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COASTAL WATERSHED ASSESSMENT

Level 1



Mashiter Creek Community Watershed

January 1997

Ministry of Environment, Lands and Parks

Ministry of Forests

EXECUTIVE SUMMARY

The Coastal Watershed Assessment Procedure (CWAP) is an assessment of the cumulative impacts that past forestry development has had on the water resource and is used to guide the Forest Development Plan to minimize future impacts.

Although no development is currently proposed for Mashiter Creek community watershed, this assessment was requested to be completed by members of the Integrated Watershed Management Plan (IWMP) of the Stawamus River and Mashiter Creek.

Mashiter Creek community watershed is located approximately 13 km northeast of Squamish. The District of Squamish holds a WWKLA water licence which, in conjunction with the Stawamus River, supplies water to the community. The watershed encompasses an area of 25.74 km² and ranges in elevation from 300 to 2000 m.a.s.l. The lower portion of the watershed is underlain by Coast Plutonic Complex granitic rocks. The upper portion is dominated by volcanic flows and pyroclastic material derived from relatively recent eruptions of Mt. Garibaldi. The Mashiter Creek watershed has been extensively modified by glaciers which have left a variety of unconsolidated materials that are a major factor in determining terrain stability (Baumann, 1994).

The watershed was divided into five sub-basins, two of which are entirely inside Garibaldi Park and have no impacts from past forest development. One sub-basin has an extremely high equivalent clearcut area (ECA) and no logging will be allowed until the ECA levels fall below moderate levels. All three sub-basins, outside of Garibaldi Park, have high values for the surface erosion, mass wasting, riparian buffers and headwater hazard indices.

An intensive road deactivation program, completed in 1992, has addressed many of the concerns identified in this CWAP. However, a field survey completed as part of this CWAP, determined that improper drainage on some deactivated roads was causing surface erosion of road surfaces, undercutting of fill slopes and subsequent gully sidewall failure. In addition, large quantities of logging debris were observed in several gullies. It is recommended that ground inspections be completed in the spring of 1997 to assess:

- 1) the requirements for further cross ditches
- 2) need for repairs to the existing cross ditches
- 3) opportunity for gully cleaning programs
- 4) revegetation of active gully sidewalls

These inspections should include an analysis of the amount of sediment being introduced from past forest development compared to that being introduced from natural processes in Garibaldi Park. It is suggested that the IWMP secure funds through Forest Renewal BC to complete these assessments. These assessments and their recommendations will negate the requirement for a Channel Assessment Procedure to be completed at this time. Recommendations for further forest development are not made and it is suggested that another CWAP be completed prior to the approval of future development.

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1. INTRODUCTION

A complete description of the Coastal Watershed Assessment Procedure (CWAP) can be obtained from the *Coastal Watershed Assessment Procedure Guidebook* (Ministry of Forests and BC Environment, 1995). Much of this introduction is taken from this guidebook. The CWAP is a tool to help forest managers understand the type and extent of current water related problems that exist in a watershed and to recognize the possible hydrologic implications of proposed forestry related development in that watershed.

Section 32 of the Operational Planning Regulations, Forest Practices Code Act of BC, requires that a CWAP be completed for all community watersheds and for all watersheds with high value fisheries that are jointly requested by BC Environment and the Ministry of Forests. The results of the CWAP are to be submitted by forest licensees as part of the forest development plan. The forest development plan must be guided by the results of the CWAP to ensure that timber harvesting does not negatively affect watershed values.

The CWAP has three levels of analysis:

1. Level 1: A reconnaissance level analysis intended as a coarse filter to identify watersheds that may have impacts from cumulative effects of past forest harvesting or planned future forest harvesting.
2. Level 2: An overview stream channel assessment performed by someone with basic experience in hydrology and/or geomorphology (see *Channel Assessment Procedure Guidebook*).
3. Level 3: A very detailed analysis performed by a watershed specialist, involving mostly field work. The work is guided by the results of the Level 1 and Level 2 analyses.

