Results of the Stream Crossing Quality Index (SCQI) Survey for the Upper Babine River Corridor, Skeena Stikine Forest District

Prepared for
The Trustees of the:
Babine Watershed Monitoring Trust
Box 4274
Smithers, BC
V0J 2N0

Prepared by:
P. Beaudry and Associates Ltd.
Prince George, BC
2274 S. Nicholson
Prince George, BC
V2N 1V8

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1.0 INTRODUCTION

The Babine Watershed Monitoring Trust (BWMT) is responsible for guiding effectiveness monitoring in the Babine River Watershed. The Trust allocates funds to monitoring projects based on a process for determining priorities and costs prescribed in the Trust Agreement and described in the Babine Watershed Monitoring Framework (BWMF) (Price and Daust, 2005).

The 2006 Annual Monitoring Plan (Babine Watershed Management Trust, 2006) describes the second year of monitoring activities guided by the Babine Watershed Monitoring Trust. It lists high-priority monitoring topics, and identifies those topics chosen for direct funding or for seeking additional funding. The plan provides a rationale for each funding decision.

As in 2005, four projects were approved for funding by the BWMT in 2006. One of these four projects was the "Stream Crossing Quality Index (SCQI)" survey, identified as project #2006-1 in the plan. This report present the results of the SCQI survey conducted in the Upper Babine River Corridor during the week of July 4th, 2006.

This report was commissioned by the Babine Watershed Monitoring Trust. However, the methods and conclusions are the professional work of the author. The Trustees do not take a position on any conclusions that are contained in the report.

2.0 DEVELOPMENT OF THE STREAM CROSSING QUALITY INDEX

2.1 Background

Although there are many natural and land-management related processes that contribute to the overall quality of water, the accelerated erosion of sediment and its delivery to streams is generally agreed to be the single most important "water quality" problem associated with forest management activities. Activities, such as harvesting, road building and maintenance, and site preparation, can increase the rate of erosion and sediment delivery to streams. In landscapes that are not prone to mass wasting, the most dominant source of forestry related sediment input into streams is usually associated with erosion in the vicinity of stream crossings (Brownlee et al. 1988; Government of BC 1995). Roads, including associated fills and ditches, have been found to increase watershed sediment yields anywhere from 2 to 50 times over pre-disturbance levels (Reid 1993). While it is recognized that roads are not the only disturbance-related source of accelerated erosion, they are considered to be the most significant cause of increased sediment delivery to streams (Beschta 1978; Reid and Dunne 1984; Brownlee et al. 1988; Government of BC 1995). The main point of road sediment delivery to streams is at crossings such as culverts and bridges (Brownlee et al. 1988; Government of BC 1995). Therefore, good road-building and maintenance practices are required to minimize the erosion hazard and related negative impacts to water quality. This is accomplished through the proper layout, construction, deactivation and use of erosion and sediment control (ESC) measures (Beaudry 1998; Government of BC 1995).

Significant increases in sediment concentration in streams over natural levels can have a negative effect on fish and fish habitat (Phillips 1971; Slaney et al. 1977; Hall et al. 1987; Hartman and Scrivener 1990; Government of BC 1995; Scrivener and Tripp 1998). High concentrations of introduced sediment may disturb fish populations directly or indirectly through several possible avenues, such as by inhibiting incident light from reaching the streambed, which would lower primary productivity and invertebrate density (i.e., reduce numbers of food organisms) (Quinn et al. 1992) or by reducing the quality of spawning and rearing habitat through deposition of fines into streambed gravels (Newcombe and MacDonald 1991; Soulsby et al. 2001). The longer the duration of high levels of suspended sediment, the higher the risk to fish and fish habitat (Newcombe and MacDonald 1991; Newcombe 2003) and even a moderate increase in suspended sediment can limit the ability of fish to find sufficient food supplies (Arter 2004).

One of the elements of Sustainable Forest Management (SFM) is the need to demonstrate that water quality is being maintained. However, there is no formal process or protocol in place across Canada for monitoring water quality, flow rates and aquatic biota in relation to forest practices. A literature review completed in 2004 (P. Beaudry and Associates Ltd. 2004) identified over 130 aquatic indicators used in SFM planning across different jurisdictions in North America. Selecting the most appropriate indicator is most often a significant challenge for the forest licensee. The selection of the most appropriate indicator can be based on a set of seven pre-defined criteria (Center for International Forestry Research 1999; BC SFMP Working Group 2002; Reid 2003; Whitman and Hagan 2003). The seven criteria are:

1. Measurable and quantifiable; the indicator can be described numerically and objectively;
2. Cost;
3. Clear scientific basis (valid); the indicator is supported by scientific research; well grounded in biological or physical principles;
4. Transparent methodology (understandable); clear methods are available on how to apply the indicator;
5. Reasonable threshold can be developed; existing data are available or there are feasible approaches to collect the necessary data;
6. Represents a true potential impact (relevant); the indicator will respond to forestry activities in the region where it is applied; and
7. Can be used in strategic/development plans (forecasting); the indicator can be used to predict future changes in the aquatic environment and respond quickly enough to provide results in the desired time frame.

The development of the Stream Crossing Quality Index (SCQI) is an attempt to design a water quality SFM indicator that meets the criteria described above.

2.2 The Stream Crossing Quality Index (SCQI)

The SCQI procedure is based on the concept that the impact of stream crossings on water quality can be reduced through effective erosion and sediment control practices, and that this can be evaluated and scored. The SCQI field evaluation systematically assesses the size and characteristics of sediment sources in the vicinity of stream crossings and the potential for that sediment to reach the stream. If there is no potential for erosion, or the sediment cannot reach the stream, the crossing receives a score of zero (i.e. no hazard). As the number and size of the sediment sources increase at an individual stream crossing, so does the score. A low score indicates good erosion and sediment control, while a high score indicates that there is a significant hazard to water quality caused by an accelerated introduction of fine sediments to the aquatic environment. Since the objective is to maintain low scores, the SCQI survey procedure provides an incentive to implement good ESC measures.

The SCQI survey is a relatively new procedure that has been implemented extensively by forest licensees in west central Alberta and throughout the central interior and north eastern regions of British Columbia. Like any survey procedure, it is necessary to calibrate the SCQI method in order to verify that results are accurate and reliable. The validation of the SCQI procedure utilised in-stream continuous turbidity monitoring to assess the ability of the SCQI survey to predict changes to stream turbidity caused by accelerated erosion and delivery of fine sediment to the stream. Validation provided an opportunity to test the SCQI procedure and refine it as necessary to improve its accuracy and reliability as an indicator of the impacts of forest harvesting activities on water quality. Validation has been ongoing since 2001 and a total of 50 stream crossings have been monitored to evaluate the effectiveness of the SCQI score in predicting increases in stream turbidity.

As an SFM indicator, the basic assumption that underlies the SCQI is that if erosion and sediment delivery in the vicinity of stream crossings are minimized, through proper road building and maintenance practices, then the potential impact to water quality from increased sediment delivery is also minimized. It is important to emphasize that the SCQI focuses exclusively on the sediment source and the potential of that sediment to reach a stream environment. It does not in any way attempt to measure, evaluate or score the impact of increased sediment delivery to the aquatic environment. Consequently, the procedure does not collect any data about the stream environment itself relative to determining the "sensitivity" of the stream to increases in sediment delivery. The procedure does collect some very basic information about the size and gradient of the stream in the vicinity of the crossing; however, this information is not used to judge the sensitivity of the stream or in the determination of the hazard assessment. The stream information is used solely to provide some descriptive information about the assessment site.

3.0 SCQI METHODOLOGY AND SAMPLING

3.1 Sampling Intensity

The intensity of SCQI sampling for any given project is usually determined by a combination of field access and project budget. For this particular project, the sampling intensity was mostly defined by budget, which allowed for sampling of approximately 100 crossings. The priority sampling areas were defined by members of the BWMT prior to the commencement of the work. The top priority for 2006 was the upper Babine River corridor, immediately downstream of the confluences of the Nilkitkwa and Nichyeskwa Rivers. During the planning phase of this project we identified approximately 150 stream crossings along the upper Babine River corridor based on the stream network provided on the TRIM II maps. We completed surveys on 100% of all stream crossings encountered within the sampling area (a total of 103 crossings). All Terrain Vehicles (ATV) were used to access all sampling sites in 2006.

3.2 Survey Methodology

SCQI surveys focus exclusively on the potential for accelerated erosion and sediment delivery at road crossings. All stream crossings that were encountered within the sampling area were surveyed. Once the surveyor has arrived at a crossing, the main “steps” of the survey include: 1) description of the characteristics of the crossing, 2) collection of that data used to score the erosion potential (EP), 3) collection of that data used to score the delivery potential (DP), 4) calculation of the SCQI score for the entire crossing (EP*DP, for each element) and 5) writing of erosion and sediment control prescriptions for crossings with a high SCQI score. A full description of the methodology is provided in detail in Appendix 1 of this report.

