by MoE and was generated by a GIS model, not fieldwork.

Table 33. Milk River watershed – Extent of Riparian Harvest by Reach (Figure 15)

Reach Number	Reach Length (m)	Ave reach gradient (%)	Rosgen Stream Type	Inherent sensitivity to increased peak flows	% riparian logged	Apparent stability
1	2280	0.9	B4	Low	0	Stable
2	2400	0.8	B4	Low	4	Stable
3	1550	0.8	B4	Low	0	Stable
4	2210	1.1	B4	Low	56	Localized instability caused by rip logging
5	2670	1.12	B4	Low	12	Stable
6	2230	1.1	B4	Low	0	Stable
7	4100	1.0	B4	Low	22.9	Local instability
All other reaches	No riparian logging in any of the other mainstem reaches					

Table 34. Identified sensitive stream reaches (or stream sections) in the Milk River watershed.

ID (Refer to Figure 13**)**	**Description**	**ID** (Refer to Figure 13**)**	**Description**
1	Sensitive fan	11	Sensitive floodplain back channel
2	Sensitive floodplain habitat	12	Sensitive channel type
3	Likely BT, sensitive stream	13	Unstable fan
4	Sensitive back channel habitat	14	Unstable fan
5	Likely BT habitat	15	Sensitive floodplain backchannel
6	Sensitive stream type	16	Sensitive channel type
7	Sensitive stream type	17	Sensitive floodplain backchannel
8	BT habitat	18	Sensitive stream type
9	Sensitive stream type	19	Sensitive stream type
10	Sensitive channel type	20	Sensitive stream type

Table 35. Identified sensitive small sub-basins in the Milk Creek Watershed

ID (Refer to Figure 14**)**	**Description**
Basin #1	BT Likely, sensitive stream type
Basin #2	BT habitat, sensitive stream type
Basin #3	BT likely, sensitive stream type
Basin #4	Sensitive stream type
Basin #5	Sensitive stream type
Basin #6	Sensitive stream type
Basin #7	BT likely, Sensitive stream type
Basin #8	Sensitive stream type
Basin #9	Sensitive stream type
Basin #10	Sensitive stream type

7.1.3 Information that will support the decision to identify the Milk River watershed as a "Fisheries Sensitive Watershed".

<u>What makes this watershed "fisheries sensitive"?</u>

1. Fisheries values in this watershed are very high as the presence of bull trout has been identified throughout much of the watershed and Chinook salmon has been sampled at one location (Figure 16). Bull Trout have been sampled in both the mainstem and tributary streams (Ray Pillipow, Pers com).
2. Much like the Framstead watershed, the potential problems in this watershed are not associated with the "quantity" of disturbance and its impacts on peak flows, but rather the quality of operations and their specific locations relative to sensitive stream reaches (e.g. roads or cutblocks on fans).
3. The current ECA is quite low in the Milk watershed (Table 32). Consequently increases in peak flows in the mainstem channels are very unlikely to occur. The mainstem of the Milk River stream channel itself is not particularly sensitive to increased peakflows (Table 30). It is a large stable channel, with only minor localized instability most likely caused by the riparian logging (Table 33) (Figure 17). However, there are numerous sensitive sub-basins and tributary streams that are highly sensitive and could be impacted by inadequately managed stream crossings and/or excessive rates of cut (i.e. ECA) (Table 31 and Figure 18).
4. Thus, in summary, the high sensitivity of the Milk River watershed is very similar to the situation in the Framstead watershed and is a result of the very high sensitivity of many of the smaller sub-basins and the impact that forest harvesting activities (both stream crossings and ECA) could have on these small tributary streams. These small streams are much more physically vulnerable to disturbances than are the mainstem stream reaches in the Milk River watershed. If these small streams are significantly disturbed, through increases in peak flows and sediment supply, the stream channel may become destabilized and accelerated bank erosion could result. Such accelerated bank erosion could cause not only reduced habitat quality in the tributary stream, but an increase in sediment supply to the mainstem reach immediately below the disturbance. Since the bull trout appear to use most of the mainstem river, the increased input of fine and coarse sediment, delivered from a disturbed tributary stream, could potentially cause habitat degradation. Consequently, this watershed has both well documented high fisheries values and high sensitivity to watershed disturbances that could cause significant degradation of fish habitat.
5. The following section of this report (Section 7.1.4) provides a series of suggested management objectives that could be used to protect fish habitat in this watershed, if it was designated as "fisheries sensitive".

7.1.4 Suggested "Special Management Objectives" for the Milk River watershed for the maintenance of fish habitat, under FSW legislation.

1. I have identified twenty (20) individual tributary stream reaches in the Milk River watershed that could be classed as particularly sensitive (Figure 19). These streams have been classified as such based on one or several of the following factors.
   a) The presence of bull trout and or Chinook salmon has been identified in or near this stream
   b) The bottom reach of the stream flows through an alluvial or colluvial fan
   c) It is an off-channel floodplain habitat, which is very sensitive to disturbance
   d) It is a sensitive channel type that could potentially have bull trout use

Table 34 provides a listing of each of these sensitive stream reaches (or sensitive sites) and provides a short description of why each of these sites is considered to be sensitive.

Any forest harvesting or forest management activities in proximity to these tributary streams should be done with great care and attention to minimize disturbance to the aquatic ecosystem. This includes insuring that an adequate supply of both long and short term inputs of large woody debris to the stream and that adequate shade is provided. All stream crossings that cross these sensitive streams should be built to ensure that: 1) fish passage is maintained and 2) erosion and sediment delivery to the stream network is prevented. In order to achieve these objectives, the following recommendations are provided:

i. A minimum of 90% of the forest stand located within 15m of the edge of the stream channel should be retained. This recommendation is based on the results of the Prince George Small Streams research project (http://www.for.gov.bc.ca/hre/ffip/PGSSP.htm)

ii. Maintain the FREP WQEE score for all stream crossings over sensitive streams at or below the following thresholds:

   a. 0.2 for fish streams less than 1.5 m in width

   b. 1.0 for fish streams less than 5 m in width

   c. 5.0 for fish streams less than 20 m in width

   d. 20 for fish streams equal to or greater than 20 m in width

   The details of the FREP WQEE procedure can be downloaded from the following site (http://www.for.gov.bc.ca/hfp/frep/site_files/indicators/Indicators-WaterQuality-Protocol-2008.pdf)

iii. Use open-bottomed structures when crossing any fish stream that is 1 m in width or greater and has 200 m or more of useable fish habitat upstream of the crossing.

2. In addition to the identification of 20 individual sensitive stream sites, I have also identified 10 particularly sensitive “sub-basins” in the Milk River watershed (Figure 20). These sub-basins have been identified as sensitive for one or several of the following factors

   a) Bull trout have been identified in these watersheds, or bull trout and or Chinook salmon have been identified in close proximity to the mouth of these watersheds.
   b) The lower reaches of the mainstem stream in these watersheds appears to be sensitive to increased peak flows.
   c) The sub-basins are large enough to be reasonably managed at the watershed level.

Table 28 provides a listing of each of the sensitive sub-basins identified in Figure 14 and provides a short description of why each of these sub-basins is considered sensitive to land-use disturbances.

Given that these small basins have a sensitivity rating of Very High, or even Extreme (Table 31), and it is assumed that a Moderate level of risk to fish and their habitat is acceptable, the ECA for each sub-basin should be maintained below 25% (Table 9). Since many of these watersheds have steep terrain, any land-management disturbances on these terrain types should be done with the utmost care, in order to prevent slope failures, whether that be cutblock or road related. Currently there are no individual sub-basin that has any large amount of forest harvesting in it (Figure 20).

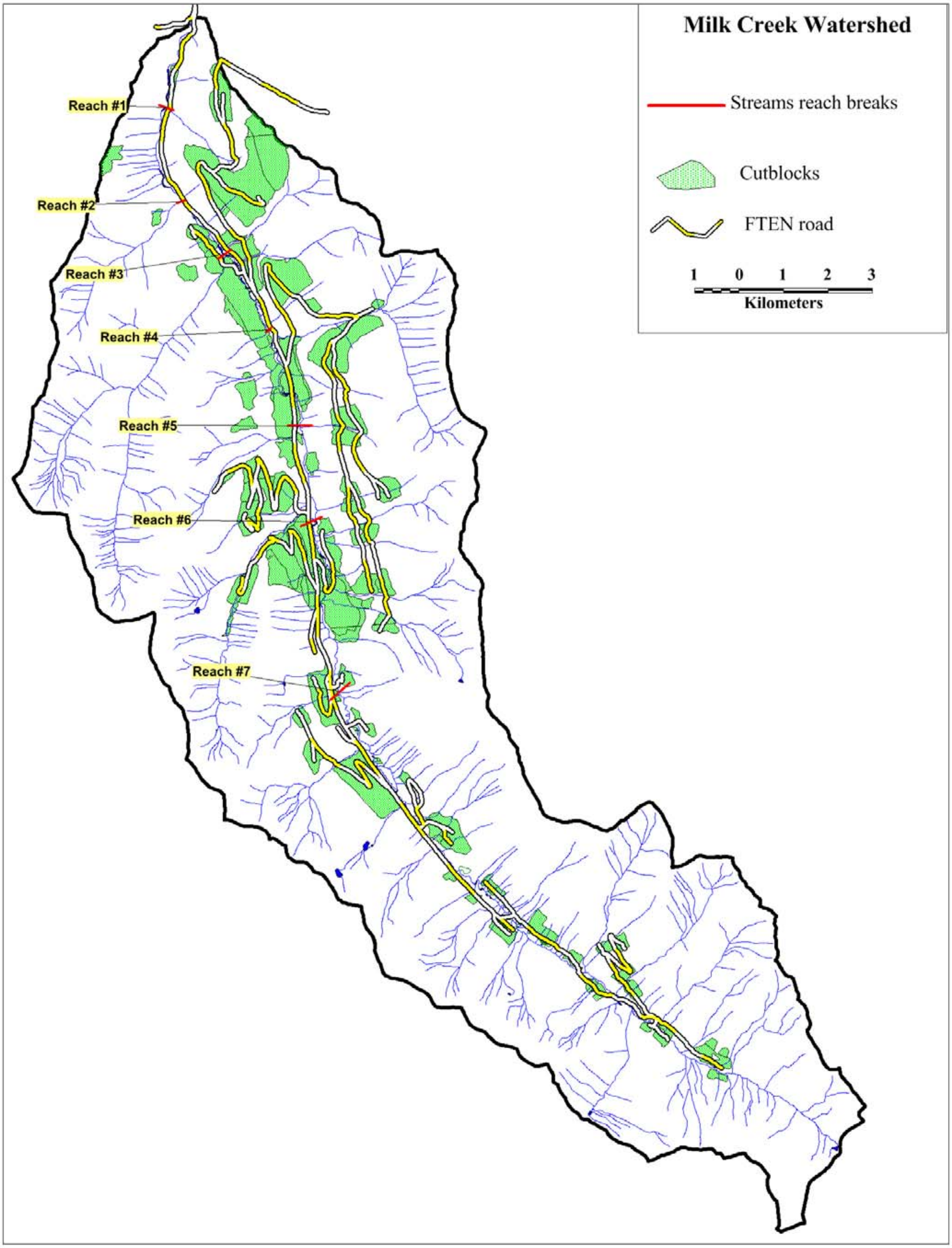

Figure 15. Location of land-use disturbances and stream reaches in the Milk Creek watershed

