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Winlaw Creek
Channel Conditions and Prescriptions Assessment

L-20b

Submitted to:

Watershed Restoration Program,
Water Management Branch,
C/o Kathy Eichenberger
B.C. Ministry of Environment
Nelson Region
Nelson, B.C.

Submitted by:

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1.0 Introduction

Apex Geoscience Consultants Ltd. (Apex) conducted a Channel Conditions and Prescriptions Assessment (CCPA) of the Winlaw Creek channel between October 28th and November 1st, 1997. The lower 6 kilometres of the main Winlaw Creek channel and 500 metres of the North Fork tributary were traversed on foot. The upper portions of the North Fork and the upper reaches of the mainstem of Winlaw Creek were observed during a helicopter fly-over. Funding for this project was provided to the Winlaw Watershed Committee by Forest Renewal B.C. and administered by the Ministry of Environment, Water Management Branch, Nelson Region.

The purpose of this project is summarized as follows;

1. To identify levels and types of disturbance present in Winlaw Creek
2. To provide an interpretation of channel stability of Winlaw Creek based on observations of sediment supply and transfer processes active in the channel.
3. To review the proposed restoration works and provide a risk assessment of in-stream works based on interpretations of channel stability.

2.0 Assessment Procedure

The Channel Conditions and Prescriptions Assessment (CCPA) for Winlaw Creek was carried out according to the procedure described in the Channel Conditions and Prescriptions Assessment (Interim Methods) Guidebook (Hogan and Bird, 1996) and the Channel Assessment Procedure Guidebook (Anon. 1996a&b). The assessment procedure consists of an initial air photograph review to identify major reach breaks, channel - hillslope coupling, major channel disturbances and historical changes in channel morphology. The intention of the initial air photograph exercise is to identify priority areas for the more detailed field assessment. Following the initial air photograph review a field program was developed by Apex and agreed on by the Winlaw Watershed Committee and the Ministry of Environment contract monitor. In addition to the field assessment an overview helicopter flight was conducted to assess the overall condition of the drainage and identify major sediment sources.

The detailed in-stream field assessment was undertaken on 6 kilometres of the main Winlaw Creek channel from the confluence of Winlaw Creek and the Slocan River (Figure 2) and on the middle and lower portions of the North Fork tributary (total of 500 metres). Measurements of bankfull width, bankfull depth, largest stone moved (in 10 year flood) and gradient were made when representative channel cross-sections were encountered (Appendix A). Observations on channel disturbance indicators were made between stations and recorded at stations (Appendix A). Photographs taken during the field assessment are identified on the field forms and included in Appendix B. As well photograph locations are identified on Figure 2 in the back pouch of this report.

3.0 Background

Location and Physiography

Winlaw Creek is located in the Kokanee Range of the southern Selkirk Mountains (Figure 1). Winlaw Creek flows west from Mt. Eccles (2161 m) towards the Slocan River. The community of Winlaw B.C. is located on the fan of Winlaw Creek. The confluence of Winlaw Creek with the Slocan River is at an elevation of 510 metres.