The final SCQI crossing score generates five hazard classes as defined in Table 1. These hazard classes are adapted from guidelines published in the Department of Fisheries and Oceans (2000) and the Government of British Columbia (2001) regarding turbidity and suspended sediment levels.

Table 1 Correspondence between SCQI score, water quality concern rating (WQCR), expected increase in turbidity and risk to fish habitat.

SCQI crossing score	Water Quality Concern Rating (WQCR)	Expected increase in turbidity caused by the crossing for a stream of approximately 1 m in width (NTU)	Risk to fish habitat (DFO 2000)
0	None	None	None
0< score <0.4	Low	1 to 8	Very low
0.4 ≤ score ≤ 0.7	Moderate	8-70	Low to moderate
0.8 ≤ score ≤ 1.6	High	70-130	High
Greater than 1.7	Very High	> 130	Unacceptable

The SCQI procedure is a useful management tool because it identifies the specific location and magnitude of accelerated erosion and sediment delivery problems. If scores are high, the crossing can be improved through remedial actions and current practices can be altered to avoid high scores in the future. If scores are low, then it shows that good erosion and sediment control practices are being implemented and by extension water quality is being protected.

It is important to note that the SCQI method was designed to be quick (about 20 to 25 minutes per crossing) so that a maximum number of crossings can be assessed, thus providing a better landscape level perspective. The SCQI has evolved over the last five years from its initial structure based mostly on subjective assessments. The procedure is now more objective, repeatable and transparent.

3.3 SCQI Sampling in 2006 in the Babine River Watershed

Sampling was conducted throughout the roaded portion of the upper Babine River corridor. Sampling focused on roads that had relatively good access and on streams, where at a minimum, at least 100m of channel was scoured (i.e. S1 to S6 but not non-classified drainages). Figure 2 shows all of the sampling sites completed during the week of July 4, 2006. Each crossing assessed was marked using a GPS. All survey points have been transferred to a GIS Arcview Shape file, which includes the complete survey database. The Shape file along with all of the photographs taken during the survey are provided on a CD in Appendix 3. The complete listing of all samples sites is provided in tabular format in Appendix 4

3.4 SCQI Data Collection

All 2006 SCQI data were collected in the field using an electronic Palm Pilot™ Personal Digital Assistant (PDA) with a HanDbase™ 3.0 database solution that has been custom developed to capture and process SCQI survey data (Figure 1). The location of each survey point is collected in the field with a Garmin™ etrex GPS receiver. Data are downloaded from the PDA database and exported to a Microsoft Excel Spreadsheet where it is merged digitally with the GPS coordinates. Once all of the field data have been exported and merged in a spreadsheet format, the spreadsheet is imported into the Mapinfo Professional™ mapping/GIS solution for spatial analysis.

Project #: Can-GP-04
Surveyor: ▼ DH
Site #: ⊕ ⊖ 6
Easting: 0
Northing: 0
Structure type:
Culvert size:
Precip regime 1
Wetted width(m):
Wetted depth (m):

Figure 1. Personal Digital Assistant (PDA) loaded with SCQI database on HanDbase™ software.

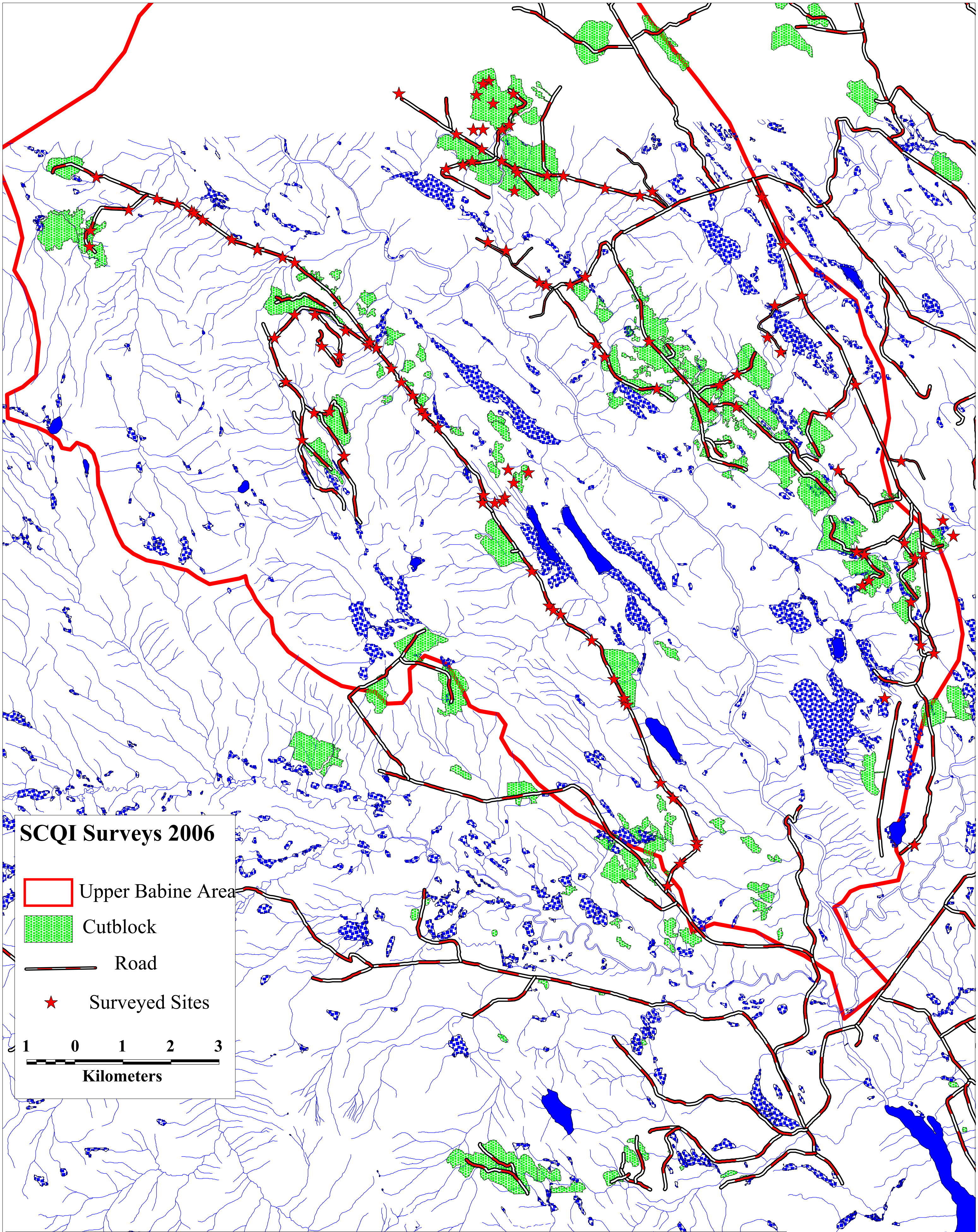


Figure 2. Location of all stream crossings surveyed in the Upper Babine Corridor in 2006.

4.0 RESULTS

4.1 Upper Babine River Corridor

A total of 103 stream crossings were surveyed in the Upper Babine River corridor in 2006. Of these, 96.1% received a WQCR rating of Moderate or lower. Only 3.9% received a WQCR of High or Very High (Table 2). Of the crossings that received a WQCR of high or very high, 3 crossings were located over moderate sized streams (class 3, 1.5 to 5.0 m in width) and 1 crossing was located on a small sized stream (class 4, 0.5-1.5m in width). Table 3 shows that most of the crossings surveyed (82.6 %) were located over small streams (class 4 and 5), 16.4 % were located on moderate sized streams (class 3) and only 1.0 % of crossings surveyed were located over large streams (class 2). Overall, water quality concerns associated with stream crossings were very low in the upper Babine River corridor.

Table 2 Water Quality Concern Ratings in the Upper Babine River Corridor – 2006 survey results.

# of Crossings Surveyed	Water Quality Concern Rating (WQCR)									
	None		**Low**		**Medium**		**High**		**Very High**	
	#	%	#	%	#	%	#	%	#	%
103	60	58.3	30	29.1	9	8.7	3	2.9	1	1

Table 3 Water Quality Concern Ratings by stream width class in the Upper Babine River Corridor – 2006 survey results.

Stream Width Class*	Total number per class	Water Quality Concern Rating (WQCR)									
		None		**Low**		**Medium**		**High**		**Very High**	
		#	%	#	%	#	%	#	%	#	%
1	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	1	1	1.0	0	0.0	0	0.0	0	0.0	0	0.0
3	17	12	11.6	2	1.9	0	0.0	2	1.9	1	1.0
4	56	28	27.2	22	21.4	5	4.9	1	1.0	0	0.0
5	29	19	18.4	6	5.8	4	3.9	0	0.0	0	0.0

* 1=Greater than 20m 2=5-20 m 3=1.5-5 m 4=0.5-1.5m 5=Less than 0.5

4.2 Interpretation of the Results

Figure 3 shows the relationship that has been established between the SCQI score and the expected increases in stream turbidity caused by the stream crossing. Hazard ratings of moderate or less are considered to generate a low risk to fish and fish habitat. This is based on the data from DFO (2000) and the work completed by Newcombe (2003). Figure 4 and Table 4 (adapted from Newcombe 2003) show that short duration increases in turbidity of 30 NTU or less do not have a significant negative impact on fish or their habitat (i.e. SEV score of less than 1). Our SCQI validation work consistently showed that increases in turbidity caused by road crossings are always short-lived, i.e. no longer than the durqtion of the intense rainfall event that generated the sediment (usually less than one hour). Increase in turbidity in the range of 30 to 75 NTU for a duration of less than three hours (SEV score of 1 to 3, from Figure 4) will cause slight impairment of fish habit (Newcombe 2003). Based on this information, we consider that only the crossings with a High and Very High hazard ratings are a sediment concern for fish habitat.