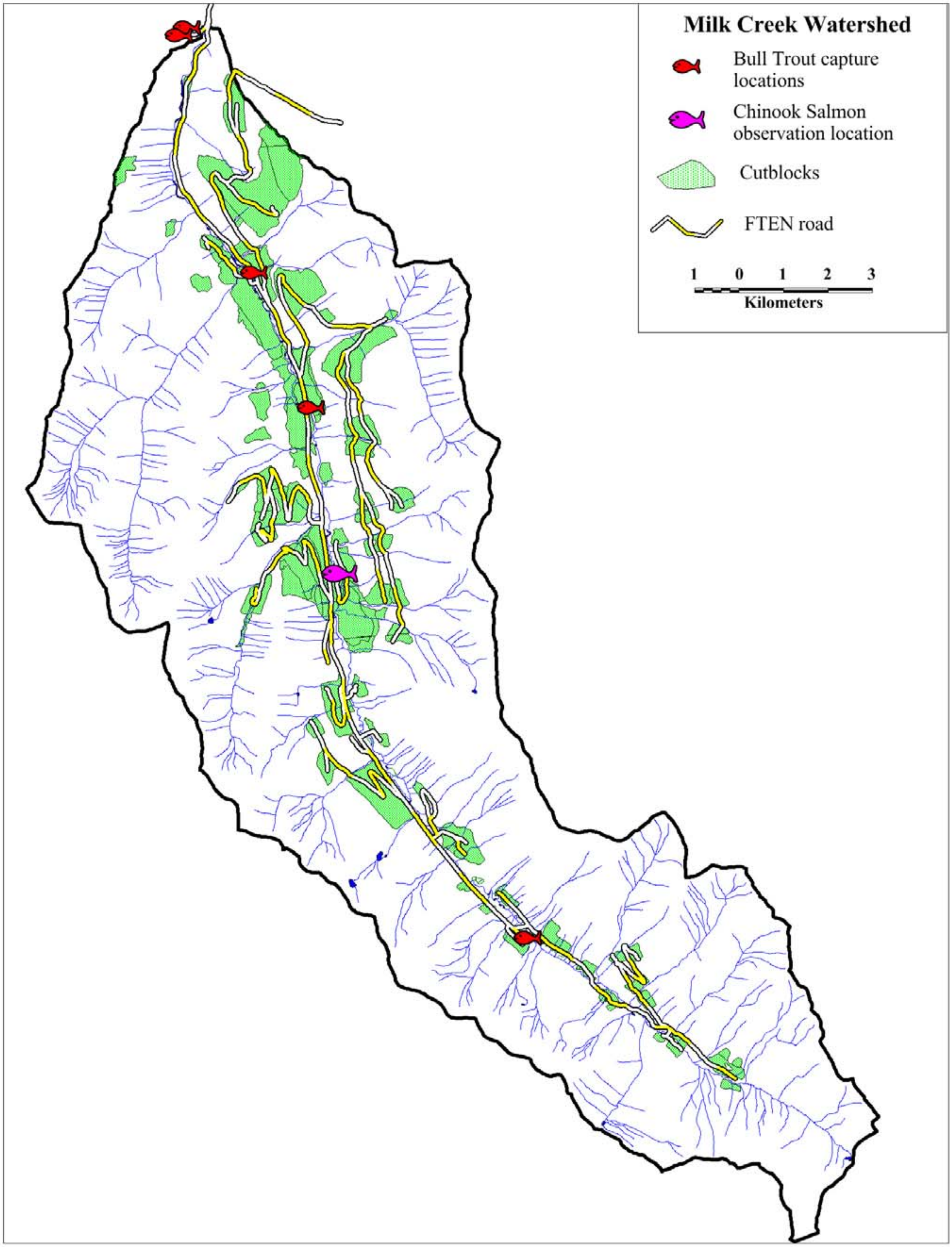

Figure 16. Location of sampling sites where bull trout and Chinook salmon were identified in the Milk River watershed

Figure 17. Lower reaches of Milk River. At this location, this is a stable B4 type stream.

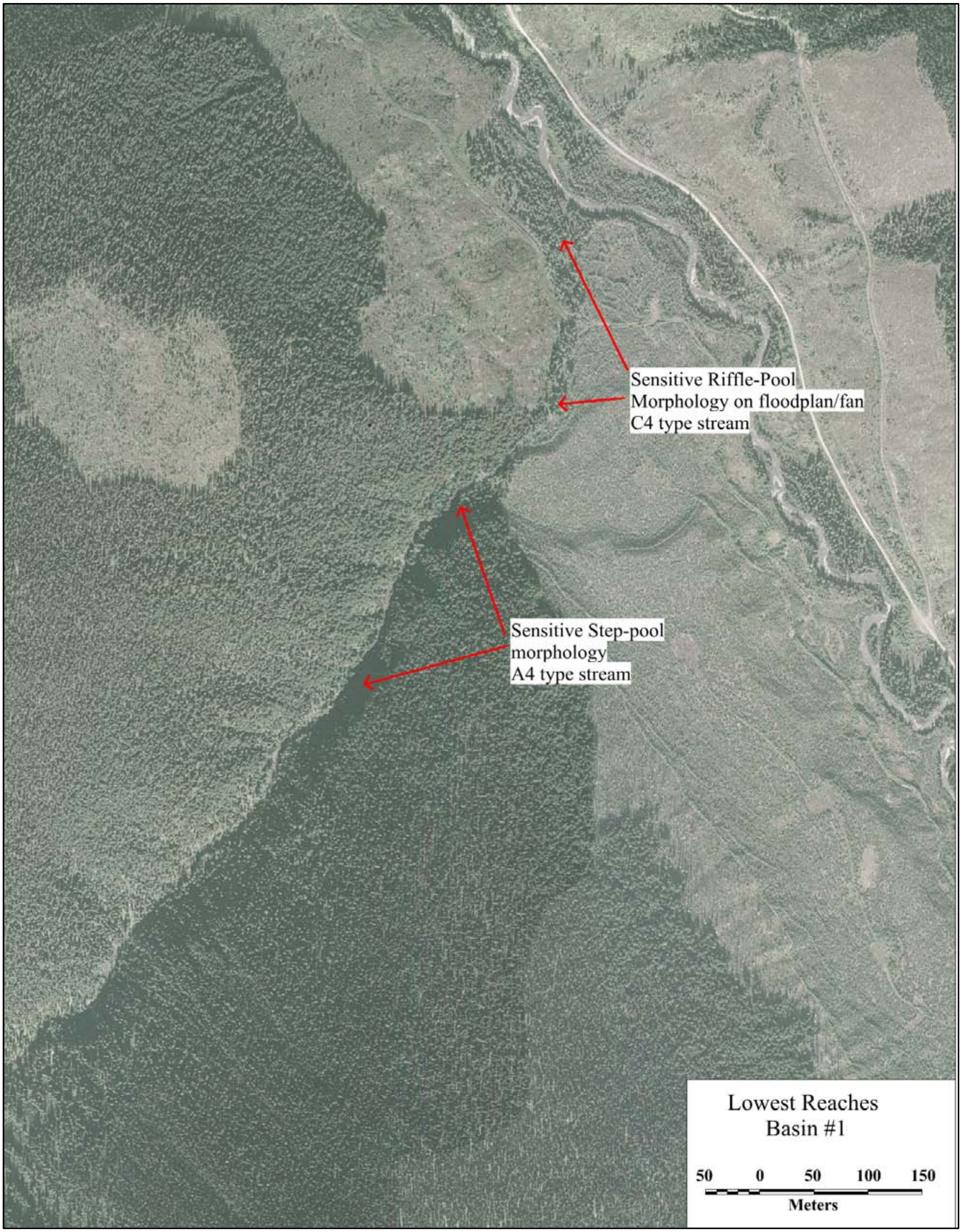

Figure 18. Typical stream types of sub-basins identified as "sensitive". This particular example is Basin #1

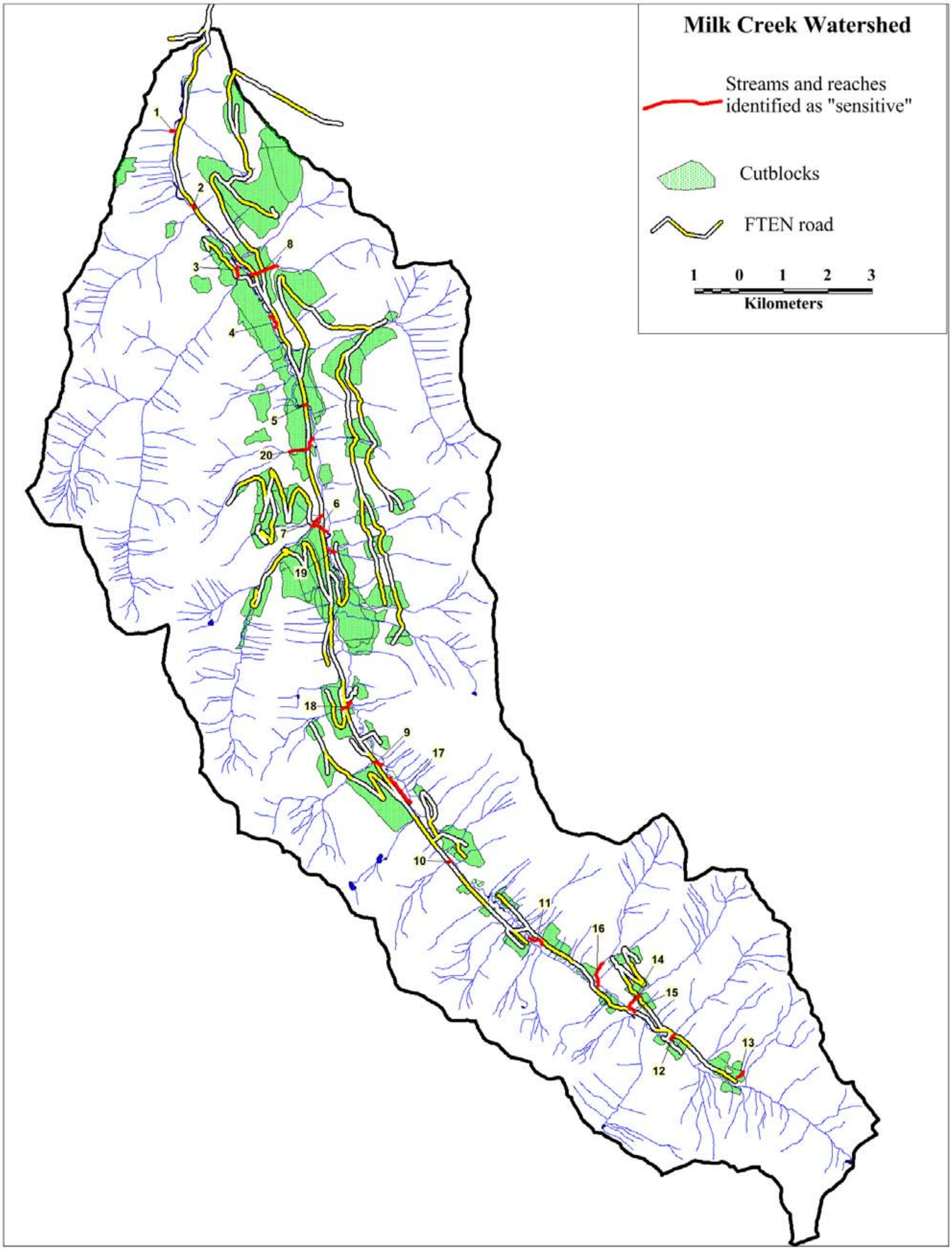

Figure 19. Location of streams or stream reaches identified as “sensitive” in the Milk watershed