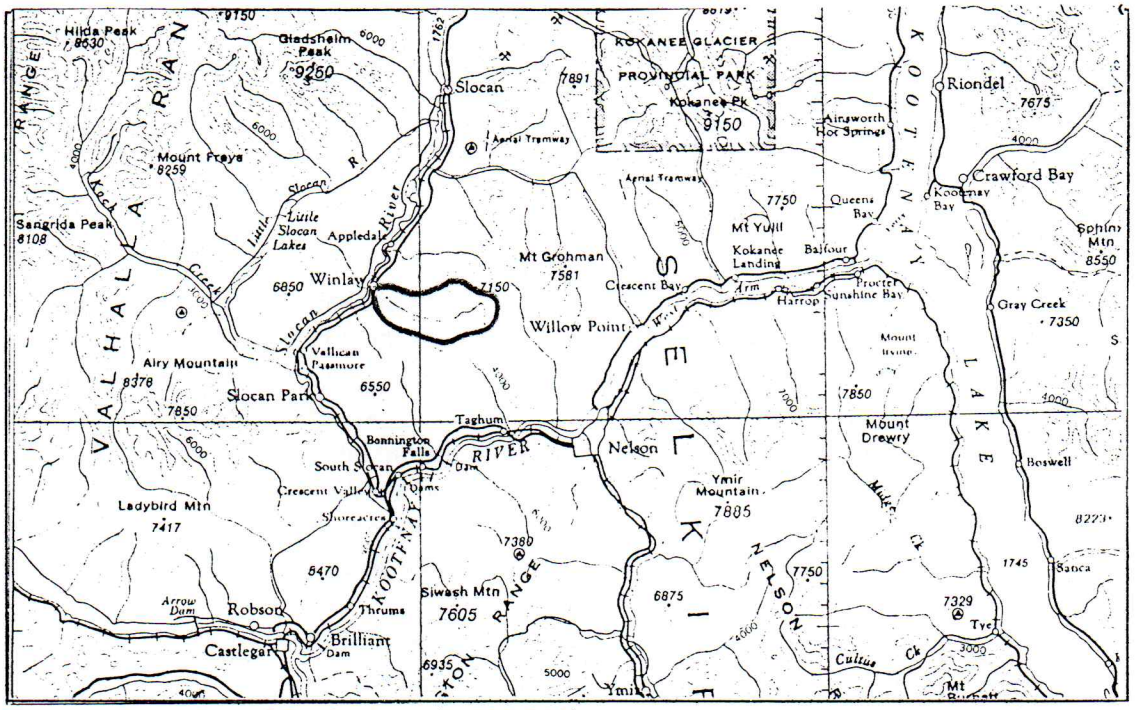


Figure 1. Location of Study Area (1:600,000)

The drainage area of Winlaw Creek is primarily low elevation with the majority of the area below 1800 metres. Only a small percentage of the drainage in the westernmost headwaters area lies between 1800 and 2100 metres.

Most of the ridges at the height of land are rounded indicating they were covered by glacial ice during the Fraser Glaciation (~12,000 ybp). As well, the valley of Winlaw Creek and the upper portion of the North Fork valley are rounded indicating they were occupied by small valley (cirque) glaciers during the last glacial event.

South-facing slopes on the north side of Winlaw Creek and the North Fork tributary are rocky, well drained and sparsely forested. North-facing slopes south of the streams are densely forested and are drained by numerous steep gullies

Climate

The Winlaw Creek area lies within the Moist climatic region of the Nelson Forest Region (Braumandl, 1992). The western portion of Winlaw Creek lies within the Warm Dry

Interior Cedar - Hemlock Subzone (ICHdw). The eastern portion of the drainage below approximately 1800 metres lies within the Columbia Shuswap Moist Warm Interior Cedar - Hemlock Variant (ICHmw2). Above this in the very eastern portion of the drainage the climate is transitional to Selkirk Wet Cold Engelmann Spruce - Subalpine Fir Variant.

Precipitation in the eastern areas can be expected to range from 661 to 1113 mm annually. Below this is the Dry Warm Interior Cedar Hemlock (ICHdw) subzone variant. This zone can be expected to have a light snow pack and hot summers.

Geology

Winlaw Creek is almost completely underlain by competent granite and granodiorite of the mid Jurassic Nelson Batholith. The north-trending Slocan Lake Fault cuts across the south west portion of the drainage. Eocene biotite quartz monzonite underlies a small portion of the drainage area west of the Slocan Lake Fault (Carr, 1986)

During the Fraser Glaciation (~12,000 ybp) glacial ice overlay all of the Winlaw Creek drainage except for the very top of Mount Eccles and adjacent peaks above 2000 metres. As the glacial ice retreated from the valley of Winlaw Creek till was deposited over most of the hillsides. For a period of time following de-glaciation Winlaw Creek flowed into a lake which occupied a large portion of the Slocan Valley. During this time thick deltaic sediments accumulated at the mouth of Winlaw Creek. As the glacial lake drained from the Slocan Valley Winlaw Creek began cutting down through its delta to equilibrate with the lowering water level in the Slocan Valley. Remnant terraces of deltaic sediments occur on both sides of Winlaw Creek where it emerges from it's confined valley[#].

Kame terrace deposits occur discontinuously along the valley bottom on both sides of Winlaw Creek up to the end of Reach 7. Kame terraces are formed by streams flowing along side the glacial ice and are characterized by discontinuous lenses or layers of sandy, cobbly and locally silty sediments. Layers of glacial till which slough off the glacier and adjacent hillslopes often occur intermixed with the kame deposits.