All of the 2006 SCQI data collected for this project are provided in three formats:

1. Excel spreadsheet provided on CD in Appendix 3
2. Arcview GIS Shapefile provided on CD in Appendix 3.
3. Complete data table provided in Appendix 4.

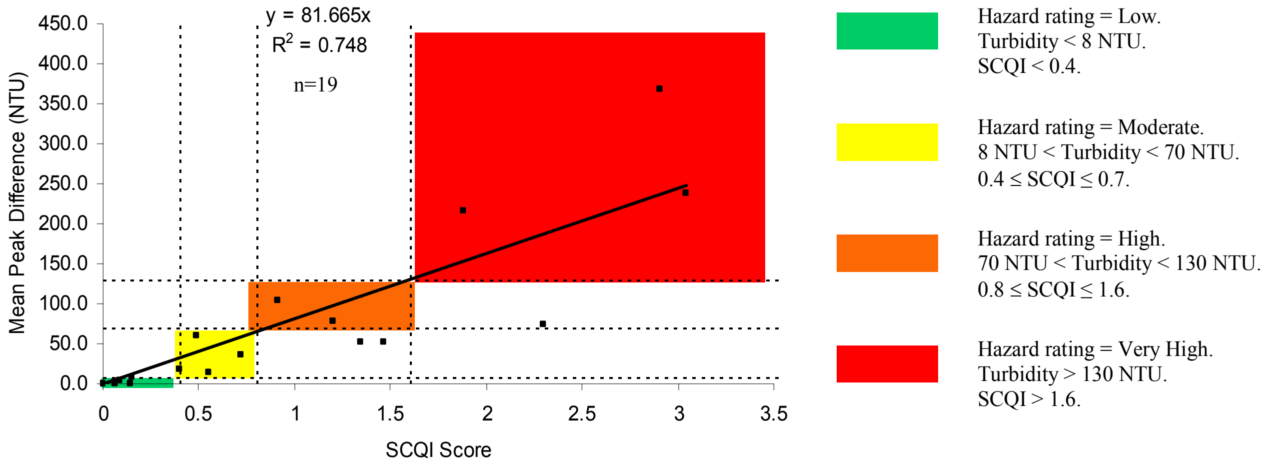
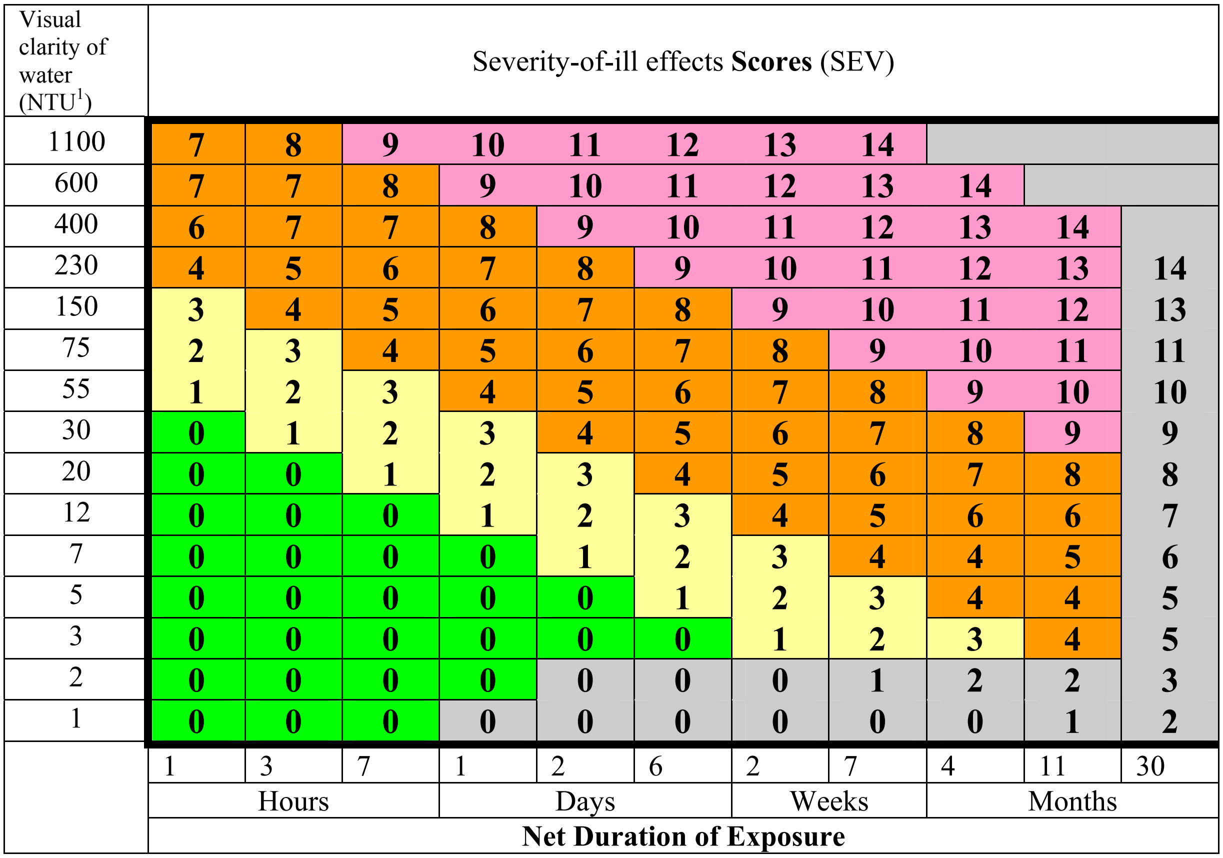


Figure 3. Relationship between SCQI score and induced turbidity (mean peak difference NTU).

Figure 4 Impact assessment model for clear water fishes exposed to conditions or reduced water clarity (from Newcombe 2003).



Visual clarity of water (NTU[1])	Severity-of-ill effects **Scores** (SEV)									
1100	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**			
600	**7**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**		
400	**6**	**7**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	
230	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
150	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
75	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**11**
55	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**10**
30	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**9**
20	**0**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**8**
12	**0**	**0**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**6**	**7**
7	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**4**	**4**	**5**	**6**
5	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**4**	**4**	**5**
3	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**3**	**4**	**5**
2	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**	**3**
1	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		
	Net Duration of Exposure										

Note: The SEV impact assessment is based on *net* duration (less clear-water intervals) and weighted-average visual clarity. Recurrent events sum when integrated over relevant intervals

[1] NTU is the Nephelometric turbidity unit, which is a measure of light scattering by suspended clay particles and is directly related to water clarity.

Table 4 Interpretations provided by Newcombe (2003) for his Severity-of-ill effects scores (SEV).

Severity-of-ill-effects-scale	Severity of ill effects	Colour coding	Interpretation
Greater than 0 and less than or equal to 0.5	Nil	🟩	**Ideal**. Best for adult fishes that must live in a clear water environment most of the time
Greater than 0.5 and less than or equal to 3.5	Minor	🟨	**Slightly Impaired**. Feeding and other behaviours begin to change: severity of effect increases with duration
Greater than 3.5 and less than or equal to 8.5	Moderate	🟧	**Significantly Impaired.** Marked increase in water cloudiness could reduce fish growth rate, habitat size, or both.
Greater than 8.5 and less than or equal to 14.5	Severe	🟪	**Severely Impaired.** Profound increase in water cloudiness could cause poor condition or habitat alienation.
		⬜	Areas with least supporting data (1day to 11 months), or least likelihood of problems.

5.0 SELECTED PHOTOS FROM FIELD ASSESSMENTS

5.1 Selected Photographs of crossings with a High or Very High WQCR

Four crossings surveyed in the 2006 field season were rated at high or very high in terms of water quality concern (3.9% of all crossings surveyed). A stream crossing with a high or very high WQCR will likely result in accelerated delivery of fine sediment to the streams, which will in turn cause an increase in turbidity above the acceptable provincial standards (although the increase will likely be of short duration). This section provides a series of pictorial examples to illustrate these problems.

All photos for crossings surveyed in the upper Babine River corridor in 2006 have been included on the digital photo CD ROM enclosed in Appendix 3.

Figure 5. Crossing SB19-Very large sediment source area with partial vegetation cover.

Figure 6. Crossing SB19-runoff water cuts road fill and spills directly into stream.

Figure 7. Crossing SB27 long uninterrupted road surface.