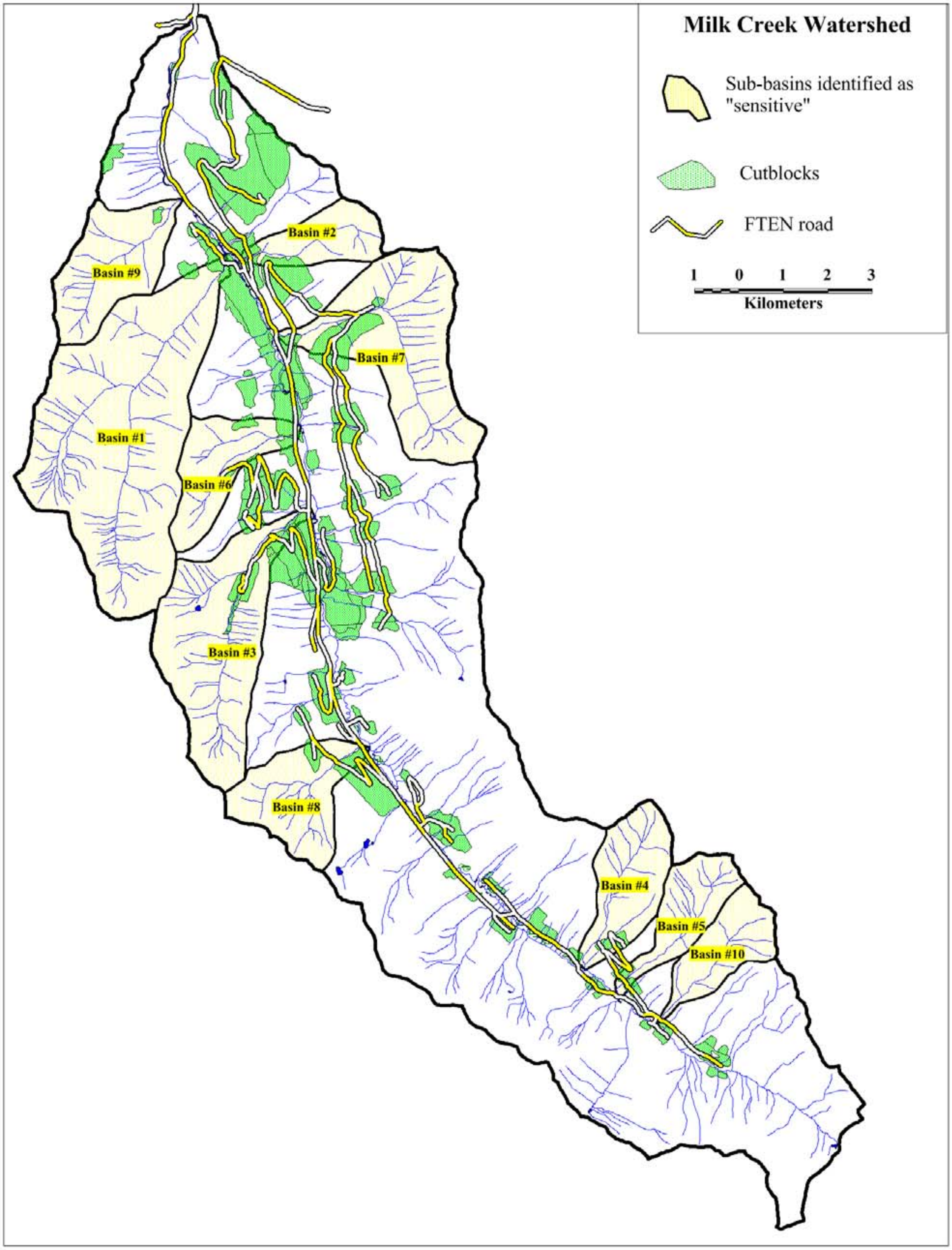

Figure 20. Location of sub-basins identified as “sensitive” in the Milk watershed

8 Upper Goat River Watershed (including Macleod)

8.1.1 Biophysical Characteristics of Upper Goat River Watershed

Table 36. Summary Information – Watershed Characteristics – Upper Goat River Watershed

Size (km^2)	Dominant BEC Zones	Dominant NDT	Elevation Range (m)	Stream Density (km/km^2)	% of watershed that is in "low elevation"[1]	Distribution of slope gradients within the watershed (% of watershed)			
						<10% slope	10 to 30% slope	30 to 60% slope	>60% slope
345	ESSFwk1 AT	NDT2 NDT1	836-2521 (1685)	2.8	7.5	4	18	54	24

[1]"low elevation" is defined as the part of the watershed that is less than 300 metres in elevation above the elevation of the watershed outlet. The greater the % of the watershed in "low elevation", the greater will likely be the effect of forest harvesting on increased peak flows due to the theoretical concept of "synchronization"

Table 37. Summary Information – Watershed Characteristics – Macleod Creek Watershed

Size (km^2)	Dominant BEC Zones	Dominant NDT	Elevation Range (m)	Stream Density (km/km^2)	% of watershed that is in "low elevation"[1]	Distribution of slope gradients within the watershed (% of watershed)			
						<10% slope	10 to 30% slope	30 to 60% slope	>60% slope
80.45	ESSFwk1 AT	NDT2 NDT1	1035-2477 (1442)	2.9	16.2	5	16	47	32

Table 38. Rating of "Sensitivity" of mainstem of the lower reaches of Upper Goat River to Increased Peak Flows

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type =B4 Score =2	1.05	1.1	1.05	1.1	0.9	1.05	Score = 2.52 Rating = **Moderate**

[1]Sensitivity of stream channel refers to the lower reaches of the watershed in question. Rating is on a scale of 1 to 5 where 1 = Very low sensitivity and 5 = very high sensitivity, according to Rosgen 1996 and 2006.
[2]Steeper topography is more sensitive (see section 4.3 for scoring details)
[3]Low stream density and lots of lakes and wetlands is less sensitive (see section 4.3 for scoring details)
[4]Deep soils with fractured bedrock is less sensitive than shallow soils with unfractured bedrock (see section 4.3 for details)
[5]Dry climates less sensitive than wetter climates with lots of snow and rain-on-snow (see section 4.3)
[6]Frequent disturbance type less sensitive than infrequent type (see section 4.3 for scoring details)

Table 39. Rating of sensitivity of mainstem of the lower reaches of Macleod Creek to Increased Peak Flows (in the vicinity of the proposed WHA)

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows (1= Very Low, 5 = Very High)
Type = Stable C4 Score =4	1.05	1.05	1.0	1.1	0.95	1.05	Score = 4.8 Rating = **Very High**

Table 40. Rating of typical “Sensitive” Sub-basins to Increased Peak Flow – Upper Goat Watershed

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type =A4 or G4 Score =5	1.1	1.1	1.05	1.1	0.9	1.05	Score = 6.6 Rating = **Extreme**

8.1.2 Description of Land Disturbance History in the Upper Goat River Watershed

Table 41. Forest harvesting and sediment source hazards – Upper Goat River Watershed

Total area Disturbed in 2007 (% of watershed)	Current ECA (% of watershed)	# of x-ings	#of fish bearing X-ings	#of non-fish bearing X-ings	density of x-ings (#/km^2)	Density of fish bearing X-ings (#/km^2)	Density of non-fish bearing X-ings (#/km^2)
0	0	0	0	0	0	0	0

[1]Note: The information on stream crossings was provided by MoE and was generated by a GIS model, not fieldwork.

Table 42. Upper Goat River watershed – Extent of Riparian Harvest by Reach

Reach Number	Reach Length (m)	Ave reach gradient (%)	Rosgen Stream Type	Inherent sensitivity to increased peak flows	% riparian logged	Apparent stability
All reaches	There is no riparian logging along any of the stream reaches in the Upper Goat watershed					

Table 43. Identified sensitive stream reaches (or stream sections) in the Upper Goat River watershed.

Reach ID (Refer toFigure 27)	**Description**
1	Sensitive stream reach
2	Sensitive off-channel habitat
3	Sensitive type, likely BT
4	Sensitive channel reach
5	Sensitive channel reach
6	Sensitive channel reach
7	Alluvial fan
8	Sensitive back channel habitat
9	Likely BT habitat
10	Sensitive channel type, BT use likely
11	Sensitive type, BT use likely
12	Sensitive channel type
13	Likely BT habitat, sensitive type
14	BT identified, sensitive channel type
15	Likely BT habitat
16	sensitive channel type,
17	sensitive stream type - C4 with BT habitat
18	alluvial fan that flows into BT habitat
19	Alluvial fan that flows into BT habitat

Table 44. Identified sensitive small sub-basins in the Upper Goat River Watershed

ID (Refer to Figure 28)	**Description**
Basin #1	BT in shed - sensitive channel
Basin #2	Possible BT use, sensitive reach type
Basin #3	Sensitive stream type, possible BT use
Basin #4	BT use likely - sensitive stream type
Basin #5	BT use likely - sensitive stream type
Basin #6	Likely BT use, sensitive channel type
Basin #7	Likely BT use
Basin #8	Possible BT use, sensitive channel type
Basin #9	Colluvial fan that flows into BT habitat
McCloud Sub-Basin (see Figure 29)	Relatively sensitive C4 stream type with very high value fisheries (Table 39)

8.1.3 Information that will support the decision to identify the Upper Goat River watershed as a "Fisheries Sensitive Watershed".

<u>What makes this watershed "fisheries sensitive"?</u>

1. Fisheries values in the Upper Goat River watershed are very high as the presence of bull trout, bull trout redds and Chinook salmon have been identified throughout most of the watershed (Figure 21). Bull trout have been sampled in both the mainstem and tributary streams (Ray Pillipow, Pers com).
2. The maistems of the Upper Goat River and Macleod Creek are relatively stable stream types (Figure 23 and Figure 24). There are numerous natural sources of sediment and woody debris along both of these mainsteam channels. Given the amount of economically operable landbase in this watershed, these big river systems are unlikely to be de-stabilized by increased peak flows as a result of current "best management" forest harvesting practices.
3. Much like the Framstead and Milk River watershed, the potential problems for the Upper Goat River and Macleod Creek watersheds are not associated with the potential "quantity" of disturbance and its impacts on peak flows in the mainstem, but rather the quality of operations and their specific locations relative to sensitive stream reaches (e.g. roads or cutblocks on fans). Although the quantity of logging (i.e. ECA), and its impacts on peakflows, will most likely not be an issue for the maistems of the Upper Goat and Macleod Rivers, it could be a potential issues in the smaller tributary watersheds.
4. Do date, there has been no forest harvesting activity in the Upper Goat River watershed, however there are some informal plans by Carrier Lumber to do so in the near future. Although increases in peak flows in the mainstem channels are very unlikely to occur., there are numerous sensitive sub-basins and tributary streams that are highly sensitive and could be impacted by inadequately managed stream crossings and/or excessive rates of cut in the tributary sub-basins (i.e. ECA) (Table 40, Figure 25 and Figure 26).
5. Thus, in summary, the high sensitivity of the Upper Goat River watershed is very similar to what was identified for the Framstead and Milk River watersheds, and is a result of the very high sensitivity of many of the smaller sub-basins and the impact that forest harvesting activities (both stream crossings and ECA) could have on these small tributary streams. These small streams are much more physically vulnerable to disturbances than are the mainstem stream reaches. If these small streams are significantly disturbed, through increases in peak flows and sediment supply, the stream channel may become destabilized and accelerated bank erosion could result. Such accelerated bank erosion could cause not only reduced habitat quality in the tributary stream itself, but an increase in sediment supply to the mainstem reach immediately below the disturbance. Since the bull trout appear to use most of the mainstem of the Upper Goat and Macleod rivers, the increased input of fine and coarse sediment, delivered from a disturbed tributary stream, could potentially cause habitat degradation. Consequently, this watershed has both well documented high fisheries values and high sensitivity to watershed disturbances that could cause significant degradation of fish habitat.
6. The following section of this report (Section 8.1.4) provides a list of suggested management objectives that could be used to protect fish habitat in this watershed, if it was designated as "fisheries sensitive".

8.1.4 Suggested "Special Management Objectives" for the Upper Goat River watershed for the maintenance of Fish Habitat, under FSW legislation.

1. I have identified nineteen (19) individual small tributary streams in the Upper Goat River watershed that could be classed as particularly sensitive (Figure 27). The Macleod Creek watershed, on its own, has also been classified as sensitive to disturbance (Figure 29 and Table 37) These streams have been classified as such based on one or several of the following factors.
   a) The presence of bull trout has been identified in or near this stream
   b) The bottom reach of the stream flows through an alluvial or colluvial fan
   c) It is an off-channel floodplain habitat, which are very sensitive to disturbance
   d) It is a sensitive channel type that could potentially have bull trout

Table 43 provides a listing of each of these sensitive stream reaches (or sensitive sites) and provides a short description of why each of these sites is considered to be sensitive.

Any forest harvesting or forest management activities in proximity to these tributary streams should be done with great care and attention to minimize disturbance to the aquatic ecosystem. This includes insuring that an adequate supply of both long and short term inputs of large woody debris to the stream and that adequate shade is provided. All stream crossings that cross these sensitive streams should be built to ensure that: 1) fish passage is maintained and 2) erosion and sediment delivery to the stream network is prevented. In order to achieve these objectives, the following recommendations are provided:

i. A minimum of 90% of the forest stand located within 15m of the edge of the stream channel should be retained. This recommendation is based on the results of the Prince George Small Streams research project (http://www.for.gov.bc.ca/hre/ffip/PGSSP.htm)

ii. Maintain the FREP WQEE score for all stream crossings over sensitive streams at or below the following thresholds:

   a. 0.2 for fish streams less than 1.5 m in width

   b. 1.0 for fish streams less than 5 m in width

   c. 5.0 for fish streams less than 20 m in width

   d. 20 for fish streams equal to or greater than 20 m in width

   The details of the FREP WQEE procedure can be downloaded from the following site (http://www.for.gov.bc.ca/hfp/frep/site_files/indicators/Indicators-WaterQuality-Protocol-2008.pdf)

iii. Use open-bottomed structures when crossing any fish stream that is 1 m in width or greater and has 200 m or more of useable fish habitat upstream of the crossing.