Water Licenses

Winlaw Creek is a consumptive use watershed which serves the community of Winlaw B.C. A total of 55 water licenses are registered on Winlaw Creek. Water license information and the map identifying points of diversion (POD's) are included in Appendix D.

Timber

Most of the Winlaw Creek drainage is under forest license to Slocan Forest Products Ltd. In addition a Woodlot has recently been established in the north western portion of the drainage. (as of 1995)

[#] An excellent exposure of the delta sediments occurs at the start of the old mining road into Winlaw Creek.

Previous Studies

Winlaw Creek Watershed Restoration Program Level 2 Field Assessment (Associated Environmental Consultants Ltd., 1997)

The objective of the Level 2 Field Assessment of the Fish Habitat Assessment Procedure (FHAP) was to map the fish habitat restoration structures within Reach 1 of Winlaw Creek. The report located about 30 sites in Reach 1 that were deemed suitable for installation of pool creation structures in the channel. Detailed designs for log and boulder weirs and deflection structures are included in the report.

Winlaw Creek Watershed Restoration Program Level 1 Fish Habitat Assessment (Associated Environmental Consultants, 1997).

The Level 1 Fish Habitat Assessment provided a detailed survey of fish habitat through the lower 7.4 kilometres of the Winlaw Creek channel and a portion of the North Fork tributary channel.

Winlaw Creek Overview Fish Habitat Assessment (Associated Environmental Consultants Ltd., 1996).

Information presented in this report is based on a preliminary office exercise intended to define reach breaks and channel gradients. Information in the overview assessment report is used to identify portions of the channel appropriate for the Level 1 Fish Habitat field assessment.

Terrain Survey and Management Interpretations for the Winlaw Planning Area (Utzig, G. 1988)

Only the northwestern portion of Winlaw Creek was included in the study area for this report. Information on terrain type, soil development, mass wasting and surface erosion are presented in this study. Recommendations for road construction and location and forest management and planning are also included in this report.

4.0 Hydrological Summary

Water levels in Winlaw Creek were gauged from 1944 to 1948, and 1971 to 1980. In 1996 a new gauge was installed and gauging resumed for 1997. A graph and table of peak flow levels for Winlaw Creek is included in Appendix G. The average peak flow for Winlaw Creek from 14 years of gauging is 5.98 cubic metres per second. The historic daily maximum peak flow was13.6 cubic metres per second which occurred in 1980. Water levels on Lemon Creek which is located just north of Winlaw Creek have been gauged continuously since 1973. A comparison of peak flows for the two streams during the period of overlap shows poor correlation between levels and timing of peak flows (Appendix G). The poor correlation between the two watersheds suggests that the factors controlling peak flows differs significantly between the two drainages. Lemon Creek has an area of 19,453 hectares which is approximately 4 times larger than the drainage area of Winlaw Creek (3891 ha) and contains substantially more high elevation area than Winlaw Creek.

Winlaw Creek flows west and slopes draining into Winlaw Creek have either south or north aspects. Information from individuals who live in Winlaw and are familiar with the drainage indicate that the low elevation south-facing slopes north of Winlaw Creek remain generally snow-free during most of the winter months. Peak flows in Winlaw Creek are most likely controlled by snowmelt from the north-facing slopes south of Winlaw Creek and the high elevation slopes below Mt. Eccles in the headwaters of the drainage. A comparison of the timing of peak flows on Winlaw Creek with Lemon Creek which is controlled primarily by snowmelt from high elevation areas shows that Winlaw Creek peaks on average 2 to 3 weeks earlier than Lemon Creek (Appendix E).

A flood frequency analysis conducted using 14 years of maximum daily peak flow measurements returned the following return period flood flow estimates. As only 14 years of data is available for analysis return period flows beyond 25 years should be considered tentative. Detailed analysis results are provided in Appendix E.