Hydrological impacts, in a Level 1 CWAP, are assessed in five categories:

1. potential for changes to peak flows
2. potential for accelerated surface soil erosion
3. anticipated changes to riparian buffers
4. potential for landslides
5. potential for changes to headwater streams

Each of the impact categories is evaluated by measuring 2 to 4 indicators (total of 15). These indicators are summarised and a hazard index is produced for each impact category. Depending on the values of these hazard indices, a channel assessment (Level 2 CWAP) may be initiated. In many cases, it is advised that a Level 2 channel assessment be completed at the same time as a Level 1 CWAP.

2. STUDY AREA

2a. Background

Mashiter creek community watershed is located approximately 13 km northeast of Squamish (Figure 1). The District of Squamish holds a WWKLA water licence on Mashiter Creek which supplies drinking water to the city of Squamish. The water intake is at approximately 300 m.a.s.l on Mashiter Creek (Figure 2).

2b. Climate and Physiography

This area of southwestern British Columbia receives approximately 2200 mm of precipitation annually in the form of rain and snow of which 70 % falls between October and March. The area has a mean annual temperature of approximately 9°C. The Dry Maritime, Very Wet Maritime Coastal Western Hemlock, Moist Maritime Mountain Hemlock and Alpine Tundra biogeoclimatic subzones are represented in the watershed.

Mashiter Creek community watershed has an area of approximately 2600 ha and ranges in elevation from 300 to 2000 m.a.s.l. (Figure 2). The lower portion of the watershed is underlain by Coast Plutonic Complex granitic rocks. The upper portions of the watershed are dominated by volcanic flows and pyroclastic material derived from relatively recent eruptions of Mt. Garibaldi. The Mashiter Creek watershed has been extensively modified by glaciers which have left a variety of unconsolidated materials that are a major factor in determining terrain stability (Baumann, 1994).

The major terrain units from highest elevation to lowest include bedrock (volcanic flows), multi-layered pyroclastic blankets, colluvial and glacial till veneers and blankets, upper elevation glacial deposits (lateral moraines and glaciofluvial deposits) and lower valley glacial deposits (till blankets, glaciolacustrine and glaciofluvial deposits) (Baumann, 1994). Natural hazards in the watershed include debris flows, debris slides, rockfalls, rockslides, slumps, lake outburst floods and snow avalanches (Baumann, 1994).

2c. Land Use

Mashiter Creek community watershed consists of approximately equal proportions of operable forest, inoperable forest (Garibaldi Park) and non-forest. Garibaldi Park occupies the most upstream reaches of the watershed (Figure 2). Private land accounts for 35 ha (1.4%) of the Mashiter Creek community watershed.

At the present time, 88 % of the operable forest land is of age class 4 (61-80 years) or less. The remaining 12 % is age class 8 (141-250 years) or greater. Most of the past forestry development took place from 1950 to 1980 when the area was in Halray Logging Ltd.'s chart area. The area was chartered to the Ministry of Forest's Small Business Enterprise Program in the late 1980's. There is limited opportunity for near future development due to the age distribution of timber.

3. Materials and Methods

Figure 2


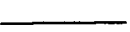
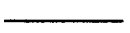
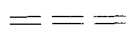