2. In addition to the identification of the 19 sensitive sites, I have also identified 9 particularly sensitive “sub-basins” in the Upper Goat River watershed (Figure 28 and Figure 29). These sub-basins have been identified as sensitive for one or several of the following factors

   a) Bull trout and/or Chinook salmon have been identified in these watersheds or just downstream from the mouth of these watersheds
   b) The lower reaches of the mainstem stream in these watersheds appears to be sensitive to increased peak flows.
   c) The sub-basins are large enough to be reasonably managed at the watershed level.

Table 44 provides a listing of each of the sensitive sub-basins identified in Figure 28 and Figure 29 and provides a short description of why each of these sub-basins is considered sensitive to land-use disturbances.

Given that these small basins have a sensitivity rating of Very High, or even Extreme (Table 39 and Table 40) and it is assumed that a Moderate level of risk to fish and their habitat is acceptable, the ECA for each sub-basin should be maintained below 25% (Table 9)

Since many of these watersheds have steep terrain, any land-management disturbances on these terrain types should be done with the utmost care, in order to prevent slope failures, whether that be cutblock or road related. Currently there is no forest harvesting or forestry roads anywhere in the Upper Goat River watershed.

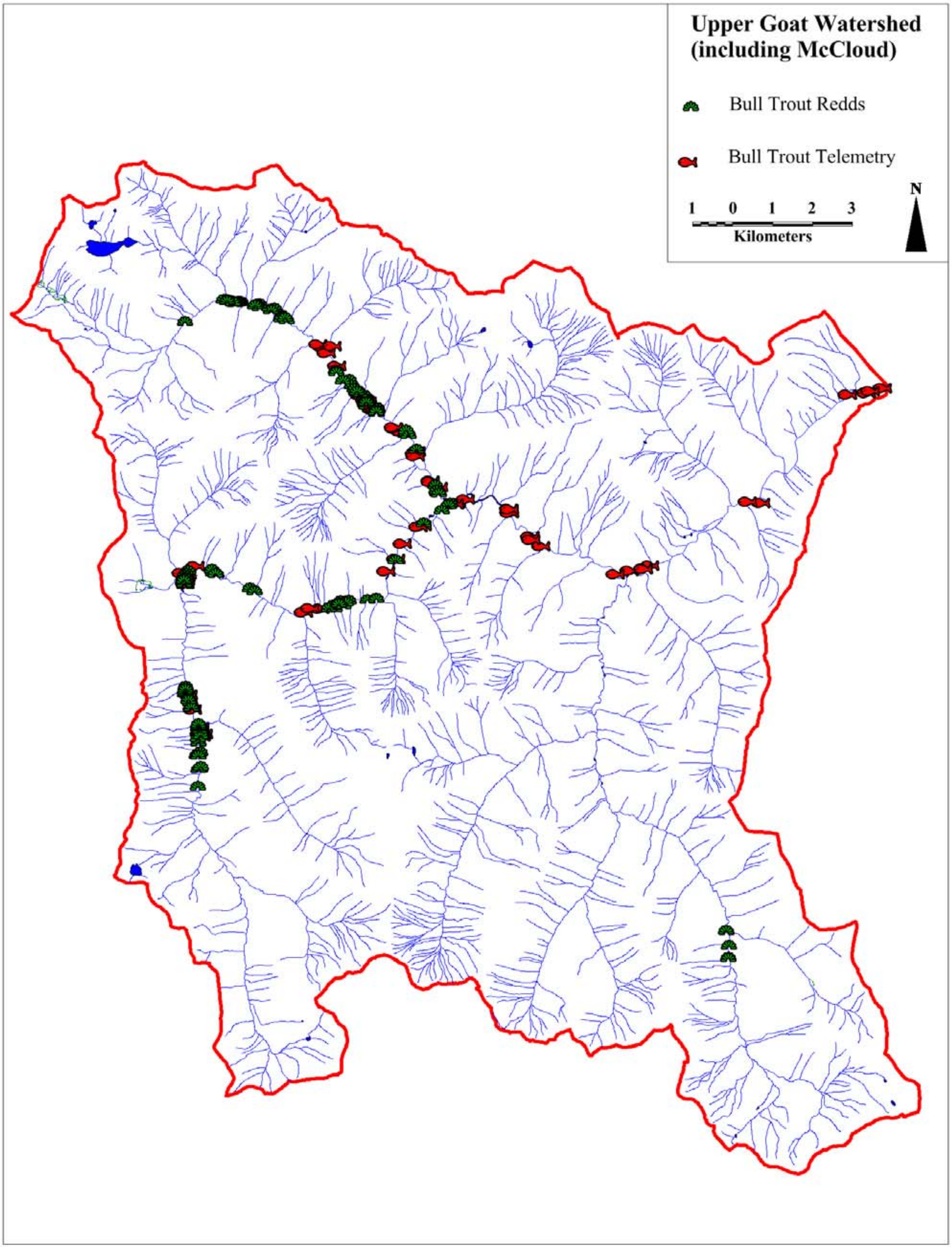

Figure 21. Location of sampling sites where bull trout and bull trout redds were identified in the Upper Goat River watershed.

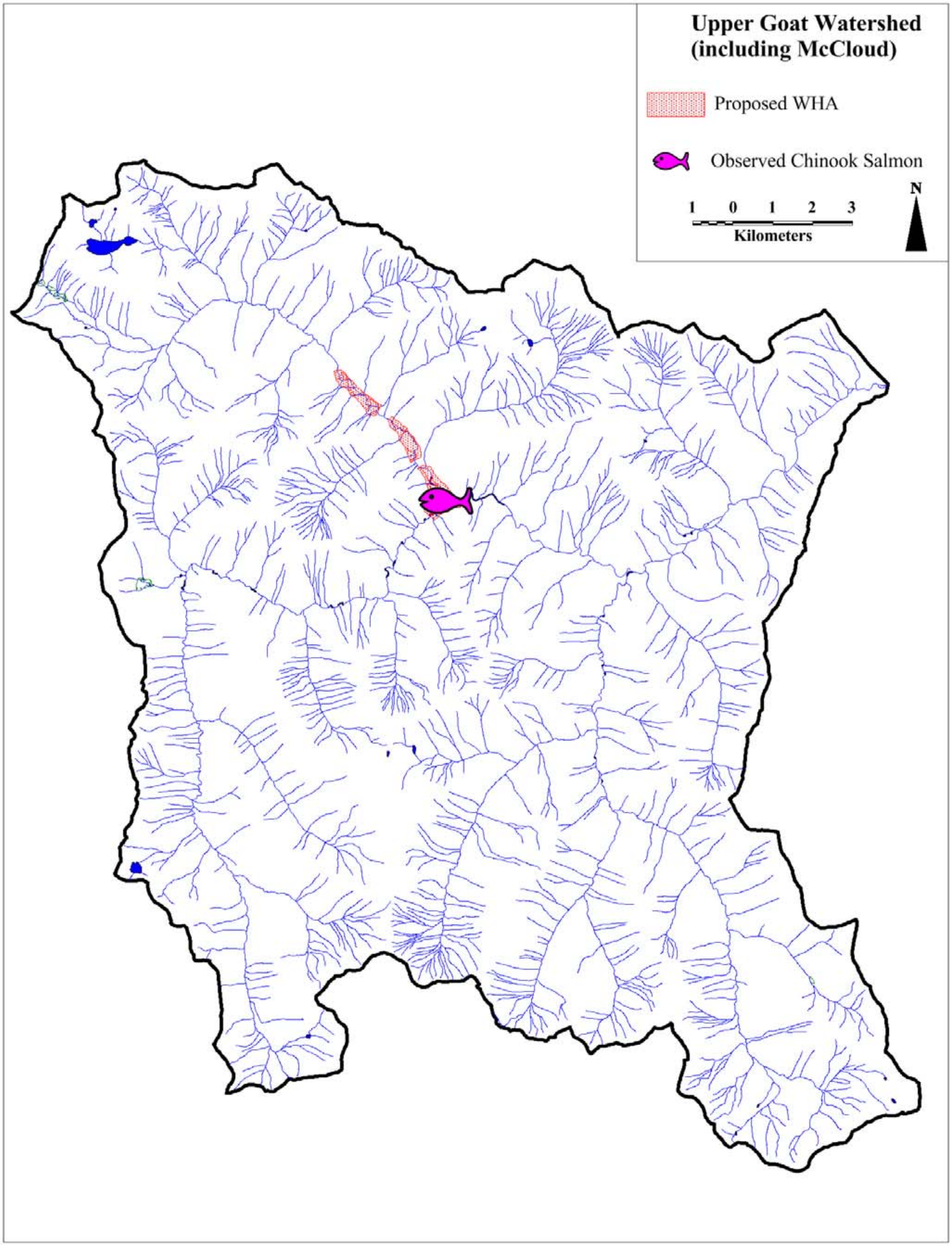

Figure 22. Location of proposed Wildlife Habitat Area (WHA) and observed Chinook salmon in the Upper Goat River watershed.

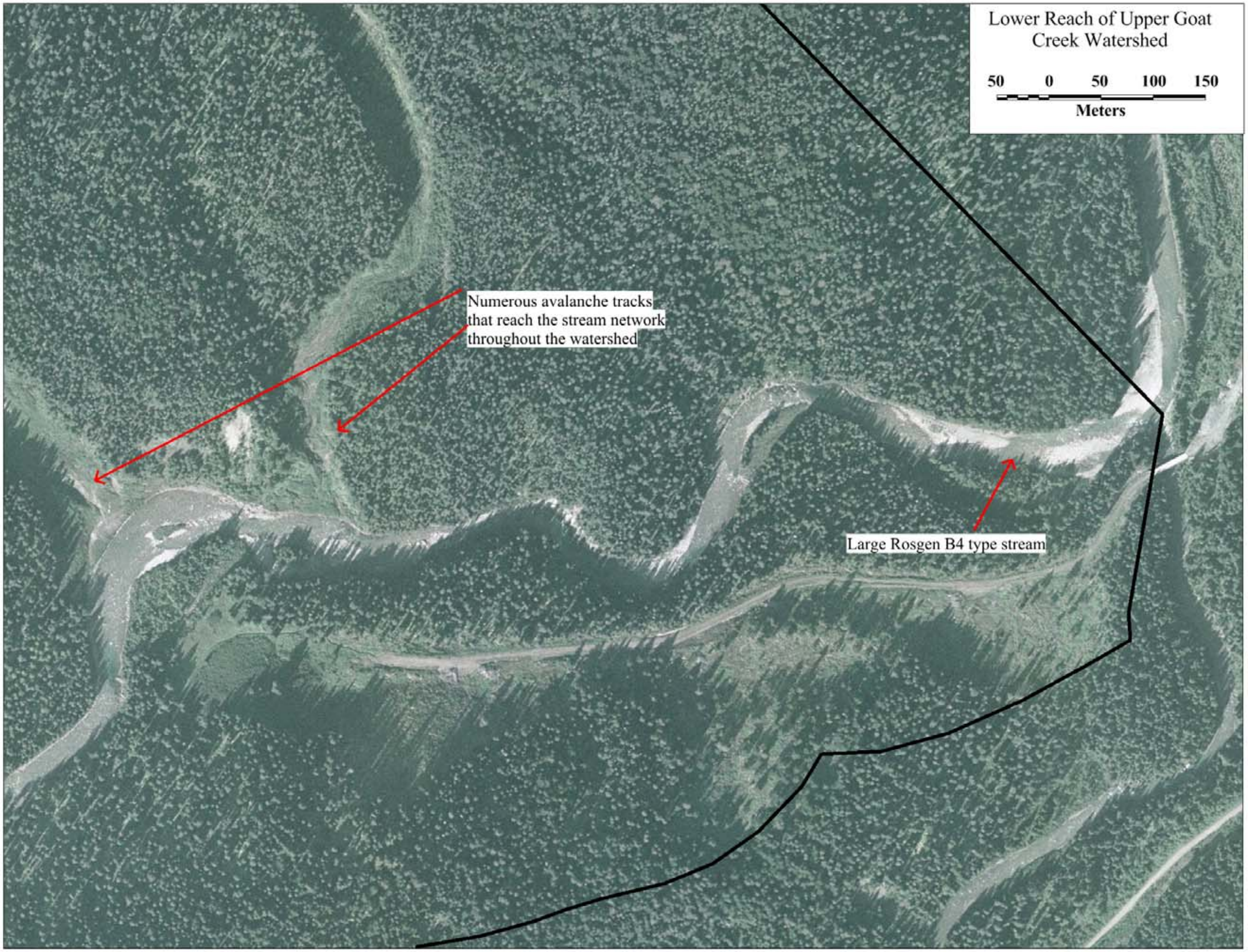

Figure 23. Lower reaches of the Upper Goat River. At this location, this is a stable B4 type stream.