Figure 8. Crossing SB27-Coarse sediment trapped on bridge but fine sediments spill directly into stream.

5.2 Selected Photographs of crossings with a Moderate WQCR

Approximately 8.7 % of the stream crossings surveyed in the upper Babine River corridor in 2006 were given a rating of moderate for water quality concerns. This means that during large rainfall events, the crossing will likely cause an increase in stream turbidity that is slightly higher than provincial water quality guidelines, and typically only for a very short duration. According to Newcombe (2003), this type of turbidity event does not cause a significant impairment to fish habitat (SEV of less than 3). This section provides examples of several crossings with a moderate water quality concern.

Figure 9. Crossing SB07-Surface water confined along wheel grooves puddles and spills into stream at culvert crossing.

Figure 10. Crossing SB26-eroded material from small areas along ditch cut-slopes filter through thin vegetation before spilling into stream

Figure 11. Crossing SC33- approaches left after culvert removal require vegetation or protection from raindrop erosion.

Figure 12. Crossing SB14-runoff water confined to road surface spills over shoulder into stream.

5.3 Selected Photographs of crossings with a Low WQCR

A component of the stream crossings surveyed in the upper Babine River corridor during the 2006 season (29.1 %) received a WQCR of Low. These are crossings with very minor to slight problems concerning sediment delivery to the stream.

Figure 13. Crossing SB03-small ditch-line remains active sediment source.

Figure 14. Crossing SB67-coarse material falling off cutslope is trapped by several small retention features

Figure 15. runoff from relatively small sediment source filters through relatively thick vegetation on road fill.

Figure 16. Sediment from road surface mostly trapped by depressions in road.

5.4 Selected Photographs of a None WQCR

Crossings with a water quality concern rating of None made up the largest component of those surveyed in the 2006 season at approximately 58.3 %. This indicates that there were no visible signs of sediment delivery to the stream caused by crossings. This section provides examples of typical crossings with a low WQCR.

Figure 17. Crossing SB32-road surface and ditches completely covered by vegetation

Figure 18. Crossing SC08- bridge deck slightly elevated and all sediment sources completely covered with large, coarse material.

Figure 19. Road surface crowned with coarse material, ditches and fill slopes completely covered with vegetation.

Figure 20. Small amount of sediment completely contained to road surface, ditches completely covered with vegetation

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APPENDIX 1. SCQI SCORING RATIONALE

The Stream Crossing Quality Index (SCQI) is a field based exercise that systematically assesses the hazard of road originated sediment sources at stream crossings as a potential impact to water quality. A variety of sediment source characteristics, which may have potential to deliver sediment to the stream, are examined in the field. The purpose of this document is to provide explanations and examples of the components used to assess the sediment source hazard and delivery potential at stream crossings and how the SCQI is calculated.

The entire procedure is summarized as follows:

- **Step One**: Planning of the field work (Office)
- **Step Two**: Go to crossing and initiate survey by completing the general description of the crossing (Field)
- **Step Three**: Divide the crossing into 8 elements (Field)
- **Step Four**: Collect data to score the erosion potential for each element (Field)
    - 4a: Score sediment source area
    - 4b: Score road use
    - 4c: Score soil type
    - 4d: Score gradient
    - 4e: Score effective area
    - 4f: Score erosion control
    - 4g: Score ditch shape
    - 4h: Calculate erosion potential (EP)
- **Step Five**: Collect data to score the delivery potential for each element (Field)
    - 5a: Score effectiveness of sediment control type (diversion, filter, retention)
    - 5b: Score sediment control location
    - 5c: Calculate delivery potential (DP)
- **Step Six**: Calculate the crossing score (SCQI)
- **Step Seven**: Write prescriptions where needed (Field)

Division of Crossing into eight elements (Step Three)

The primary sources of road related sediment at stream crossings are the road surface, the ditchlines, and the cut and fill slopes. For the purposes of the SCQI assessment, each crossing is divided into eight “elements”: (1) right back ditchline, (2) right front ditchline, (3) left front ditchline, (4) left back ditchline, (5) front fill slope, (6) back fill slope, (7) right road surface, and (8) left road surface (Figures A1-1 and A1-2). Each component or element” is assessed and scored for its erosion potential and also the potential for the eroded material to be delivered to the stream network.

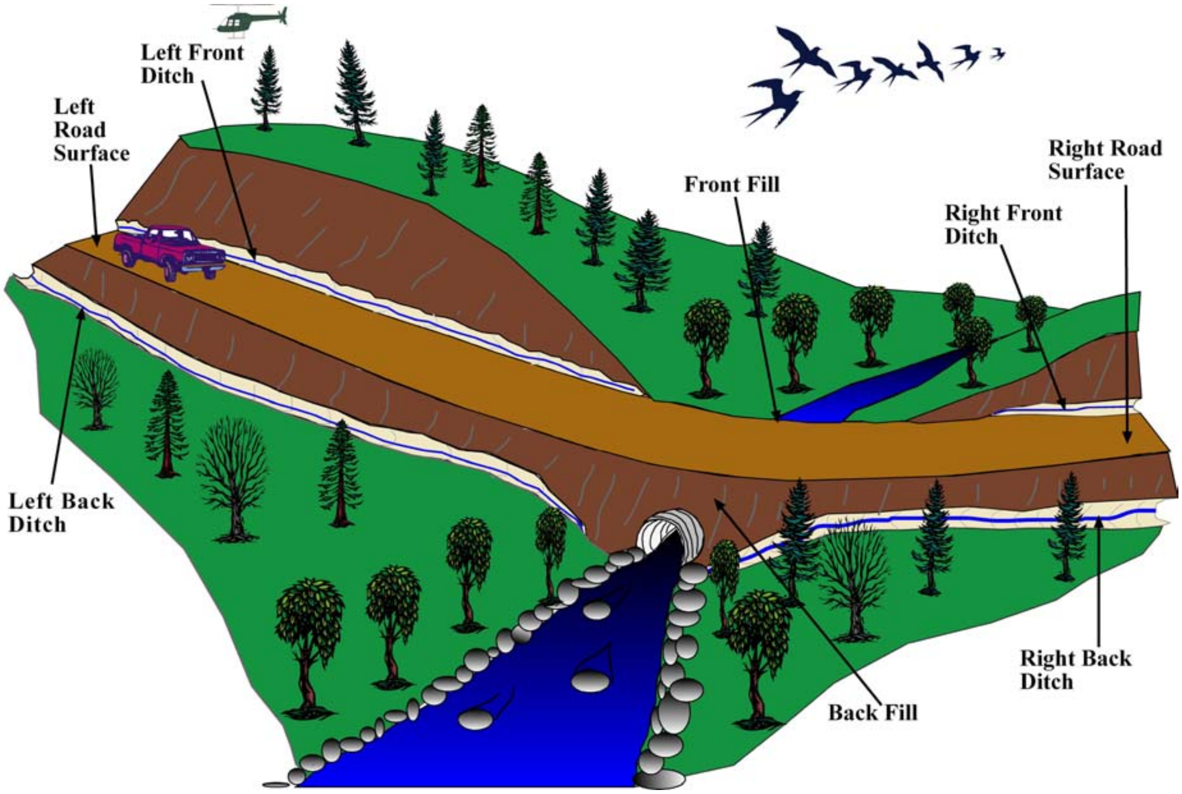


Figure A1-1. Diagram of the components assessed during an SCQI survey.

Figure A1-2 Photograph of a bridge crossing where six (6) of the eight (8) potential elements are present. The elements are outlined in red while the dominant direction of sediment transport is indicated by the brown arrows.

The SCQI score for each element of each individual crossing is a product of the *erosion potential* and the *delivery potential* of the sediment source.

Computation of Erosion Potential (Step Four)

The erosion potential is a function of several factors that include the following:

1) the gross size of the sediment source,
2) the % effective area of the sediment source,
3) the % erosion control cover of the effective area,
4) the shape of the ditch and the size of its side slopes,
5) the soil texture of the source,
6) the slope of the source, and
7) the level of road use.

Each of these factors are measured, or assessed, and assigned a value. The erosion potential is computed as the product of these seven values. This number is then multiplied by the delivery potential to generate a sediment source hazard score, termed the "individual crossing score". The following text provides a description of each of these factors, how they are measured or assessed and how they are rated.

We define the "sediment source" as the "contributing watershed area" of each sediment source feature. This is simply the area that is topographically able to direct suspended sediment towards the stream. Once the sediment source area is determined, it receives a score based on Table A1-1. For example, if a sediment source feature is determined to have an area of 12 m^2, it receives a score of "0.5".

Table A1-1 Sediment source area scores.