Return Period (years)	Probability	Log-normal distribution estimate (m3/sec).	Gumbel distribution estimate (m3/sec)	Person Type III distribution estimate (m3/sec)	Log Person Type III distribution estimate (m3/sec)
1	0.999	1.55	0.741	1.57	1.39
2	0.5	5.29	5.48	5.36	5.32
5	0.2	8.03	7.81	8.14	8.00
10	0.1	10.1	9.36	9.99	9.97
25	0.04	12.8	11.3	12.3	12.7
50	0.02	15.1	12.8	14.0	14.8
100	0.01	17.4	14.2	15.6	17.2

The daily maximum peak flow of 13.6 cubic metres per second which occurred in 1980 exceeded the estimated 1 in 25 year return period flood flow.

5.0 Geomorphic summary

In it's undisturbed state the morphology of Winlaw Creek is described as a cascade-pool (cobble/boulder) to riffle-pool (cobble) channel in the lower gradient sections with single pieces and small jams of LWD forming an important structural component. The channel pattern varies from confined meandering in Reaches 2 through 7 to irregular meandering on the fan in Reach 1. From Reach 1 to 7 the valley bottom of Winlaw Creek consists primarily of alluvial sediments. Winlaw Creek is laterally stable except during very large flood events. During low flows fine sediment (sand-gravel) is stored in pools and along lateral bars in the riffle sections. Typically only the cobble and smaller bedload is transported during peak flow events. Under natural conditions sediment is delivered to the Winlaw Creek channel through occasional debris flows and slides off the steep valley sides on the south side of Winlaw Creek and from very frequent snow avalanches and debris flow which occur in the steep chutes in the headwaters of the drainage.

A particularly interesting characteristic of Winlaw Creek which was noted during the field assessment is the relatively high frequency of large flood events. Evidence of three major flood events over the last 150 to 200 years is observed along almost all of the main stem channel traversed during the field assessment. The oldest event probably occurred between 150 to 200 years ago and resulted in the deposition of large boulder levees along the channel and caused extensive bank erosion on the inactive flood plain of Winlaw Creek which is least 2 to 3 metres above the present bankfull stage. The second large flood event appears to have occurred between 10 to 20 years ago (possibly during the high flows in 1980) and resulted in extensive bank erosion along the lower reaches of the channel. Although banks through Reaches 1 and 2 stabilized following this event they are not yet overhanging. The most recent high peak flow event occurred during the 1997 freshet. This last flood has resulted in extensive bank erosion and channel aggradation in the upper reaches and an extensive amount of bedload transport through the lower reaches.

As a result of the 1997 flood event the channel of Winlaw Creek from Reach 2 to Reach 7 shows little resemblance to the channel documented in the Level 1 Fish Habitat Assessment which was conducted in 1996.

6.0 Reach Descriptions and Interpretations of Changes

Winlaw Creek

Reach Descriptions

Reach 1

The fan of Winlaw Creek is 2.2 kilometres long. Channel morphology is described as cascade-pool (boulder/cobble) to riffle-pool (cobble) with single pieces of large woody debris (LWD) forming a key structural element. Along the upper segment of Reach 1 the present day Winlaw Creek channel has eroded down through, and is partially confined by, glaciodeltaic sediments deposited by Winlaw Creek during de-glaciation. The average channel gradient is 5% and channel width ranges up to 8 metres. For most of Reach 1 Winlaw Creek is slightly to moderately entrenched in its flood plain (0.5 - 2.0m).

The main disturbance indicators noted through this reach, other than direct disturbance by numerous water intake arrangements and road crossings, are the lack of functioning LWD, disturbed stone lines, the lack of overhanging banks and minimal pool area. As well, moss is lacking from boulders and cobbles in the riffle sections. A number of large debris jams, some quite old and many containing cut wood, have formed in the channel above the highway crossing. Above the debris jams extensive sediment wedges comprised of small cobble and finer material have accumulated. In places the woody debris jams have caused the channel to avulse forming a braided pattern around the jams. In one location a portion of Winlaw Creek is flowing over the forest floor on the flood plain adjacent to the channel.

Other than one location where soil was being pushed into the channel as a result of construction of new water intakes no significant sediment sources were noted along Reach 1.

Reach 1 varies from partially degraded to moderately aggraded above the LWD jams. Overall Reach 1 is interpreted as being partially degraded.