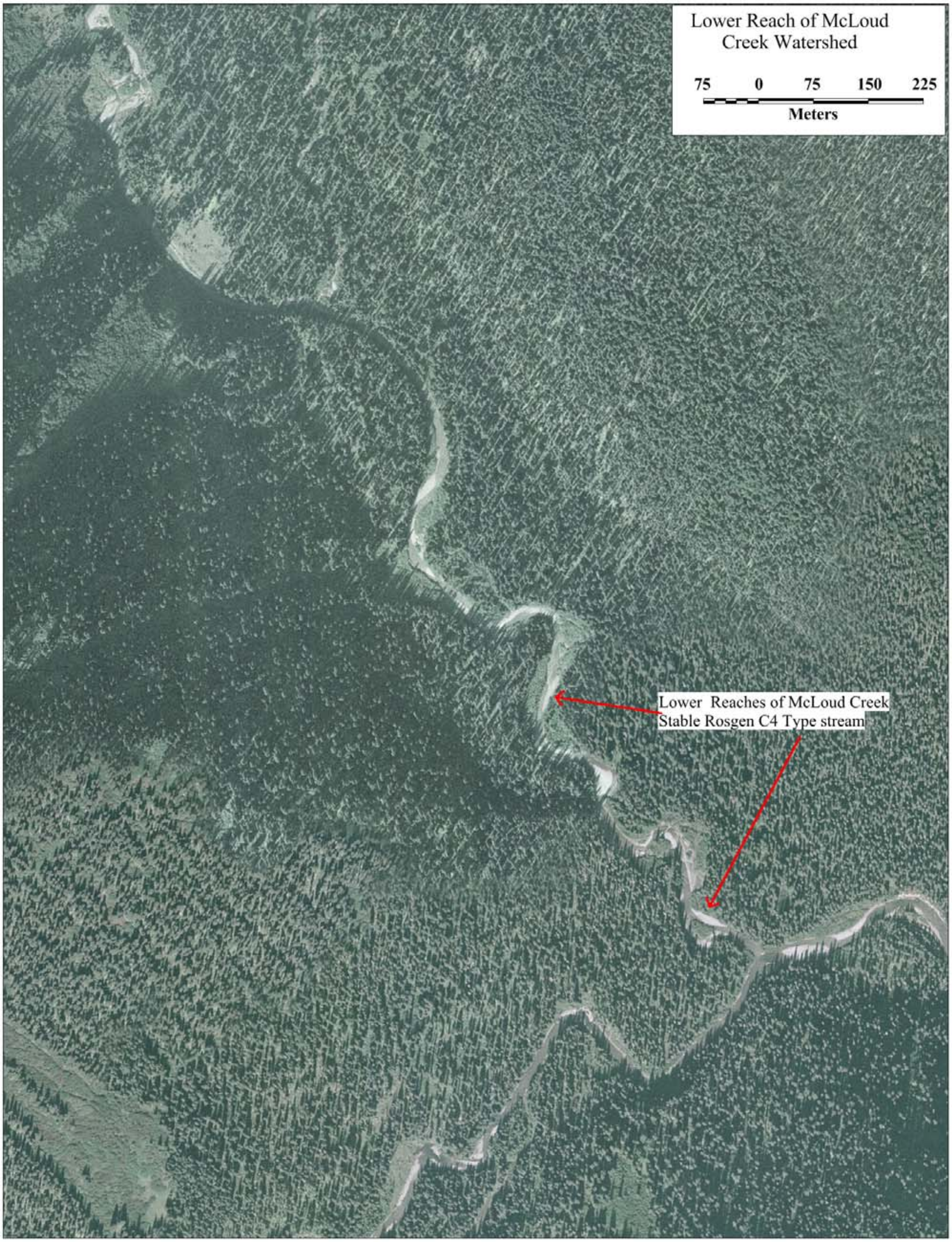

Figure 24. Lower reaches of Macleod Creek. At this location, this is a stable C4 type stream

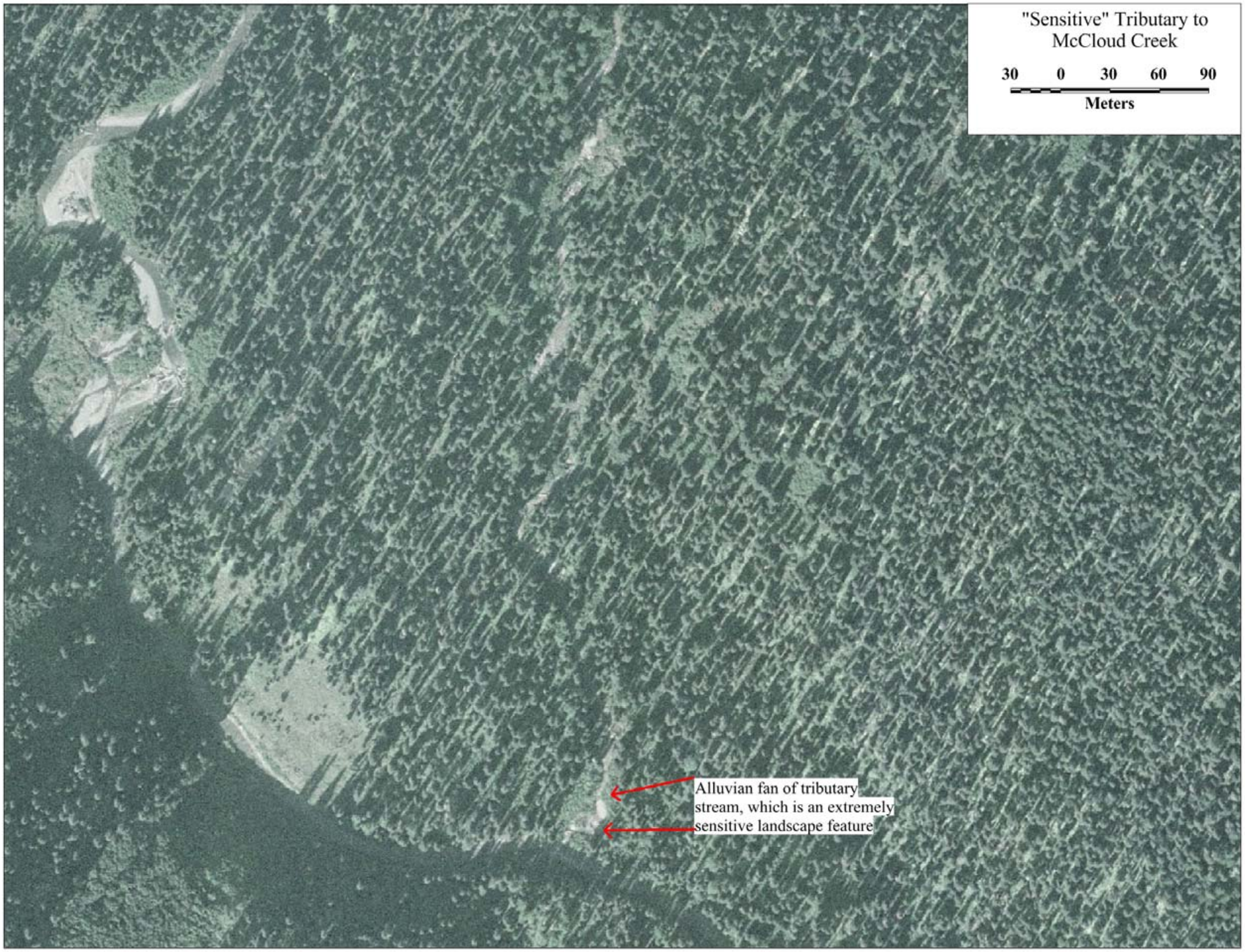

Figure 25. Typical "sensitive stream" in the Mcleod Creek watershed. These stream types can be easily disturbed by increased peak flows and sediment supply.

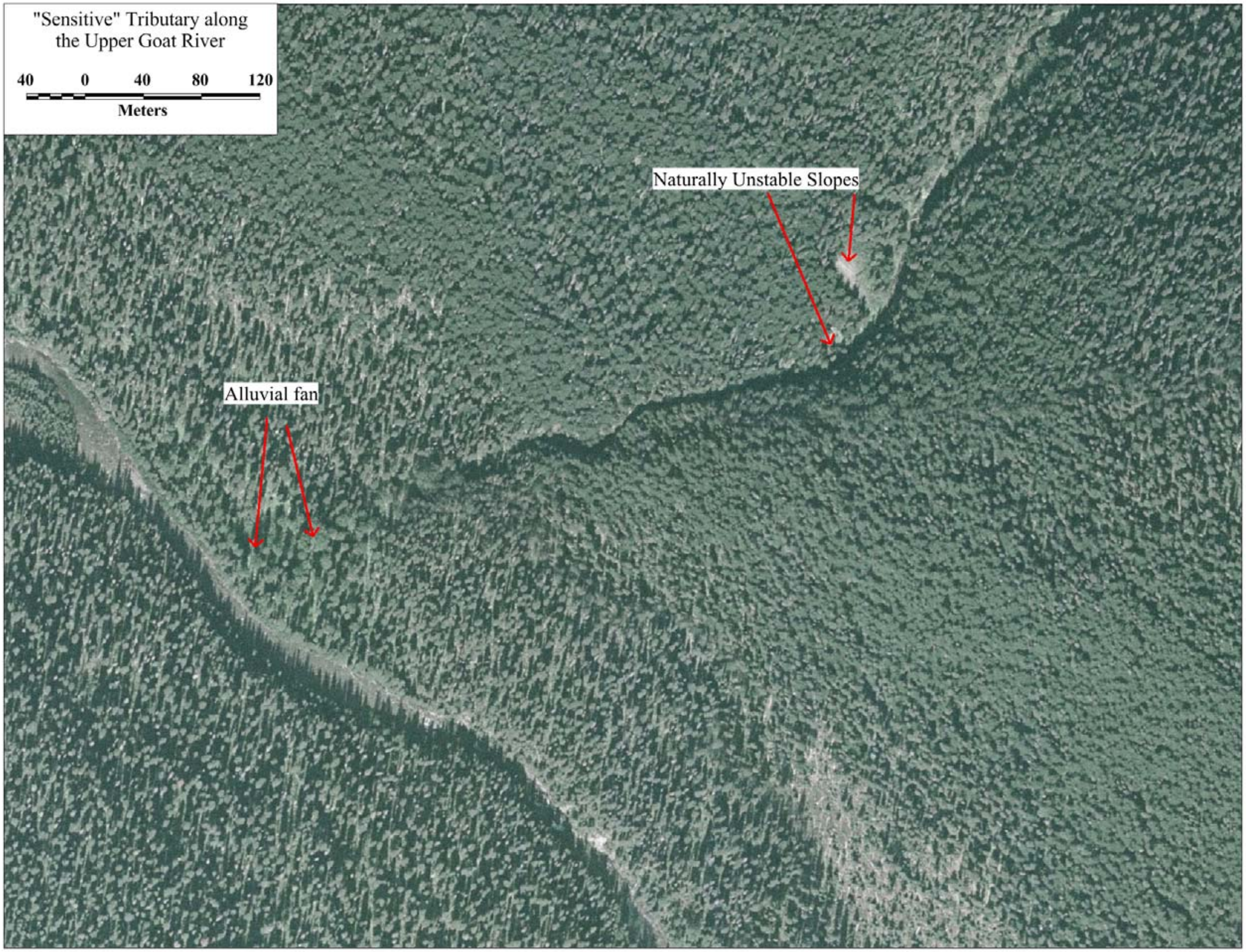

Figure 26. Typical "sensitive stream" along the upper Goat River. These stream types can be easily disturbed by increased peak flows and sediment supply.