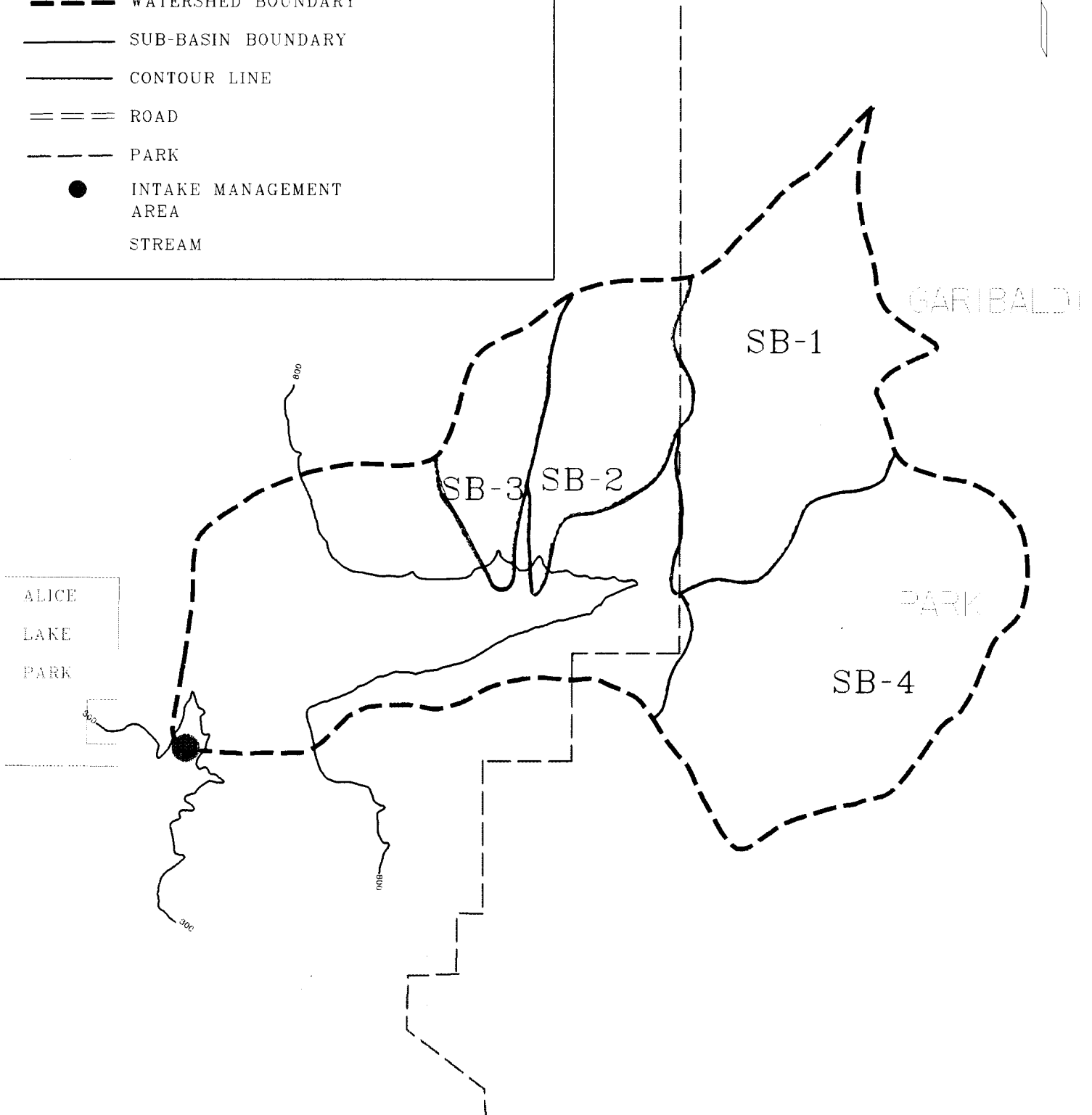
MASHITER CREEK

WATERSHED

Tripartite Management Areas Sub-basin Areas

Key Map

-  WATERSHED BOUNDARY
-  SUB-BASIN BOUNDARY
-  CONTOUR LINE
-  ROAD
-  PARK
-  INTAKE MANAGEMENT AREA
-  STREAM



Since there is no proposed development for the Mashiter Creek community watershed, this CWAP only assesses past development. The Mashiter Creek community watershed was divided into 5 sub-basins for the purpose of this CWAP (Figure 2). The following materials were used to measure the 15 indicators:

- 1:20 000 Terrain Resource Inventory Map - 92G075
- 1:20 000 Forest Cover Map - 92G075
- 1:20 000 Mashiter Creek Access Management Plan
- Aerial Photographs BCC94122 - \approx 1:18 300
- Terrain Stability Analysis of the Mashiter Creek Watershed (Baumann, 1994)
- Soil Erosion Potential Interpretation (Geo-Alpine Environmental Consulting, 1996)
- Silviculture Information Access Database (Ministry of Forests)

An intensive road deactivation program was completed between August and September, 1992. The program focussed on sidecast pull back, stream crossing removal (culverts and bridges) and cross ditch construction in sub-basins B, C and the residual. Revegetation with grasses and conifers was contemplated but never carried out. For the purpose of measuring road lengths for peak flow and surface soil erosion indices, the following weighting system was used for deactivated roads:

Table 1: Weighting Factors for Deactivated Roads

Deactivation Type	Weighting Factor
semi-permanent deactivation	1
permanent deactivation without recontouring	0.3
permanent deactivation with recontouring	0

A helicopter reconnaissance flight was taken by an assistant to the District Planner, Ministry of Forests and the Water Resource Specialist and Regional Geomorphologist, Ministry of Environment Lands and Parks. The flight was used to obtain a general overview of the watershed's physiography as well as to gain an idea as to the extent of impacts caused by past forestry development. Particular attention was given to the quality and state of past road deactivation and to the extent that landslides are directly impacting watercourses.