Size (m^2)	**Score**	**Size (m^2)**	**Score**	**Size (m^2)**	**Score**
0	0	**100-150**	3	**900-1000**	15
0-1	0.1	**150-200**	4	**1000-1200**	16
1-2	0.2	**200-250**	5	**1200-1400**	17
2-4	0.3	**250-300**	6	**1400-1600**	18
4-8	0.4	**300-350**	7	**1600-1800**	19
8-14	0.5	**350-400**	8	**1800-2000**	20
14-20	0.6	**400-450**	9	**2000-2500**	21
20-26	0.7	**450-500**	10	**2500-3000**	22
26-32	0.8	**500-600**	11	**3000-3500**	23
32-40	0.9	**600-700**	12	**3500-4000**	24
40-50	1	**700-800**	13	**4000-4500**	25
50-100	2	**800-900**	14	**4500+**	26

The % effective sediment source area modifier adjusts the sediment source area defined in Table A1-1 to account for erosion control features that have effectively made portions of the contributing watershed area non-erodible (see Table A1-2). Examples of erosion control that would reduce the % effective sediment source area include forest floor with developed LFH layer, 100% grass cover with developed humus layer or area that is essentially bedrock.

Table A1-2 Effective sediment source area scores.

% Effective Area	Score	% Effective Area	Score
0-10	0.1	**51-60**	0.6
11-20	0.2	**61-70**	0.7
21-30	0.3	**71-80**	0.8
31-40	0.4	**81-90**	0.9
41-50	0.5	**91-100**	1.0

The % erosion control cover accounts for processes that have occurred within the effective sediment producing area that reduce the erosion potential. The following list includes the type of characteristics that develop within a sediment source that reduce its erodibility (i.e., potential of sediment from a given source to become suspended and transported):

a) Extent and type of vegetative cover (e.g., grass, shrubs, herbaceous vegetation)

b) Extent and type of erosion control materials (e.g., straw mulch, debris, etc.), or

c) Stoniness of surface (i.e., how armoured is the sediment source or how much of the fines have been washed away by rain and other erosion processes over time).

Based on these characteristics, the surveyor makes a visual estimate of the extent to which the effective sediment source area should be further reduced to account for erosion control that has occurred (see Table A1-3). For example, the effective sediment source area of a road surface with low activity that has 50% cover of pea gravel and stones emerging after the fine sediment has washed off the top receives a score of 0.53.

Table A1-3 Percent (%) erosion control cover scores.

% Cover	Score	% Cover	Score
0	1	**51-60**	0.45
1-0	0.95	**61-70**	0.35
11-20	0.85	**71-80**	0.25
21-30	0.75	**81-90**	0.15
31-40	0.65	**91-100**	0.05
41-50	0.55		

The “Soil Texture Class” modifier is based on the various soil texture classes and their degree of compaction. Each textural class is assigned a value (Table A1-4) that is incorporated into the final SCQI calculation. For example, pure silt that has a Low compactness level receives a score of 0.86. Highly compacted clay is less erodible than pure silt and receives a score of 0.41. The soil textural class score modifies the element score to account for the difference in erosion characteristics that result with different soil textural classes (e.g., with the exception of clay and its cohesiveness, smaller particle sizes are more easily eroded than larger particles). These soil texture classes relate to how easily the material can be eroded from its source and is used to estimate erosion potential. The water quality monitoring work of 2004 identified that a different set of soil texture modifier scores need to be used in the estimation of delivery potential (i.e., how easy the material can be transported). This is important because the erosion characteristics of a certain soil are not necessarily the same as the transport characteristics. For example a sand is easily eroded but because of its size and weight is not easily transported. On the other hand a clay particle is relatively difficult to erode because of it cohesiveness, yet is very easily transported in water once it is eroded. One of the major changes to the SCQI procedure in 2004 was the introduction of this concept in the estimation of the delivery potential.

Table A1-4 Soil texture class modifier scores to estimate erosion potential.

	Soil Compactness Level			
Soil Textural Class	**L**	**M**	**H**	**V-H**
Very Fine Sand	0.9	1.0	0.8	0.65
Silt	0.86	0.97	0.77	0.66
Silt-Loam	0.8	0.88	0.7	0.55
Silty-Clay Loam	0.7	0.74	0.6	0.5
Clay	0.46	0.51	0.41	0.31
Sandy Loam	0.27	0.3	0.24	0.19
Medium Sand	0.14	0.16	0.13	0.09
Coarse Sand	0.013	0.014	0.011	0.008
Stones and Gravel	0.006	0.006	0.006	0.006

The "Road Use Level" modifier refers to activity/maintenance level of the road and crossing. Table A1-5 presents the road use level categories and the score that each receives. Frequent grading disturbs the fine, more erodible material, so roads with high activity are assigned a higher score. It is our observation that high ATV traffic can cause substantial disturbance to the surface of the road pullbacks/stream banks and can tear up vegetation/erosion control structures that are already in place. For this reason, deactivated roads with evidence of frequent ATV use are assigned a higher score than ones with occasional use. Abandoned roads are assigned the lowest score because they have had time to stabilize, and vegetation cover is usually abundant.

Table A1-5 Road use level modifier scores.

Road Use Level	**Score**
Active mainline	1.0
Active branch line	0.99
Moderate activity (occasional grading)	0.95
Low activity (no grading, crossing structure still present)	0.90
De-activated (crossing structures removed)	
-used extensively by 4 wheelers	0.92
-minor use by 4 wheelers	0.85
-no 4 wheeler use evident	0.80

Gradient of the sediment source towards the stream is measured to account for the erodible force of flowing water. As the gradient increases, water flows faster and has increased potential to erode the surface it is flowing over. Furthermore, high, fast flows are not only able to suspend more material than low, slow flows, but they are also able to suspend and transport a larger range of particle sizes (i.e., coarser material). Thus, the assigned modifier score increases with the steepness of the slope (Table A1-6).

Ditchlines are unique in that they are comprised of two side slopes as well as the main water flow surface. The shape of the ditch and steepness of the side slopes are an important "erosion potential" characteristic of any ditch sediment source. The conceptual image of a ditch is that of a small scale valley.Each of the side slopes can be of differing gradients, just as the gradient of the main surface perpendicular to the stream gradient is site-specific (Figure A1-3). Precipitation falling in the local area can flow over all of the three surfaces, and thus the erosion potential of each must be incorporated into the overall SCQI score. The main surface is accounted for by the average gradient modifier list in Table A1-6. The two side slopes are addressed by incorporating a ditch shape variable. Each ditch starts out with a score indicated by the ditch shape (see Table A1-7), which also acts as a modifier to the total sediment source size. There are two main types of ditch shape, being 'V' or 'U'. The difference between the two is that the 'V' shape indicates a greater potential for down-cutting than the 'U' shape, which corresponds to a higher rate of erosion. All the possible permutations of steepness for the two side slopes from very steep down to flat modify the ditch shape score further. For example, a ditch that is V-shaped and both side slopes are very steep will get a score of 1.55, while a U-shaped, flat sloped ditch will get a score of 0.85. Since the ditch shape score acts as a modifier of the sediment source size, a very steep V-shaped ditch will result in a much higher score than will a flat U-shaped ditch, for the same sized sediment source.

Table A1-6 Slope modifier scores.

Gradient	Score	Gradient	Score
away from stream	0	**7%**	0.65
0.1 to 1%	0.1	**8%**	0.72
1%	0.15	**9%**	0.81
2%	0.22	**10%**	0.85
3%	0.26	**11%**	0.9
4%	0.35	**12%**	0.96
5%	0.46	**greater than 12%**	1
6%	0.55		

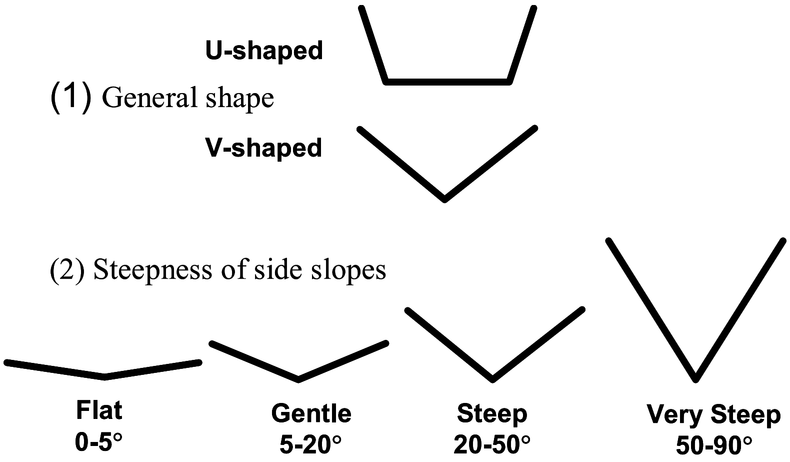


Figure A1-3 Definitions of the ditch shape. (1) Defines the general shape types of the ditch as U-shaped or V-shaped and (2) defines the steepness of the side slopes from flat to very steep.

Table A1-7 Ditch shape modifiers.