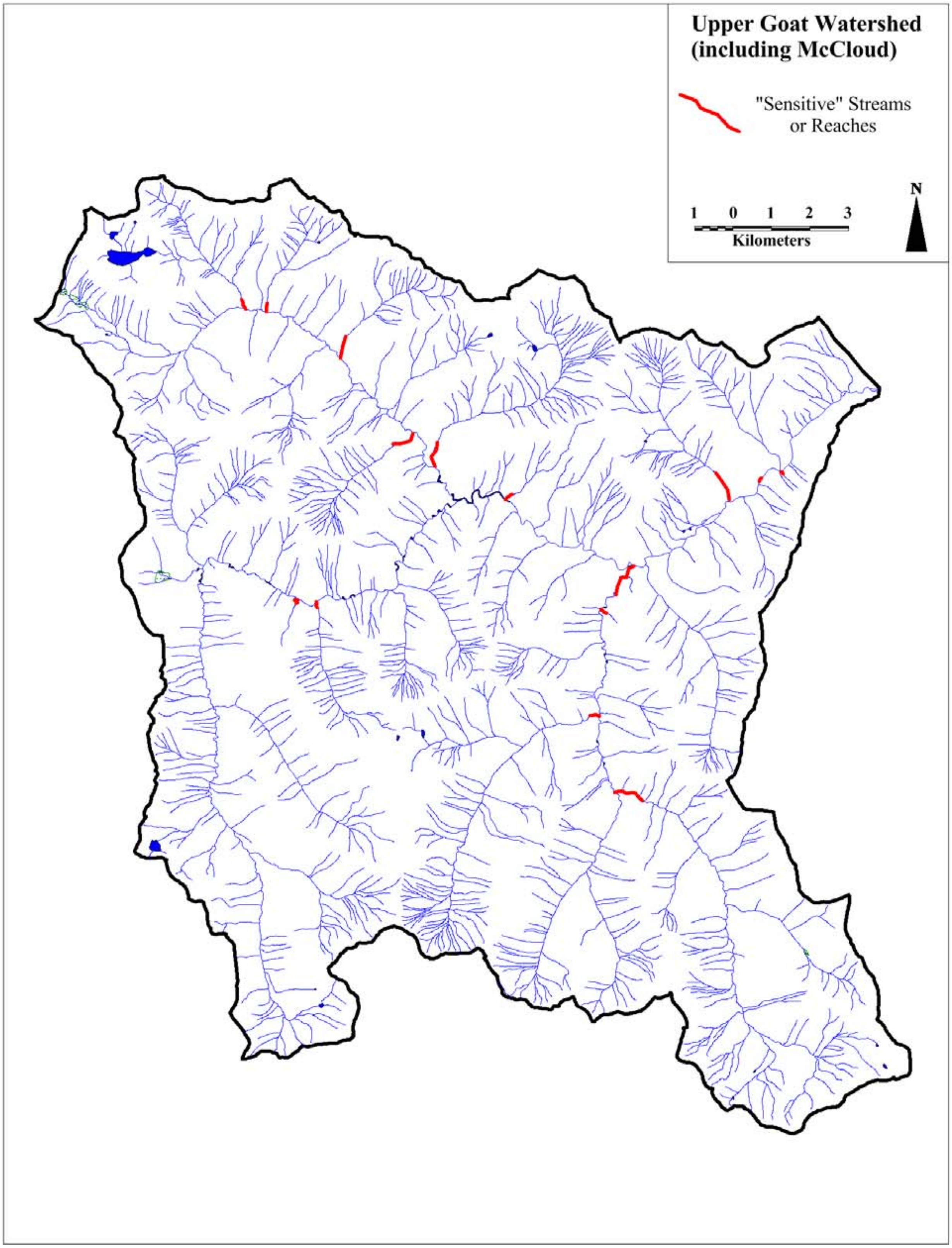

Figure 27. Location of streams or stream reaches identified as “sensitive” in the Upper Goat River watershed

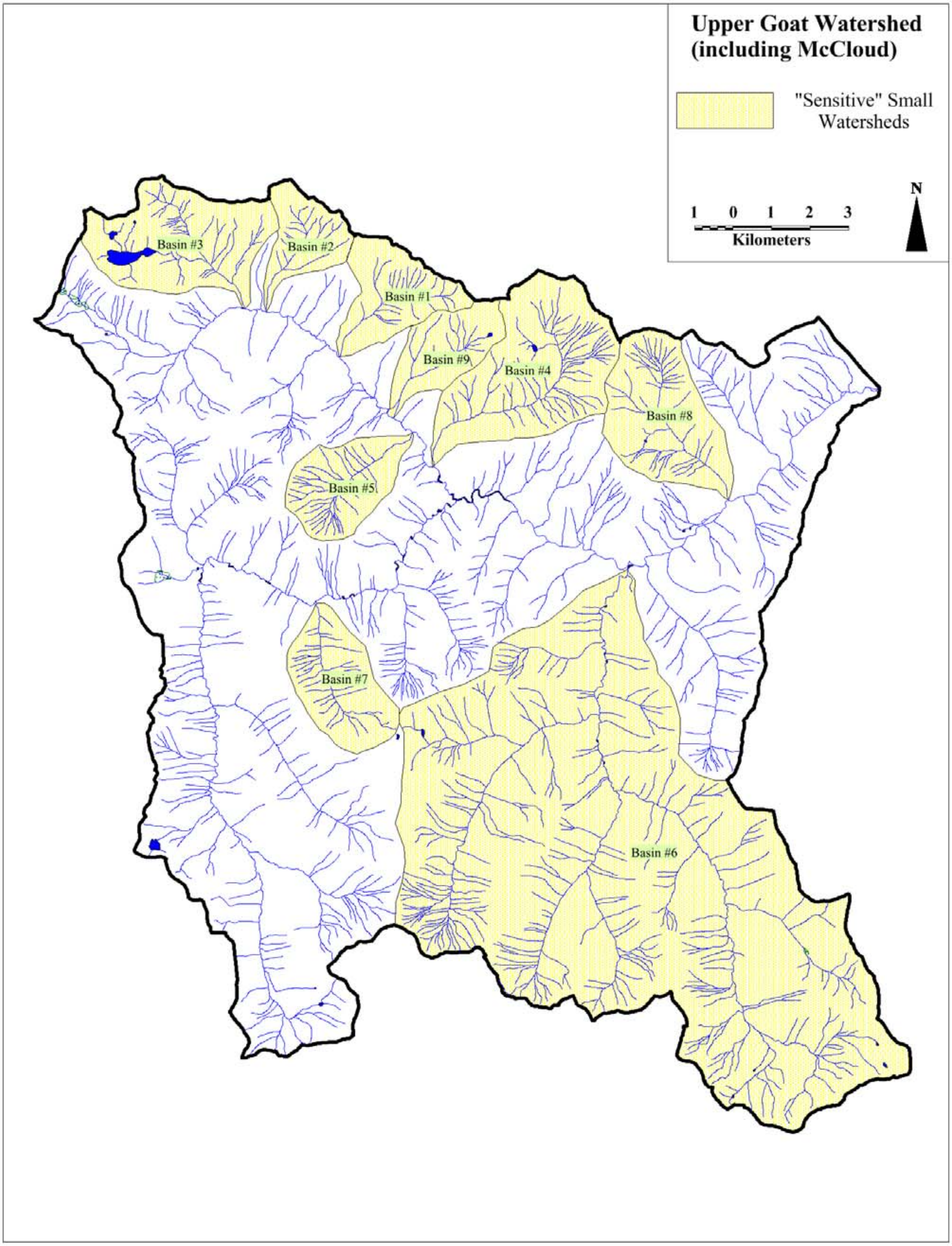

Figure 28. Location of sub-basins identified as "sensitive" in the Upper Goat Creek watershed

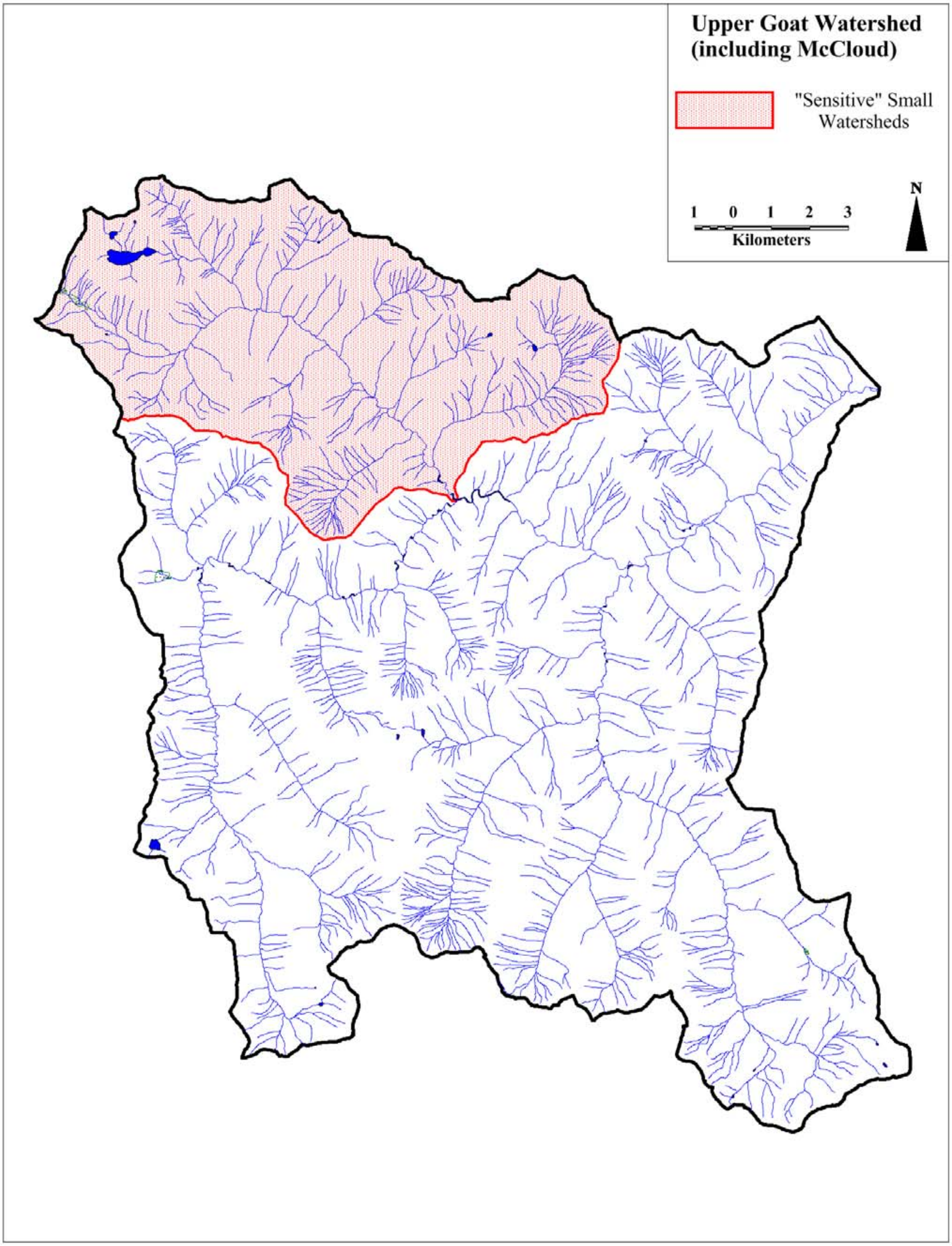

Figure 29. Location of the Mcleod sub-basin identified as “sensitive” in the Upper Goat Creek watershed.