4. RESULTS

The watershed report card which lists the 15 indices, calculated as per the CWAP guidebook, is presented in Table 2. Table 3 gives the hazard indices and the CWAP guidebook tables and calculations are given in Appendix 1. Only those hazard indices which indicate moderate (0.5-0.7) or high (>0.7) potential (bold in Table 3) for increased hazards from future forest development will be discussed below. Sub-basins A (SB-A) and D show no impacts from past

development due to the fact that they are in Garibaldi Park. Measured impacts are due to natural geomorphic processes and to a road that BC Parks maintains for access.

Table 2: Watershed Report Card

Impact Category	Indicator	Sub-Basin Scores				
		A	B	C	D	Res.
Peak Flow	Peak Flow Index	0.0	0.3	0.9	0.0	0.3
	Road Density	0.0	0.1	0.3	0.1	0.1
Surface Soil Erosion	Road Density	0.0	0.1	0.3	0.1	0.1
	Density of Roads on Erodible Soil	0.0	0.4	1.0	0.0	0.7
	Density of Mainline Road Within 100 m of a Stream	0.0	0.0	0.0	0.0	0.0
	Density of Stream Crossings	0.0	1.0	1.0	0.0	0.9
Riparian Buffer	Portion of Stream Logged	0.0	1.0	1.0	0.0	1.0
	Portion of Fish Stream Logged	0.0	0.0	0.0	0.0	1.0
	Mainstem Logged	0.0	0.8	1.0	0.0	1.0
Mass Wasting	Density of Landslides	0.3	0.8	1.0	0.0	0.1
	No. of Large Landslides Hitting Mainstem	0.0	0.0	0.3	0.0	0.5
	Density of Class IV or V Road	0.0	0.7	1.0	0.6	1.0
	Percent of Class IV or V Logged	0.0	1.0	1.0	0.0	1.0
Headwaters	Portion of Headwater Stream Logged	0.0	1.0	1.0	0.0	1.0
	No. of Headwater Stream Crossings	0.0	1.0	1.0	0.0	0.7

Table 3: Hazard Indices

Impact Category	Sub-Basin Indices				
	A	B	C	D	Res.
Peak Flow	0.0	0.3	0.9	0.1	0.3
Surface Soil Erosion	0.0	0.7	1.0	0.1	0.8
Riparian Buffer	0.0	1.0	1.0	0.0	1.0
Mass Wasting	0.3	0.9	1.0	0.3	1.0
Headwaters	0.0	1.0	1.0	0.0	1.0

4a. Peak Flow Effects

SB-C has a high potential for increased peak flows. This increased potential was due to an elevated ECA (Table 2).

4b. Surface Erosion Effects

The residual sub-basin (SB-Res), SB-B and SB-C were assessed to have a high potential for increased surface soil erosion from future forest development. The increased potential in SB-B was related to the elevated number of stream crossings. The increased potential in SB-C and the SB-Res were a result of very high scores for the roads on erodible soil, mainline road within 100 m of a stream and the number of stream crossings indicators.

4c. Riparian Buffer Effects

The SB-Res, SB-B and SB-C have maximum hazard indices of 1.0 with respect to the riparian buffer hazard category. In all 3 sub-basins, this was the result of a large proportion of streams and mainstem being logged to the banks.

4d. Mass Wasting Effects

A combination of elevated landslide density, unstable terrain logged and roads on unstable terrain have produced a high likelihood that landslides will continue to occur in the SB-Res, SB-B and SB-C should further forestry development occur.