Reach 2

Reach 2 is approximately 750 metres long and extends upstream from the apex of the Winlaw Creek fan up to the point where the channel becomes confined on both sides by steep valley sides. Through Reach 2 Winlaw Creek is typically confined on one side by steep valley sides or bedrock cliffs. The channel morphology is described as cascade-pool (boulder) with single pieces and small jams of LWD forming an important structural component. Channel gradient averages 5 percent and channel width is approximately 8 metres.

Disturbance indicators noted through Reach 2 include minimal functioning LWD, abundant LWD jams (containing cut logs) and single pieces oriented parallel with channel banks, recent bank erosion and minimal pool area. Large sediment wedges consisting mainly of cobble sized material have accumulated upstream of the LWD jams

Very old stream-side harvesting was noted along Reach 2 for the first 600 metres. No recent sediment sources occur along Reach 2.

Reach 2 is interpreted as being partially to moderately aggraded upstream of LWD jams.

Reach 3

Reach 3 is approximately 1.2 kilometres long and is confined on one or both sides by steep valley sides or bedrock cliffs. In a number of locations along Reach 3 bedrock occurs in the channel. The North Fork confluence is the eastern boundary of Reach 3. The gradient of Reach 3 averages 7% and channel width is around 8 metres. The channel is described as a cascade-pool (boulder) channel with large woody debris forming a key structural element.

Disturbance indicators noted through Reach 3 include numerous, recently formed LWD jams with extensive sediment wedges deposited upstream (cobble and finer sediment), minimal pool area and a lack of functioning LWD. One particularly large jam has formed approximately 200 metres downstream from the confluence with North Fork.

Two segments of channel between 200 to 300 metres long through Reach 3 appear to have been completely unaffected by the 1997 high peak flow event. Both of the unaffected channel segments are confined in places by bedrock along the banks and in the channel. Through these sections banks are overhanging and mossy, boulders and cobbles in the channel are mossy, stone lines are well developed and there are abundant pools and functioning LWD in the channel.

At one location along Reach 3 the Winlaw Creek channel has undercut a section of kame terrace sediments (Photo R1/P23, Appendix B) and the slope is raveling down to the active flood plane of Winlaw Creek. This raveling slope is the only active sediment source noted along the main Winlaw Creek channel. During most years the majority of the sediment derived from this slope is the result of surface erosion during snow melt or heavy rain fall events and it is unlikely that it contributes any significant or detectable amounts of sediment to the creek. Significant amounts of sedimentation from this site would be limited to very high peak flows events (> 1in 25yr flows) when it is being actively undercut and eroded by Winlaw Creek.

The disturbance level in Reach 3 varies from stable to moderately aggraded upstream of LWD jams.

Reach 4

The lower 1.3 kilometres of Reach 4 was traversed during the channel assessment. The channel is classified as cascade-pool to riffle-pool (cobble) with large woody debris forming a key structural element. Channel gradient averages 6% and width is around 7 metres.

Some of the disturbance indicators observed throughout this channel segment include extensive recent bank erosion, large amounts of non-functioning woody debris (pushed aside parallel to stream banks), minimal pool area, extensive lateral and mid-channel cobble bars and fresh boulder/cobble levees deposited along the channel margins. In addition, a number of old slides scars occur on the south side of Winlaw Creek along Reach 4. Old boulder levees and bank erosion from the older flood events were also noted along this channel segment.

The disturbance level in Reach 4 is determined to be moderately to severely aggraded.

Reaches 5 to 7 (Helicopter Reconnaissance)

During the helicopter fly-over the upper portions of North Fork and Winlaw Creek were assessed to determine the general condition of the channels. From the point where the Winlaw Creek channel was visible from the helicopter (upper portion of Reach 7) the channel displays characteristics similar to those described for Reach 4. The channel is severely aggraded, banks are eroded, woody debris is pushed aside in places so that it is no longer functioning and numerous recent LWD jams have formed. Lateral and mid-channel cobble bars are abundant and there is minimal pool area.

North Fork Tributary

Reach Description

Approximately 500 metres of the North Fork were traversed on foot. North Fork is a steep (15-20%) step-pool to cascade (boulder/rock) channel that experienced a major debris flow event during the 1997 spring freshet. As a result of the recent debris flow the

channel is moderately aggraded with cobble to sand sized sediment. There is a large number of recently blown down trees in and suspended above the channel. Numerous old natural slide scars are evident along the steep valley sides on both sides of the channel. As well there are a number of recent slides off the old mining road into the channel. Most of the North Fork channel from the apex of the fan up to the headwaters is classified as non-alluvial. On the fan of North Fork the channel is moderately aggraded, banks are eroded and there are abundant lateral and mid-channel bars. Sand occurs as overbank deposits along the channel for the length of the fan.