9 Chehischic Creek Watershed

9.1.1 Biophysical Characteristics of Chehischic Creek Watershed

Table 45. Summary Information – Watershed Characteristics – Chehischic Creek Watershed

Size (km^2)	Dominant BEC Zones	Domin-ant NDT	Elevation Range (m)	Stream Density (km/km^2)	% of watershed that is in "low elevation"[1]	Distribution of slope gradients within the watershed (% of watershed)			
						<10% slope	10 to 30% slope	30 to 60% slope	>60% slope
191.1	SBdw3	NDT3	676-1141 (466)	2.91	97	87	12.8	0.2	0

[1]"low elevation" is defined as the part of the watershed that is less than 300 metres in elevation above the elevation of the watershed outlet. The greater the % of the watershed in "low elevation", the greater will likely be the effect of forest harvesting on increased peak flows due to the theoretical concept of "synchronization"

Table 46. Rating of "Sensitivity" of Watershed to Increased Peak Flow – Chehischic Creek

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type =unstable C4 Score =5	0.9	1.0	1.0	1.1	1.10	1.0	Score =5.4 Rating =**Very High**

[1]Sensitivity of stream channel refers to the lower reaches of the watershed in question. Rating is on a scale of 1 to 5 where 1 = Very low sensitivity and 5 = very high sensitivity, according to Rosgen 1996 and 2006.
[2]Steeper topography is more sensitive (see section 4.3 for scoring details)
[3]Low stream density and lots of lakes and wetlands is less sensitive (see section 4.3 for scoring details)
[4]Deep soils with fractured bedrock is less sensitive than shallow soils with unfractured bedrock (see section 4.3 for details)
[5]Dry climates less sensitive than wetter climates with lots of snow and rain-on-snow (see section 4.3)
[6]Frequent disturbance type less sensitive than infrequent type (see section 4.3 for scoring details)

Table 47. Rating of "Sensitivity" of Watershed to Increased Peak Flow – North Basin

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type = Stable E4 Score =3	0.9	0.9	1.0	1.1	1.1	1.0	Score =2.9 Rating =**Mod**

Table 48. Rating of "Sensitivity" of Watershed to Increased Peak Flow – East Basin

Rosgen Stream Channel type/Channel Sensitivity	Sensitivity score relative to topography[3]	Sensitivity score relative to lateral connectivity[4]	Sensitivity score relative to surficial and bedrock geology[4]	Sensitivity score relative to climate[5]	Sensitivity score relative to flow synchroniza-tion potential[6]	Sensitivity score relative to NDT type7	Overall watershed sensitivity to increased flows
Type = StableE4 Score =3	0.9	0.9	1.0	1.1	1.1	1.0	Score =2.9 Rating =**Mod**

9.1.2 Description of Land Disturbance History within Chehischic Creek Watershed

Table 49. Forest harvesting and sediment source hazards – Chehischic Creek Watershed (Figure 30)

Total area Disturbed in 2007 (% of watershed)	Current ECA[1] (% of watershed)	# of x-ings[2]	#of fish bearing X-ings	#of non-fish bearing X-ings	density of x-ings (#/km²)	Density of fish bearing X-ings (#/km²)	Density of non-fish bearing X-ings (#/km²)
63	40	369	308	61	1.93	1.61	0.32

[1]Note: This is the HEDA number provided in Beaudry 2008, which includes the accounting for pine beetle mortality
[2]Note: The information on stream crossings was provided by MoE and was generated by a GIS model, not fieldwork.

Table 50. Chehischic watershed – Equivalent Clearcut Area (ECA) by major sub-basin

Watershed ID	ECA (ha)	Watershed area (ha)	ECA (%)
Entire Chehischic (Figure 30)	7651	19270	39.7
North Sub-basin (Figure 31)	2490	7877	31.6
East Sub-basin (Figure 31)	2690	6995	38.5

Table 51. Chehischic watershed – Extent of Riparian Harvest by Reach (See Figure 32)

Reach Number	Reach Length (m)	Ave reach gradient (%)	Rosgen Stream Type	Inherent sensitivity to increased peak flows	% riparian logged	Apparent stability
1	1040	1	C4	High	65	Severe localised instability
2	1644	1.5	C4	High	100	Severe localised instability
3	1320	1.5	C5	High	88	Frequent localised instability
4	1493	1.5	C5	High	92	Frequent localised instability
5	1001	1.5	C4	High	52	Frequent localised instability
All other reaches	No significant riparian logging in any of the other mainstem reaches					

9.1.3 Information that will support the decision to identify the Chehischic Creek watershed as a "Fisheries Sensitive Watershed".

What makes this watershed "fisheries sensitive"?

1. This watershed supports a large variety of fish species, including rainbow trout, mountain whitefish and burbot. The fish sampling also suggests an extensive use of the lower reaches by Chinook salmon, i.e. Chinook salmon was sampled throughout the reaches below the confluence of the upper and east tributaries (Figure 32).
2. The sensitivity analysis suggests that the lower reaches of the Chehischic Creek watershed are very sensitive to increases in peak flows and increases in fine sediment (Table 46). These are also the reaches that support Chinook salmon. The riparian areas of these sensitive reaches have been extensively disturbed by past agricultural activities (Figure 33 and Figure 34) and are now unstable and failing (Triton 2008)
3. Given the amount and distribution of past disturbances in this watershed, there is a high probability that peakflows have been increased in the past and will be increased even further if additional logging occurs in this watershed (Figure 30).
4. Although it is difficult to determine if bank erosion and localized instability, observed by Triton (2008) along the lower reaches, have been exasperated by increased peak flows(Figure 36), the fact remains that this stream channel type and the past disturbances in the riparian area makes the lower reaches of this watershed highly sensitive to increased peak flows.
5. It is important to protect the Chinook salmon habitat in this watershed, located in the lower reaches, from further possible increases in peak flows, at least until the stream channel stability is restored as a result of the prescriptions suggested by Triton (2008).
6. Given the high ECA values in the Chehischic watershed it is very likely that extensive forest harvesting has caused increased peak flows, and given the very sensitive nature of the lower reaches, there is a high risk to Chinook salmon habitat.
7. The lower reaches of the east and north tributaries (Figure 31) are not nearly as sensitive as the lower reaches of the main stem (Table 47 and Table 48) and have not been disturbed by riparian logging and continued grazing. Consequently, these two sub-basin by themselves are not particularly sensitive. It is the lower five reaches of Chehischic Creek that are especially sensitive (Figure 31). Since this is the point where cumulative impacts from upstream disturbances will concentrate, it is important to impose special protection measures on the entire watershed in order to protect the Salmon habitat in the lower reaches (i.e. protection of the lower reaches by themselves will not be adequate).
8. The Chehischic Creek watershed is a good candidate for protection as a fisheries sensitive watershed, as it is still functional and supports a sensitive fisheries resource and yet is very sensitive due to the combination of inherent stream channel sensitivity and past land-management practices in the riparian areas of these sensitive reaches. Thus, in my opinion, is a good strategy to impose special protection measures in this watershed, before the stream channel deteriorates further resulting in probable loss of habitat for a variety of fish

species, especially Chinook salmon.

9.1.4 Suggested "Special Management Objectives" for the Chehischic Creek watershed for the maintenance of Fish Habitat, under FSW legislation.

1. Further forest harvesting and road building activities in this watershed should cease and the maximum threshold ECA should be set at 25% for the Chehischic Creek watershed as a whole (Figure 30). This recommendation is based on the Very High rating for watershed sensitivity (Table 46) and the assumption that a Moderate level of risk to fish habitat is acceptable (Table 9) The current ECA level for the entire watershed is 40%, well above the recommended threshold (Table 50). If the 25% ECA threshold is applied in conjunction with the riparian protection measures recommended by Triton (2008), this will help the natural recovery process of the lower reaches of Chehischic Creek and thus protect fisheries habitat, including Chinook habitat.

2. As per the recommendations provided in the Triton report (2008) strict grazing controls should be implemented to limit cattle access to the riparian zone and allow for natural regeneration to occur. Riparian planting in heavily impacted areas along with implementation of bioengineering techniques at specific locations will be the most efficient and cost-effective means of restoring the riparian zone and stabilizing the channel (Triton 2008).

3. S4 streams and S6 streams which are greater than 0.5 m in width and flow directly into fish bearing streams should be managed to retain both a short and long term supply of large woody debris to the stream system and enough shade should be retained to maintain stream temperatures within historical ranges. In order to achieve this objective it is recommended that at least 90% of the forest stand located within 15m of the edge of the stream channel be retained. This recommendation is based on the results of the Prince George Small Streams research project (http://www.for.gov.bc.ca/hre/ffip/PGSSP.htm)

4. Ensure that sediment production at "active" road crossings on fish streams is kept to a minimum. This objective can be achieved by maintaining the FREP WQEE score at or below the following thresholds:

    a. 0.2 for fish streams less than 1.5 m in width

    b. 1.0 for fish streams less than 5 m in width

    c. 5.0 for fish streams less than 20 m in width

    d. 20 for fish streams equal to or greater than 20 m in width

The details of the FREP WQEE procedure can be downloaded from the following site (http://www.for.gov.bc.ca/hfp/frep/site_files/indicators/Indicators-WaterQuality-Protocol-2008.pdf)

5. It is the stream channel type in the lower reaches and the fact that it flows through areas disturbed by agricultural activities and cattle grazing that makes this a "sensitive"

watershed. It is particularly sensitive to the possibility of increased peakflows in the lower reaches where further channel destabilization could occur, resulting in the possible loss of fisheries habitat. Consequently, the control of the rate of cut (or ECA thresholds) is the key management objective for the protection of this watershed.

6. For fish streams with the following characteristics, ensure fish passage is maintained by utilizing open bottom structures:

   a. Fish streams that are 1 m in width and greater

   b. Fish streams that have 200 m or more of usable fish habitat upstream of the crossing.

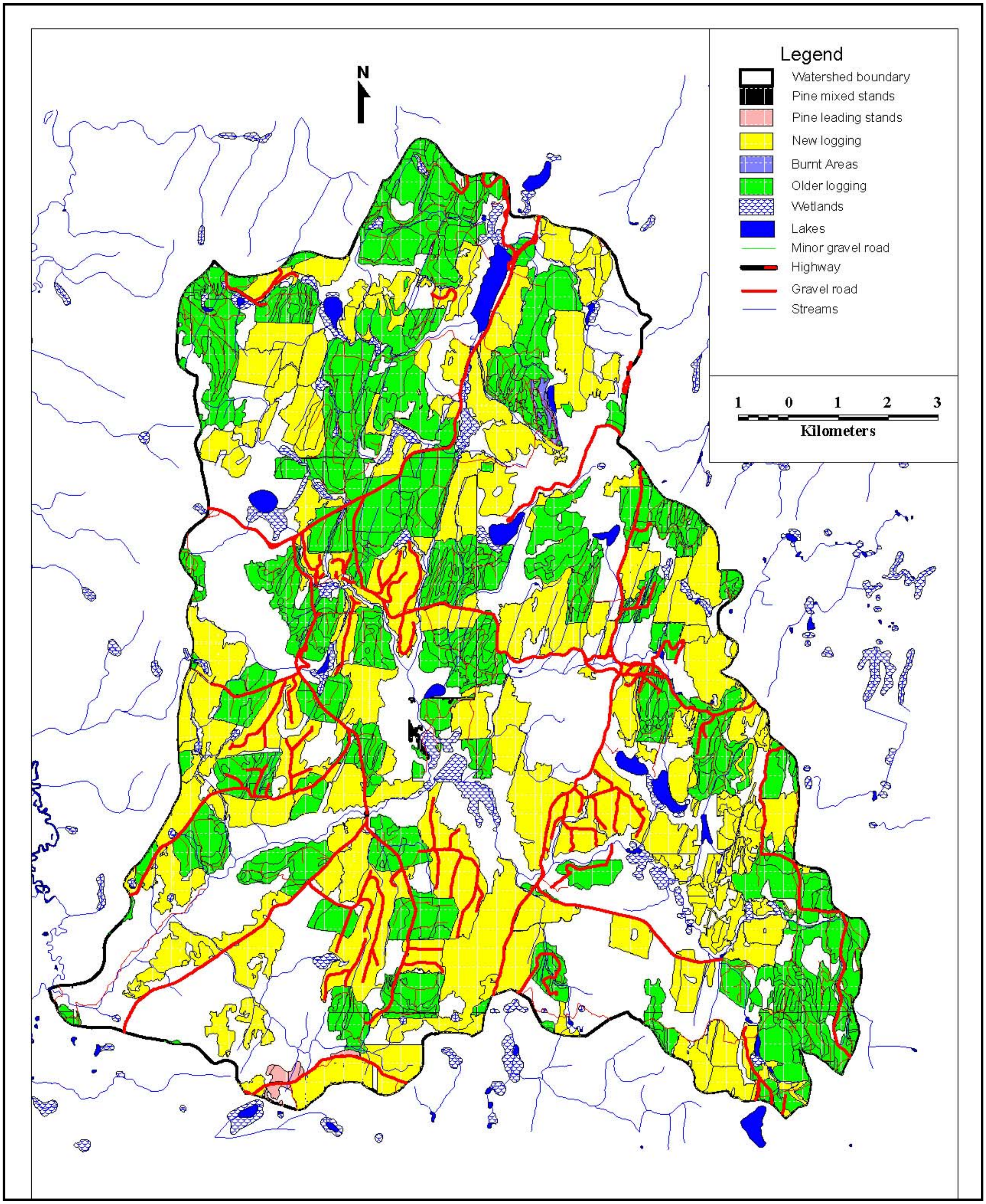

Figure 30. Distribution of disturbances in the Chehischic watershed (i.e. "entire Chehischic watershed).