4e. Headwaters

SB-Res, SB-B and SB-C were assessed to have a high potential for impacts on headwater streams from future forest development. This was due to a combination of an elevated number of stream crossings and the amount of logging that has occurred right to the banks of headwater streams.

5. RECOMMENDATIONS

5a. Rehabilitation

SB-C was assessed to have a high potential for increased peak flows. Much of the area that has not yet attained hydrologic recovery and has stand heights of less than 5 m. Hydrologic recovery of these areas is not expected for at least another 15 years. The field survey indicated obvious signs of channel disturbance which could be linked to peak flows. Further harvesting in this SB should not be allowed until the ECA has been reduced to low hazard levels. This is consistent with the SOO Management Strategy which specifies that the ECA levels in community watersheds should remain below 20 %.

The moderate potential for surface soil erosion impacts in SB-B, SB-C and SB-Res were attributed to the high number of stream crossings. An extensive road deactivation program was completed in 1992. While the deactivation program was not completed to today's WRP standards, the field survey did indicate that most of the stream crossings were deactivated properly and surface runoff from the deactivated roads was not entering any watercourses. In

addition, the natural armouring processes and natural revegetation are minimizing soil erosion from the road surface.

Notwithstanding, the field survey did indicate that improper and lack of cross ditch construction was causing sediment to enter watercourses. Lack of cross ditches was indicated by water flowing down roads and entering watercourses at old crossings. Improper cross ditch construction consisted of poor armouring of the deactivated fill slope. This has led to undercutting of the fill slope and subsequent failure into gullies. These problems are particularly obvious in the higher areas of SB-B and SB-C where the finer textured soils derived from volcanic parent materials are located. We recommend that a qualified individual be retained to assess these roads during the spring thaw of 1997 to assess to what extent the deactivated roads are impacting the natural drainage system.

The increased potential for channel impacts results from a lack of intact riparian buffers in SB-Res, SB-B and SB-C. The combination of increased peak flows and logging to the edge of streams has resulted in an elevated number of gully sidewall failures. The field survey indicated that there were large amounts of logging debris in the gullies. It is recommended that a ground survey be carried out to assess the benefits of initiating a gully cleaning program. In addition, options for revegetating gully sidewalls should be considered in conjunction with the drainage assessment mentioned above.

Potential impacts from mass wasting are related to the number of landslides and to the amount of roads and logging on class IV and V terrain. Most landslides originate from deactivated roads and gully sidewalls and are caused by lack of proper water control. The extent to which these can be controlled will be addressed in the road assessment. There are a number of larger landslides, both natural and logging related, in the Mashiter Creek community watershed. A general assessment of the potential for rehabilitating logging related landslides is also recommended. However, any assessment must quantify the extent to which logging related landslides are impacting water quality as compared to natural sediment sources, such as the large talus slopes on Mt. Garibaldi that enter Mashiter Creek directly.

Deactivated roads appeared stable except where water control was a problem. The Forest Practices Code of BC Act sets strict standards for logging in community watersheds. Further harvesting on class IV and V terrain is prohibited and road construction will be minimized and designed to higher standards in the future. The detailed terrain analysis and hazard and impact assessment, completed in 1994, will ensure that future forest development will minimize detrimental environmental impacts (Baumann, 1994).

SB-B, SB-C and SB-Res were all assessed to have potential impacts in their headwater areas. The assessments that have been recommended will address to what extent these impacts can be reduced by assessing gullies for cleaning, water control on deactivated roads and potential for landslide rehabilitation.

It should be noted that the recommendations made here are consistent with those made by Baumann (1994). It is suggested that the members of the Integrated Watershed Management

Plan for Stawamus River and Mashiter Creek investigate the opportunity to secure funds through Forest Renewal BC in order that these ground assessments can be completed.

Under normal circumstances, a level 2 CWAP or Channel Assessment Procedure should be completed for SB-Res, SB-B and SB-C. The reconnaissance flight identified the types of stream channel impacts, and, it is felt that the assessments and their recommendations will serve to reduce any further stream channel impacts.

5b. Forest Development

Recommendations for future forest development are not made here as there is no forest development planned for the immediate future. It is recommended that another CWAP be completed prior to approving further forest development.