	Score	
Gradient of Ditch Slopes (Two Slope Combination)	**V-Shaped**	**U-Shaped**
Very Steep and Very Steep	1.55	1.4
Steep and Very Steep	1.45	1.3
Gentle and Very Steep	1.35	1.2
Flat and Very Steep	1.1	1.1
Steep and Steep	1.35	1.2
Gentle and Steep	1.25	1.1
Flat and Steep	1.15	1.0
Gentle and Gentle	1.15	1.0
Flat and Gentle	0.9	0.9
Flat and Flat	0.85	0.85

The values for each of the modifiers used in determining the “erosion potential” are based on the concepts and values developed for the Revised Universal Soil Loss Equation (RUSLE) presented in Wall et al. (2002). The universal soil loss equation was initially developed by Wischmeier and Smith (1965). The objective of the RUSLE is to provide a quantitative tool to assess the potential for soil erosion at a given site. RUSLE is based on measurements of rainfall intensity, soil texture, gradient of slope, length of slope and erosion control practices. The values for the different variables in the equation are continuously being refined by a large collective of soil scientists in both the United States and Canada.

Once all of the characteristics of the sediment source area of a particular element are determined and scored, the *erosion potential* (EP) can then be calculated as follows:

Erosion Potential (EP) = SS x RU x TC x SL x EA x EC x DS

Where: SS = Sediment Source Area (Contributing Watershed Area)
RU = Road Use (used only for the road surface elements)
TC = Textural Class (Soil Type)
SL = Slope (Average Gradient)
EA = Effectiveness Sediment Source Area
EC = Dispersed Erosion Control
DS = Ditch shape modifier (used only for the ditches)

Calculation of the Delivery Potential (Step Five)

The Delivery Potential (DP) score represents the proportion of the eroded material (EP) that actually reaches the stream. Like the EP, the DP is computed individually for each of the eight (8) elements. The delivery of sediment may be direct and unimpeded, or it may be reduced or mitigated by some kind of sediment control mechanism (i.e. the control of sediment transport). The calculation of the DP score is based on the type, effectiveness and location of those sediment control mechanisms, the slope of the surface over which the sediment is being transported and the dominant texture of the material that is eroded and being transported in the flowing water.

The delivery potential assessment procedure recognizes three sediment control types. These include: 1) *diversion*, 2) *retention* and 3) *filtration*. The sediment control mechanisms are somewhat different for each sediment control type and consequently a slightly different procedure is used to determine the DP for each. The surveyor must decide which type of sediment control process is dominant for a particular element and choose the most appropriate type.

- *Diversion* is used when all of the sediment laden water being transported from the sediment source is diverted prior to reaching the stream.
- *Retention* refers to pond or dam type structures that actually retain the flow of water for a certain amount of time. The retention type may refer to one single structure or numerous structures.
- *Filtration* refers to a mechanism that slows the water down, but does not actually stop it for any significant amount of time. Examples include grass, mulch, organic matter such as humus and a porous sediment fence.

Both the retention and filtration types reduce the velocity of sediment-laden water and facilitate deposition of the sediment particles before they reach the stream.

The “effectiveness” of the sediment control mechanism is a function of how large it is (i.e. total surface area), how well maintained it is, the velocity of the flowing water, the density or thickness of the filtration material and the texture of the sediment being transported. The success of the sediment control is also a dependent on the “location” of the sediment control structures. The following paragraphs describe the procedure used to score the “effectiveness” and the “location” for each type of sediment control type.

Effectiveness for Diversion Type

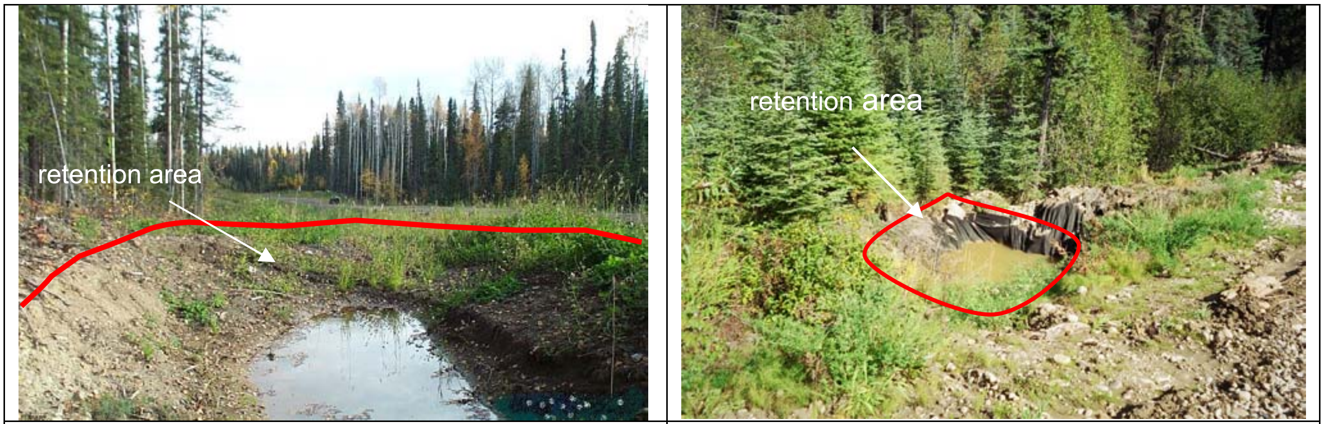
Complete diversion is the most effective sediment control mechanism and generates an "effectiveness" score of 1.0 (Table A1-9). Prior to selecting this type, check to ensure that no connecting flow paths exist between the diversion structure and the stream (Figure A1-4). If no flow paths exist then, by definition, the "location" of the control mechanism is considered optimal and will also score 1.0 (Table A1-12).

Figure A1-4 Long tail ditches with a progressively decreasing slope helps to slow and re-direct road surface runoff water away from the stream where it can percolate into the forest floor.

Effectiveness for Retention Type

The "effectiveness" of a retention type of sediment control is dependent on 1) the total size of the ponds (i.e. surface area) created by the retention structures, 2) the amount of sediment in-filling of the ponds and 3) the dominant texture class of the sediment that is eroded and flowing towards the stream. Table A1-8 provides guidelines for determining the net total size of the retention ponds. This size is determined in relation to the size of the "Effective Area (EA)", previously calculated, and the average amount of in-filling of the ponds (visual estimate). The "effectiveness" score is obtained from Table A1-9 after determining the net size. Figures A1-5 to A1-7 provide examples with text annotation to describe sediment retention structures and processes as observed in the field.

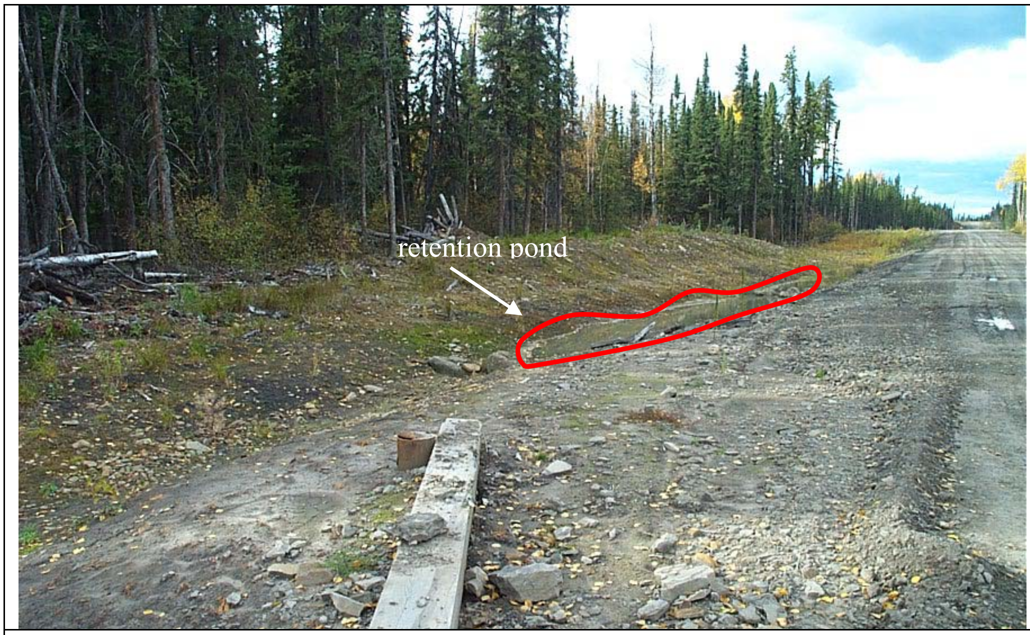
Figure A1-5 Sediment pond with nearly 100% in-filling has virtual no capacity to retain sediment. Using Table A1-8, the net size is “Very Small”.



Large retention pond that is “empty” and effectively retains a large amount of run-off water

Medium Sized retention area re-enforced with geo-textile to minimize erosion when structure overfills.

Figure A1-6 Examples of retention areas that function well.



Sediment pond created by placement of large rocks in the ditch structure. Relatively low sediment in-filling has occurred and structure functions as intended.

Check dam installed in ditch structure to retain run-off water and promote sediment retention.

“Fence style” check dam installed along ditchline to trap sediment. Although a large amount of sediment has been retained, run-off water now circumvents the fence and renders the structure in-effective because it is full.

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Hay bale check dam installed along ditch in newly constructed road. Although the retention structure is functioning well, sediment infilling is beginning to occur behind the check dam and decreases the “net size” of the retention structure.