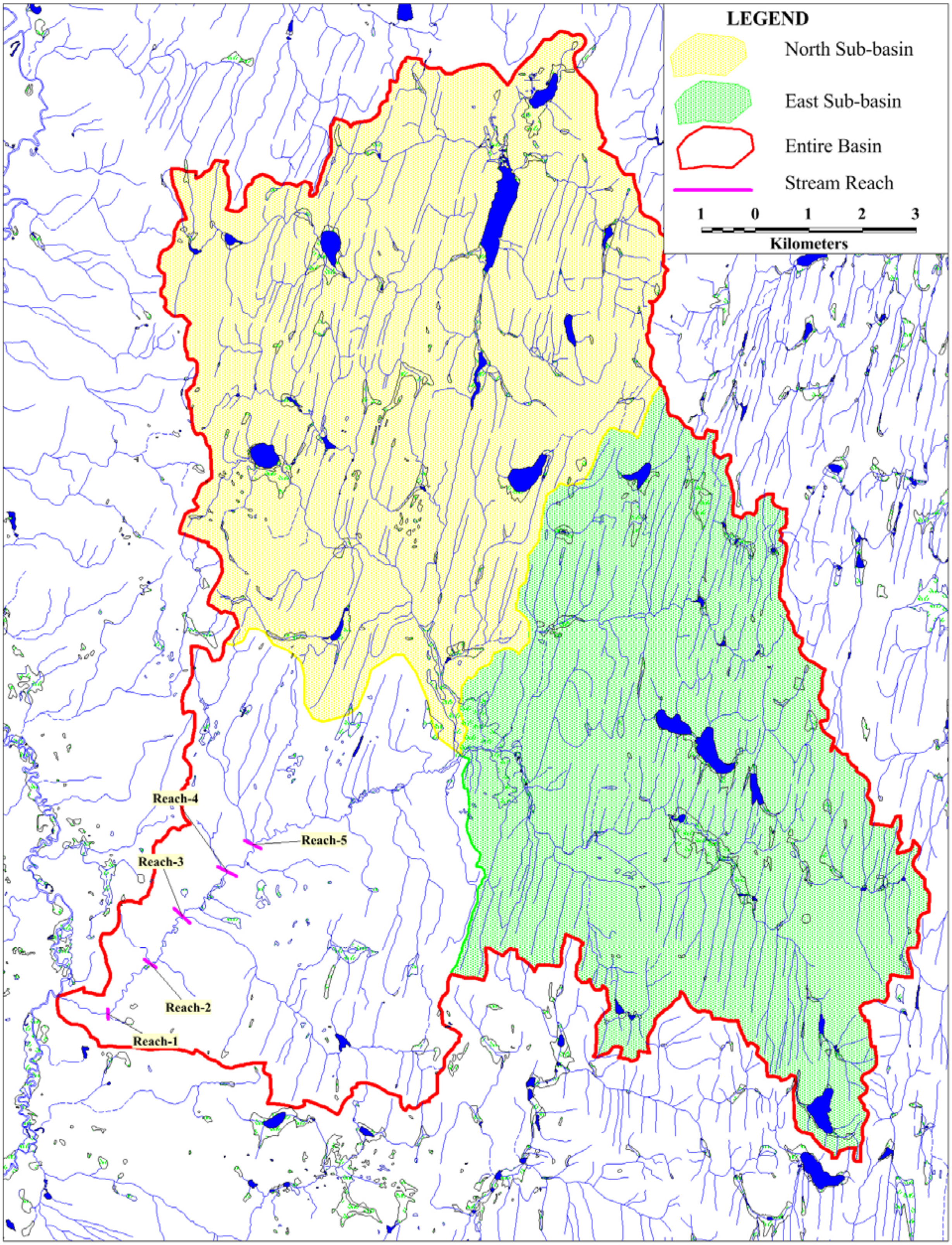

Figure 31. Sub-basins and lower stream reaches of the Chehischic watershed

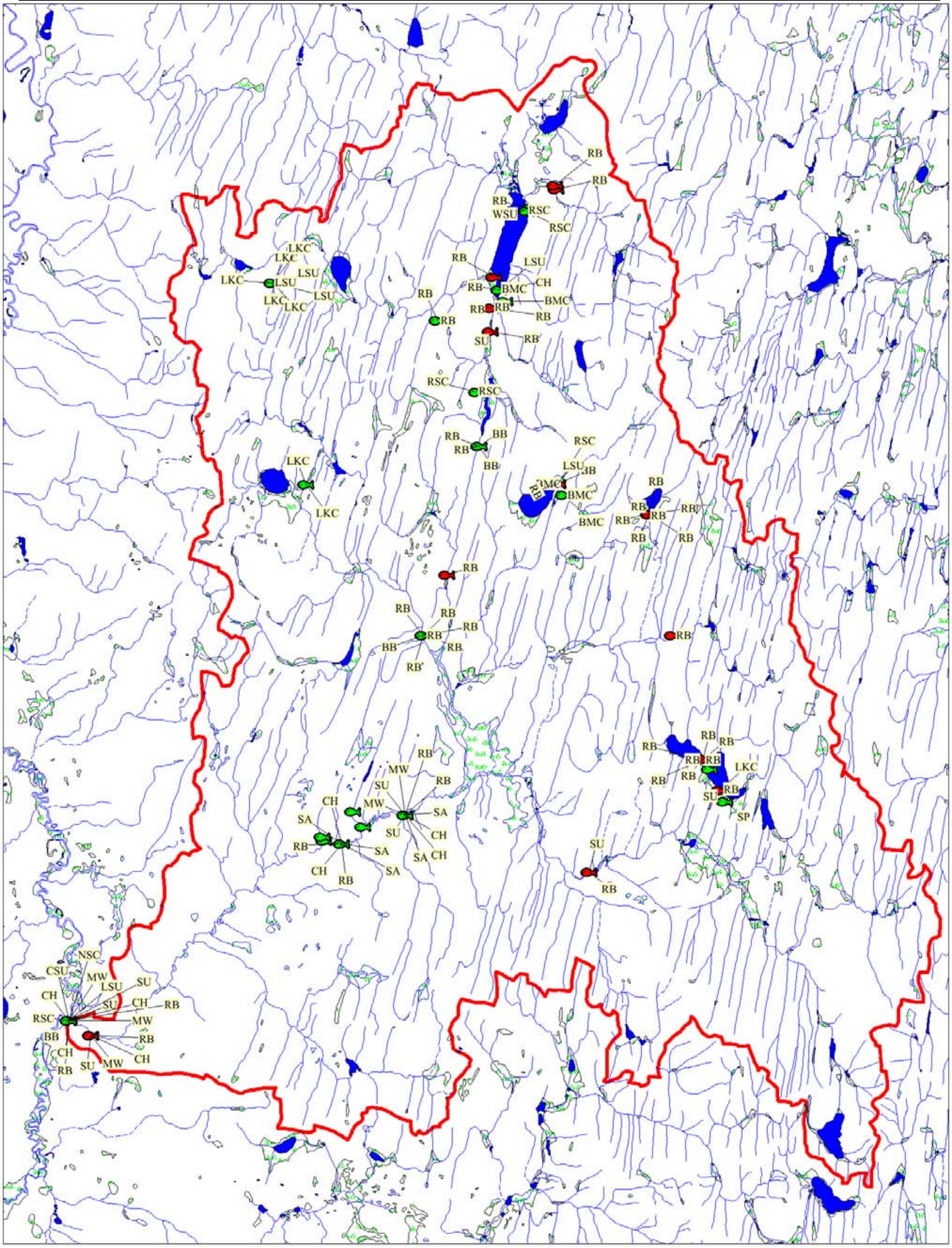

Figure 32. Location of different fish species sampled throughout the Chehischic Creek watershed.

Figure 33. Extensive agricultural disturbance along Reach 1 of Chehischic Creek, note that Chinook salmon have been sampled in this reach. .

Figure 34. Reach 2 of Chehischic Creek has also been extensively disturbed by agriculture and it too supports Chinook salmon.

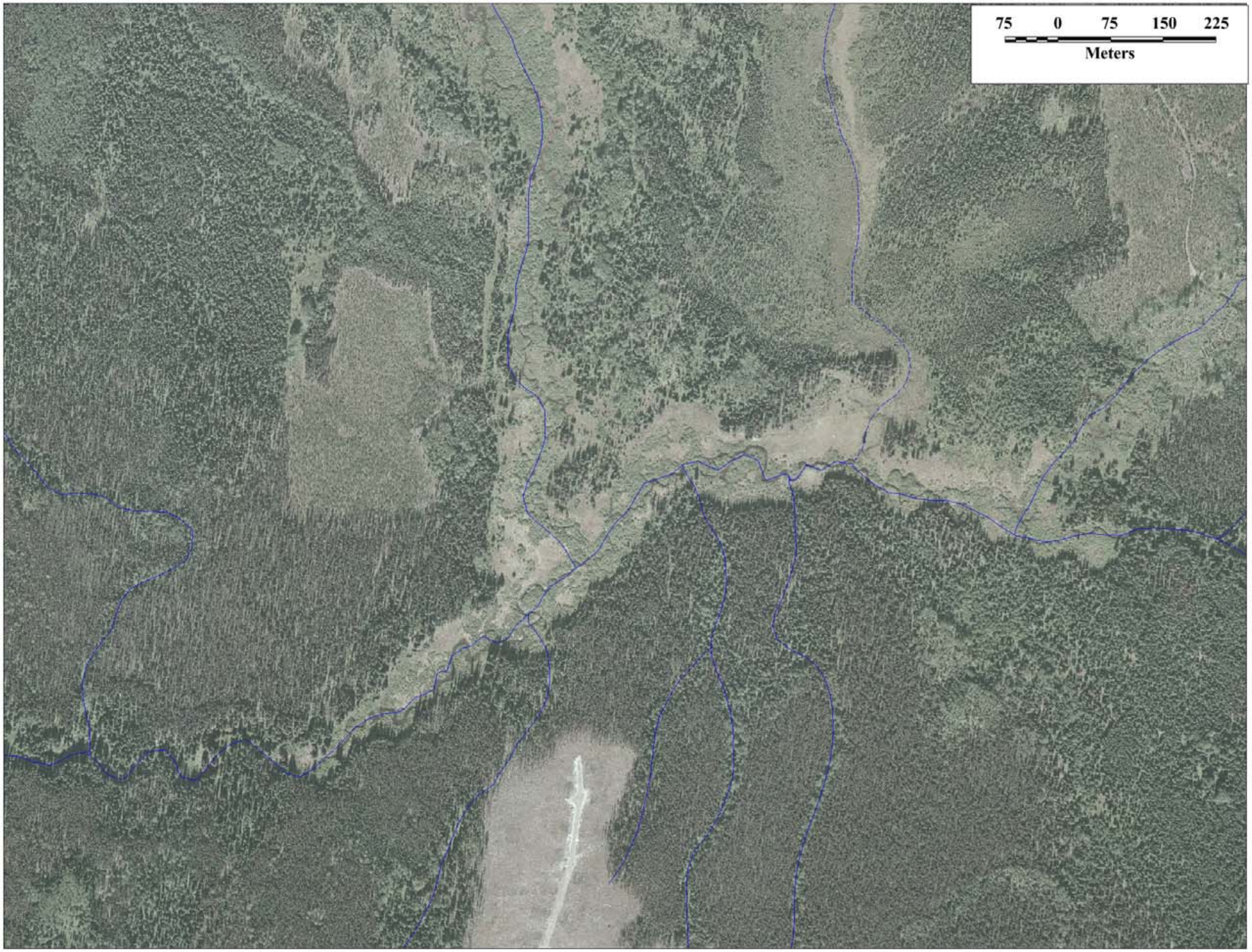

Figure 35. Junction of the tributaries that flow out of the North and East sub-basins. .

Figure 36. Photos extracted from Triton (2008) that clearly show the negative effects of riparian removal and continued grazing on stream channel instability in the lower reaches of Chehischic Creek. These reaches are used by Chinook salmon.

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