6. REFERENCES

Baumann, F.W. 1994. Terrain -Stability Analysis of the Mashiter Creek Watershed. Prepared for Ministry of Forests, Squamish, B.C.

Ministry of Forests and Ministry of Environment, Lands and Parks. 1995. Coastal Watershed Assessment Procedure Guidebook. Victoria, B.C.

Appendix 1: Mashiter Creek CWAP Calculations

Coastal Watershed Assessment Procedure Results

Watershed Name Mashiter Creek

Watershed Number 900.040

Date of CWAP Completion (dd/mm/yy) 22/01/97

TRIM 1:20000 Mapsheet(s)

92G075
92G085

Forest District	Squamish Forest District
Completed By	MOF/MELP
Cost	\$1700

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Director	Squam-Lill Reg. Dist.			1350 Aster	Pemberton	V0N 2L0	894-6371	894-6526	604

Form 2: Peak flow index (indicator #1) calculations by sub-basin.

Sub-basin name	Below 300m contour			Between 300m and 800m contours			Above 800m contour			Peak flow index Indicator #1
	ECA (km ²)	ECA ÷ total SB (km ² /km ²)	Weighted ECA (km ² /km ²)	ECA (km ²)	ECA ÷ total SB (km ² /km ²)	Weighted ECA (km ² /km ²)	ECA (km ²)	ECA ÷ total SB (km ² /km ²)	Weighted ECA (km ² /km ²)	
1	0	0.0000	0.0000	0	0.0000	0.0000	0	0.0000	0.0000	0.000
2	0	0.0000	0.0000	.0004	0.0002	0.0002	.516	0.2024	0.2024	0.203
3	0	0.0000	0.0000	.0028	0.0020	0.0031	.721	0.5263	0.5263	0.529
4	0	0.0000	0.0000	0	0.0000	0.0000	0	0.0000	0.0000	0.000
Residual	0	0.0000	0.0000	.5872	0.0680	0.1021	.8548	0.0990	0.0990	0.201
Total Watershed	0	0.0000	0.0000	.5904	0.0229	0.0344	2.0918	0.0813	0.0813	0.116

Form 6: Landslide hazard indicators #10, #11, #12 and #13).

Sub-basin name	Sub-basin Area (km ²)	Landslides in sub-basin			Road on unstable terrain		Clearcut on unstable terrain	
		Number (#)	Indicator #10 Density (#/km ²)	Indicator #11 Number hitting mainstem	Length (km)	Indicator #12 Density (km/km ²)	Area logged (km ²)	Indicator #13 Unstable terrain logged (%)
1	5.68	3	0.53	0.00	0	0.000	0	0.0
2	2.55	4	1.57	0.00	.6	0.235	.3	11.8
3	1.37	9	6.57	1.00	1.6	1.168	.5	36.5
4	7.51	0	0.00	0.00	1.6	0.213	0	0.0
Residual	8.63	2.00	0.23	2.00	7.00	0.81	2.30	26.65
Total Watershed	25.74	18	0.70	3	10.8	0.420	3.1	12.0

Form 9: Watershed characteristics by sub-basin.

Sub-basin name	Area with unstable slopes App. 3 (km ²)	Area with erodible soils App. 4 (km ²)	Area with large lakes within the sub-basin (km ²)	Hydrological Zone App. 9	Dominant bedrock geology App. 11	Glaciers in sub-basin (Y/N)
1	not calc.	not calc.	0	35-North Shore Ranges	10. Volcanic-tuffs/pyroclastics/lahars	Yes
2	not calc.	not calc.	0	35-North Shore Ranges	1. Intrusive-granite/granodiorite/diorite/monzonite/syenite/pegmatite	No
3	not calc.	not calc.	0	35-North Shore Ranges	1. Intrusive-granite/granodiorite/diorite/monzonite/syenite/pegmatite	No
4	not calc.	not calc.	0	35-North Shore Ranges	10. Volcanic-tuffs/pyroclastics/lahars	No
Residual Total	not calc.	not calc.	0	35-North Shore Ranges	1. Intrusive-granite/granodiorite/diorite/monzonite/syenite/pegmatite	No
Watershed			0.00	35-North Shore Ranges	Intrusive / Volcanic Mix	Yes