Figure A1-7 Examples of various types of retention structures.

Table A1-8 Guidelines for Determining Net Size of Retention Ponds

Total size of retention ponds relative to size of EA	**Average amount of in-filling of all sediment "ponds"**			
	Less than 20% (i.e. "empty")	**20-50%**	**50-70%**	**Greater than 70% (i.e. "full")**
Less than 5%	Very Small	Very Small	Very Small	Very Small
5-15%	Small	Very Small	Very Small	Very Small
15-30%	Moderate	Small	Very Small	Very Small
30-50%	Large	Moderate	Small	Very Small
Greater than 50%	Very Large	Large	Moderate	Small

Table A1-9 "Effectiveness" Score of retention and diversion type features.

Sediment control type	**Total net size of all retention "ponds" (from Table 2.12)**	**Dominant Soil Texture[1]**	**Score**
Retention	Very Large	Coarse	1.0
Retention	Very Large	Medium	0.9
Retention	Very Large	Fine	0.6
Retention	Large	Coarse	0.95
Retention	Large	Medium	0.75
Retention	Large	Fine	0.4
Retention	Moderate	Coarse	0.8
Retention	Moderate	Medium	0.6
Retention	Moderate	Fine	0.20
Retention	Small	Coarse	0.35
Retention	Small	Medium	0.2
Retention	Small	Fine	0.1
Retention	V. Small	Coarse	0.15
Retention	V. Small	Medium	0.05
Retention	V. Small	Fine	0.01
100%Diversion	No transport of sediment to stream possible		1.0

[1] Coarse = sandy loam, coarse sand
Medium = silt loam, fine sand
Fine = silt, silt clay, clay

Effectiveness of Filtration Type

The effectiveness of a sediment filter is a function of: 1) the velocity of the water flowing through it (slope gradient used as surrogate), 2) the thickness and density of the filter, 3) the total area covered by filtration material and 4) the dominant texture of the eroded soil that is transported in the flowing water. The determination of the "Effectiveness" score is a two step process. First you must determine the average "quality" of the filtration features using the guidelines provided in Table A1-10 and secondly determine the "Effectiveness" score from Table A1-11. It is important to note that for geographic areas where fine soils dominate (e.g. Peace), grass is not an effective sediment filter (Figures A1-8 and A1-9). This was frequently observed and documented during the validation procedure where stream turbidity was actually measured.

Table A1-10 Guidelines for determining "quality" of filtration features.

Characteristics of filtration zone	**Total size of filtration features in relation to size of EA**		
	Small (< 10%)	**Medium (10-50%)**	**Large (>50%)**
Gradient >3%, and sparse grass mostly clover	VERY LOW	VERY LOW	LOW
Gradient >3%, and moderate thick grass, some clover/shrubs	VERY LOW	LOW	MODERATE
Gradient >3%, and thick grass, clover, shrubs and humus	LOW	MODERATE	HIGH
Gradient 1-3%, and sparse grass mostly clover	VERY LOW	LOW	LOW
Gradient 1-3%, and moderate thick grass, some clover/shrubs	LOW	MODERATE	HIGH
Gradient 1-3%, and thick grass, clover, shrubs and humus	LOW	HIGH	VERY HIGH
Gradient <1%, and sparse grass mostly clover	LOW	LOW	MODERATE
Gradient < 1%, and moderate thick grass, some clover/shrubs	LOW	HIGH	VERY HIGH
Gradient <1%, and thick grass, clover, shrubs and humus	MODERATE	VERY HIGH	VERY HIGH

Table A1-11 "Effectiveness" Score of Filtration type features

"Quality" of filter features (from Table 2.14)	**Dominant Soil Texture[1]**	**Score**
Very High	Coarse	1.0
Very High	Medium	0.5
Very High	Fine	0.3
High	Coarse	0.95
High	Medium	0.80
High	Fine	0.3
Moderate	Coarse	0.7
Moderate	Medium	0.5
Moderate	Fine	0.2
Low	Coarse	0.5
Low	Medium	0.2
Low	Fine	0.0
Very Low	Coarse	0.2
Very Low	Medium	0.1
Very Low	Fine	0.0

[1] Coarse = sandy loam, coarse sand
Medium = silt loam, fine sand
Fine = silt, silt clay, clay

Figure A1-8 A small filtration zone coupled with sparse grass and a steep gradient is shown to be ineffective at filtering sediment.

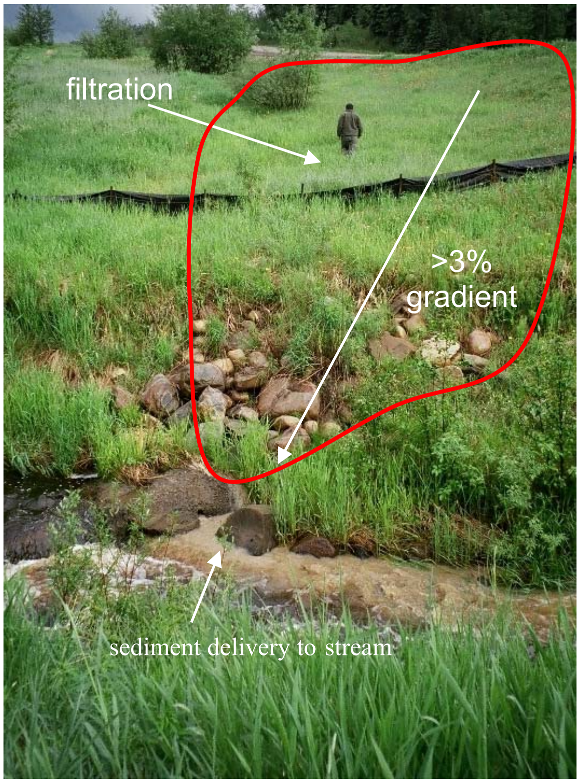


Figure A1-9 Example of a large filtration zone and >3% gradient with thick grass, clover, shrubs and humus. When coupled with fine textured soil, this sediment control feature is not able to effectively filter the sediment that is flowing in runoff water from the road.

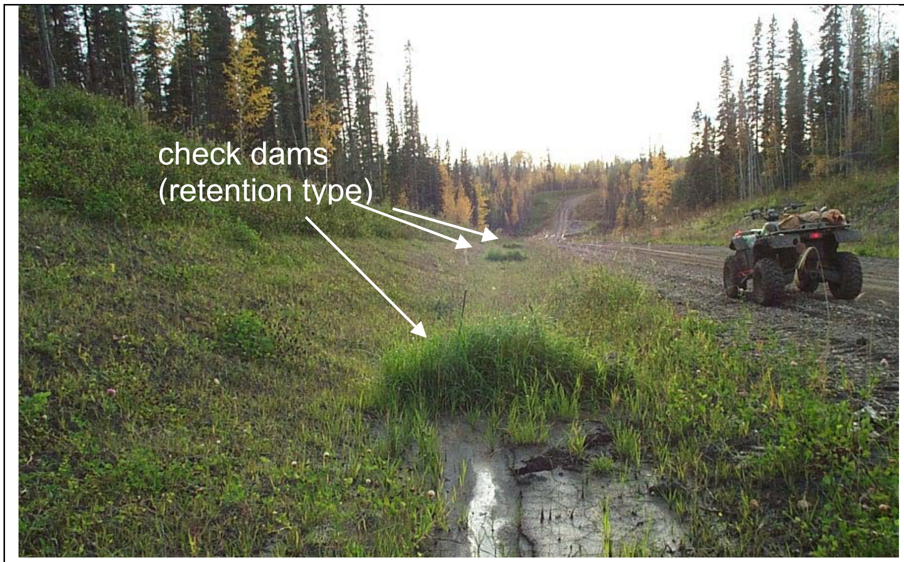
Sediment Control Location

The location of the sediment control features, in relation to their proximity to the stream, is also a component in determining the delivery potential. Table A1-12 provides a series of choices that describe some common combinations of location and quantity of sediment control features. However, this list does not provide all possible combinations that could exist in the field. Table A1-12 is meant as a guideline to help the surveyor select a score that best describes the situation at hand (the score must be selected from the list provided in Table A1-12). Figures A1-10 and A1-11 provide photos to illustrate the concept.

Table A1-12 Location of Sediment Control Features.

SC type	Location	Quantity	Score
Retention	Adjacent or close	>2	1.0
Retention	Adjacent or close	1 or 2	0.95
Retention	Dispersed along source, but not close to stream (i.e. 10-40% up from stream)	> 4	0.9
Retention	Dispersed along source, but not close to stream (i.e. 10-40% up from stream)	1 to 4	0.85
Retention	Dispersed along source, but distal from stream (i.e. more than 40% up from stream)	>4	0.7
Retention	Dispersed along source, but distal from stream (i.e. more than 40% up from stream)	1 to 4	0.65
Filter	Adjacent	1	1.0
Filter	10 to 30% up from stream along source	1	0.8
Filter	30 to 50% up from stream along source	1	0.7
Filter	>50% up from stream along source	1	0.6
Diversion[1]	No flow to stream possible		1.0
No retention or filtering – flow direct to stream			0.0

[1] Note: If diversion is not 100% effective, then the surveyor must choose another sediment control feature for that part of the flow that is not effectively diverted (i.e. retention or filtration). Thus “diversion” can only be selected if it is 100% effective.