Interpretations

Winlaw Creek is an extremely active stream channel. Three major flood events have occurred in Winlaw Creek over the last 150 to 200 (approx.) years - the most recent event occurred during the 1997 spring freshet. Following the 1997 flood event a large quantity of sediment (cobble and finer) became incorporated into the stream channel mainly as a result of bank erosion. Due to the 1997 flood most of the channel from Reach 2 through Reach 7 and the North Fork tributary is interpreted as being moderately to severely aggraded.

The large volume of sediment recently incorporated into the stream channel will eventually move downstream to the fan. Due to the lack of functioning woody debris upstream of Reach 1 the rate of sediment transport can be expected to be higher than normal over the next 30 to 50 years as the recently formed LWD jams in the upper reaches break apart and before new LWD is fully incorporated into the channel.

The partially degraded condition of the channel through Reach 1 is likely the result of the last high flow event (1980?) experienced in Winlaw Creek. In a few locations old pieces of LWD were noted on lateral cobble/boulder bars oriented parallel to channel banks. The lack of newly incorporated LWD in the channel is probably, in part, due to development activities adjacent to the channel through this reach.

Through the lower 1.5 kilometres of Reach 1 Winlaw Creek is confined by 1 to 1.5 metre high channel banks. During large flood events the channel of Winlaw Creek could easily shift over its low wide flood plain. Development including private property, the highway and commercial developments along the highway are likely to experience significant impacts during major flood events.

During the fly-over it became apparent that the debris flow in North Fork had initiated in the snow avalanche chutes in the uppermost portion of the channel (western fork). Similar debris flow scars in snow avalanche chutes were observed in the steep headwater channels of Winlaw Creek. The flood that occurred during the 1997 freshet is believed to have initiated in Winlaw Creek as a number of debris flows (snow slurry-debris flows?) in the upper headwater channels converged at the upstream end of Reach 7. The debris flows in the steep headwater channels were triggered during a period of abnormally high temperatures (23°C at headwaters of Smallwood Creek on May 15th, 1997, MoF Climate

Station data) that occurred while there was still a deep snowpack over most of the drainage.

7.0 Discussion and Risk Assessment of Proposed Restoration Works

The proposed restoration works to increase spawning habitat through Reach 1 of Winlaw Creek include the construction of boulder and log weirs through the central portion of the channel and deflection berms along the margins of the channel (Associated Environmental Consultants Ltd., 1997).

In an undisturbed condition, pool development on the fan of Winlaw Creek is controlled primarily by the incorporation of large trees which fall into the channel from along the channel banks during high peak flow events or as they begin to decay. Typically the root wads at the base of the tree act to anchor the tree to the channel bank and provide some stability to the fallen tree for a number of years. Downstream from the fallen tree turbulence from the flowing water creates an area of scour on the channel bottom and eventually a pool is created.

Other locations where pool development would be expected to occur in the undisturbed channel include intervening channel segments between riffles or cascades and beneath overhanging banks at points where the channel is meandering.

As described in Section 6.0 the channel on the fan of Winlaw Creek has experienced disturbance from a number of factors including at least three major flood events, water intake construction and private and commercial development along the riparian area adjacent to the stream channel. Of these disturbances the frequent flooding of Winlaw Creek, which appears to occur at least once every 20 to 50 years, has the most significant impacts on the channel. During the high peak flow events a significant amount of cobble and boulder bedload is mobilized, large woody debris is flushed through the channel and banks are eroded.

In an undisturbed condition these frequent floods would infill existing pools and create new pools in other locations. The development activities which exist in and adjacent to the channel have, to some degree, inhibited the development of pools by removing existing and recruitable LWD from the channel and riparian areas and altering the flow dynamics of the channel with various in-stream construction activities.

It is unlikely that the spawning enhancement and pool habitat creation prescriptions proposed in the Level 2 FHAP will function successful in Winlaw Creek over the long term (10 to 20 years) due to the naturally high rate of bedload transport through the Winlaw Creek channel. Shorter duration habitat creation structures such as anchored tree root wads along the banks to create overhanging bank habitat or placement of LWD or boulder steps and/or boulder cascades in the channel to encourage pool and riffle development may be more appropriate prescriptions when considering the natural channel processes identified in Winlaw Creek. These measures should not be considered where the

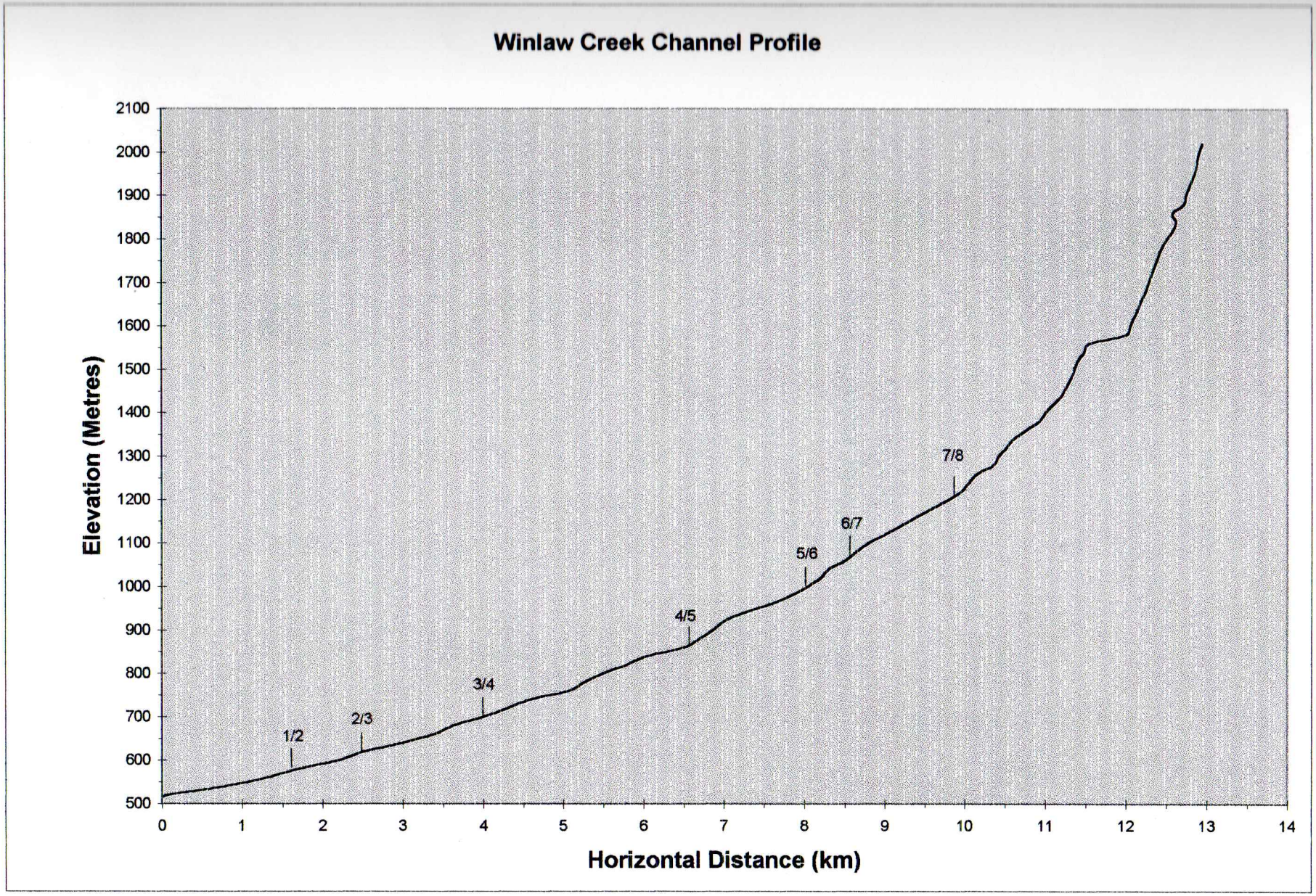
channel is not well entrenched (2 metres or more) in the flood plane due to the potential for channel avulsion and flooding in the adjacent riparian areas.