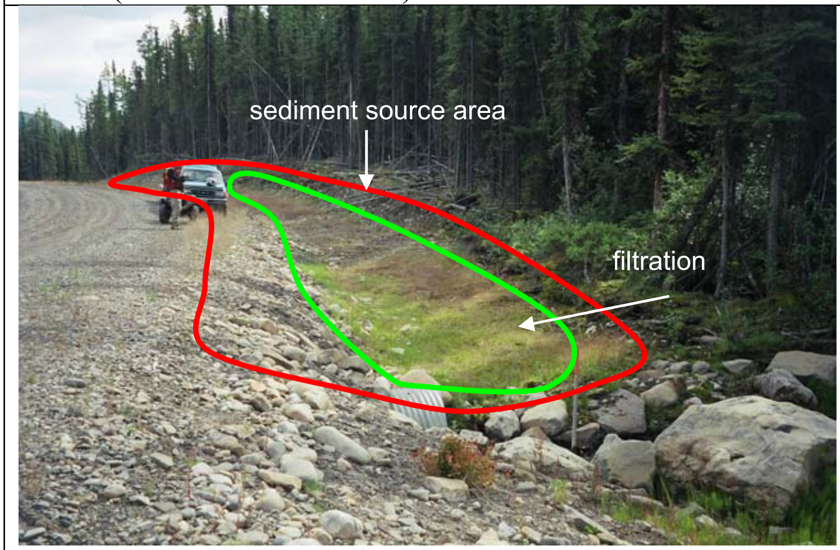


More than 4 check dams located along the entire sediment source feature. No sediment control immediately adjacent to crossing (Location score = 0.9).

Two check dams dispersed along source, but not close to the stream (i.e. 10-40% up from stream) (Location score = 0.85)

Figure A1-10 Examples showing the location of sediment control features relative to the sediment source area and their location scores.

One check dam located along sediment source 10-40% up from stream (Location score = 0.85).



Filtration zone located along sediment source and adjacent to stream (Location score = 1.0).

Figure A1-11 More examples showing the location of sediment control features relative to the sediment source area and their location scores.

The delivery potential (DP) for each individual element is calculated as follows:

Delivery Potential (DP) = 1 – (Sediment Control Effectiveness x Sediment Control Location)

Calculation of the Crossing Score (SCQI) (Step Six)

Once all the watershed characteristics are determined and scored for each element, and both the erosion potential (EP) and delivery potential (DP) are computed, the SCQI score can then be calculated for each element as follows:

Element Score = EP x DP

The total score for the crossing is simply the addition of the eight scores for each of the individual elements:

Crossing Score (SCQI) = ∑ of the eight (8) element scores

Remember that when the crossing is divided up into the eight potential elements, there may be cases when not all eight elements exist. When computing the total crossing SCQI score, the score for non-existing elements will be zero.

It is important to note that the SCQI procedure does not attempt to quantify sediment delivery to the stream (e.g., kg/year). However, this system can be used to "score" the relative hazard level of different sediment sources within an operating area to determine: (1) the magnitude of the road related sediment source problems out on the landscape and (2) priorities for erosion and sediment control activities to minimize impacts to water quality.

Determination of Water Quality Concern Rating (WQCR)

To assist in the interpretation and understanding of the SCQI scores, five water quality concern rating (WQCR) classes have been created. These five classes are "None", "Low", "Moderate", "High", and "Very High". Once the SCQI value is calculated for a crossing, the score is converted to a WQCR hazard class. For example, a High WQCR means that the road crossing related sediment source hazard is large enough that there is a high level of concern for negative impacts to water quality caused by increased sediment delivery to the stream. The relationship between the individual crossing scores and the WQCR classes is provided in Table A1-13.

Table A1-13 Relationships between the individual crossing scores and the water quality concern rating (WQCR).

SCQI Score (rounded to 1 decimal point)	WQCR
< 0.1	None
0.1 to 0.3	Low
0.4 to 0.7	Moderate
0.8 to 1.5	High
≥ 1.6	Very High

The categorization of SCQI scores into hazard classes (i.e. WCQR) was developed based on government agency guidelines for induced turbidity and the SCQI validation work cariied out in 2002, 2003, 2004 and 2005. Both the Government of BC and the Government of Alberta follow the guidelines provided by the Canadian Council of Ministers of the Environment (CCME), which are summarized in Table A1-14. These guidelines suggest that the maximum acceptable level of induced turbidity is about 8 NTU. This corresponds fairly well with the levels of risk to fish habitat suggested by the Department of Fisheries and Oceans (2000) where the identifiable risks begin at about 8 NTU (Table A1-15). Our validation work suggests that a crossing with a WQCR rating of "None" would generate a level of induced turbidity less than 8 NTU, which means it would meet the British Columbia and Alberta guidelines for protection of freshwater aquatic life and the DFO guidelines for protection of fish habitat. Table A1-16 provides the full correspondence between the DFO Risk levels, the WQCR, SCQI scores and expected increases in turbidity caused by a crossing for a stream of about 1 m in width.

Table A1-14 Guidelines for the protection of freshwater aquatic life issued by Canadian Council of Ministers of the Environment (1999).

Type of Water	**Guideline**
Clear Flow	• Maximum increase of 8 NTU from background levels for any short-term exposure (e.g., 24-h period). • Maximum increase of 2 NTU from background levels for any long-term exposure (e.g., inputs lasting between 24-h and 30-d).
High Flow or Turbid Water	• Maximum increase of 8 NTU from background levels at any one time when background levels are between 8 and 80 NTU. • Should not increase more than 10 % of background levels when background is >80 NTU.

Table A1-15 Levels of risk associated with increases in turbidity (Adapted from Department of Fisheries and Oceans 2000).

Turbidity Increase (NTU)	**Risk to Fish Habitat**
0	None
<8	Very Low
8-35	Low
35-67	Moderate
67-130	High
> 130	Unacceptable

Table A1-16 Correspondence between DFO fish habitat risk ratings and SCQI water quality concern ratings.

From DFO 2000		**From SCQI Validation Work**		
Turbidity Increase (NTU)	Risk to Fish Habitat	Water Quality Concern Ratings (WQCR)	SCQI Score	Expected increases in stream turbidity (NTU), caused by a road crossing for a one metre wide stream, for SCQI scores less than 3.5
0	None	None	< 0.1	0 to 8
<8	Very Low			
8-35	Low	Low	0.1 to 0.3	8 to 33
35-67	Moderate	Medium	0.4 to 0.7	33 to 65
67-133	High	High	0.8 to 1.5	65 to 130
>130	Unacceptable	Very High	≥ 1.6	> 130

Description of the Stream Crossing (Step Two)

Although the main focus of the SCQI survey is to assess the erosion and sediment delivery potential at stream crossings, additional data/information that is useful for analyses and access management purposes is also collected by the SCQI surveyor at the crossing. Additional data/information collected during the SCQI survey that is not factored into the final score includes the following:

1. Unique crossing identifier
2. Northing
3. Easting
4. Crossing structure type
5. Culvert diameter (if applicable)
6. Wetted Stream Width
7. Wetted Stream Depth
8. Stream gradient class
9. Stream width class
10. Functional condition of structure
11. Percentage (%) of structure plugged
12. Culvert outfall drop (in centimetres)
13. Substrate in culvert (y/n)
14. Channel Constriction (y/n)
15. Photo numbers
16. Erosion and sediment control site prescriptions for each element (when appropriate)

The following Tables A1-11 through A1-14 define the codes used in the SCQI field survey to record and identify some of the additional information that is collected.

Table A1-17 Functional condition of crossing structure.

Functional condition of structure	Code
Structure working as designed	1
Ends of the culvert are partly crushed or plugged	2
Ends of culvert are mostly crushed	3
Bridge structure showing signs of failing components	4
No structure	5

Table A1-18 Crossing structure type.

Crossing structure types	Code
Clear span bridge	1
Bridge encroaches Wb	2
Arch Culvert	3
Wooden culvert	4
Corregated metal pipe	5
Designed ford	6
No structure	8

Table A1-19 Stream gradient class.

Stream Gradient Class	**Code**
less than 1 %	1
1 to 5 %	2
6 to 10 %	3
11 to 15 %	4
16 to 20 %	5
>20 %	6

Table A1-20 Proportion of crossing structure that is plugged.

% of Structure Plugged (inlet)	**Code**
0-25	1
25-50	2
50-75	3
75-100	4

APPENDIX 2. MAP OF SCQI CROSSINGS SURVEYED IN THE UPPER BABINE RIVER CORRIDOR FOR 2006

APPENDIX 3. PHOTOGRAPHS, EXCEL AND SHAPE FILES ON COMPACT DISC OF STREAM CROSSINGS SURVEYED IN 2006

APPENDIX 4 – COMPLETE LISTING OF SCQI DATA COLLECTED IN 2006