9.0 Closure

The procedure used to conduct this channel assessment is in accordance with the current standards and guidebooks. This assessment is intended to identify channel morphology, interpret changes in channel morphology, identify types and causes of channel disturbance and provide recommendations for channel restoration measures. Interpretations of stream channel stability are based on observations of current conditions. Should existing conditions change channel stability could change as well. No other warranty, expressed or implied, is made.

Respectfully Submitted,
Apex Geoscience Consultants Ltd.

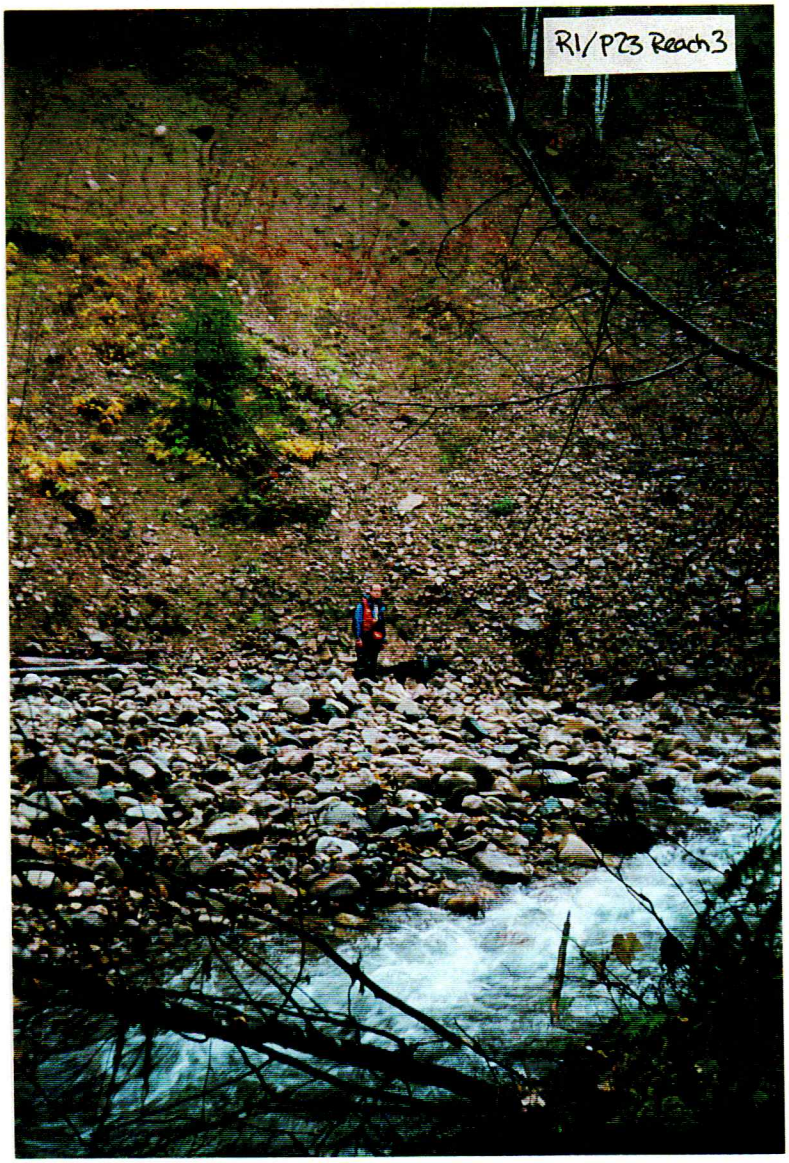
Kim Cuthen, M.Sc., P.Geo.


Winlaw Creek Channel Profile
Elevation (Metres)
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Horizontal Distance (km)
1/2
2/3
3/4
4/5
5/6
6/7
7/8

Winlaw Creek Reach 1. Cobble/boulder wedge behind LWD jam.

Winlaw Creek Reach 1. Bank Erosion due to 1980 flood event.

Winlaw Creek Reach 3. Short section of channel unaffected by 1997 flood event. Banks overhanging, LWD in channel.



Winlaw Creek Reach 3.
Only significant sediment source noted along Winlaw Creek. Most sediment entering the channel here is due to surface erosion. Note: Rilling.