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Watershed Condition Report

for

Twig Creek

Tree Farm License 49
(Vernon Forest District)

Prepared for:

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1.0 INTRODUCTION

This watershed condition assessment and report has been completed on the Twig Creek watershed for Riverside Forest Products Limited (RFPL). The purpose of the assessment is to address resource agency concerns with forest harvesting and road construction activity shown on the current (2000 – 2005) Forest Development Plan (FDP) for Tree Farm License (TFL) 49.

Twig Creek is a tributary to the Salmon River upstream of Westwold, BC with a watershed area of approximately 4,300 ha. Steep confined lower channel reaches leading up to a broad elongated mainstem valley dominated by marshlands and beaver ponds characterize the lower and middle watershed area *[Map – Appendix A]*. Tributaries to the mainstem and marshland area include Jupiter Creek entering from the southeast, and a larger un-named system entering from the northwest, defined as Upper Twig Creek for this review.

Early harvesting in the Twig watershed was confined to Interior Douglas Fir stands on lower slopes adjacent to the Salmon River. More recent development began in the mid-1980's with greenwood harvesting located throughout the middle and upper watershed area. Since the mid-1990's beetle salvage activity has dominated forest development plans focused mainly on middle elevation pine stands on both the southeast and northwest sides of the elongated mainstem valley. Considerable salvage activity is planned in the current FDP in addition to some greenwood development.

In 1998 Forsite Consultants Ltd completed an Integrated Watershed Restoration Plan (IWRP) on the entire Salmon River watershed. The IWRP included an Interior Watershed Assessment Procedure (IWAP), Sediment Source Survey (SSS), Channel Assessment Procedure (CAP) and Access Management Plan (AMP). Site-specific sediment source and channel stability issues were identified in the Twig watershed and risk rated for the purpose of directing follow-up restoration and rehabilitation work.

It is important to note that the IWRP process was designed to identify past forest development related disturbance in a watershed or other identified area and make

recommendations for remedial action. The IWRP process and component parts are not intended nor designed to comment on or direct future forest development activity (i.e. they are not forward-looking exercises).

It is also important to note that RFPL had concerns with the IWRP identification of past forest development related effects on the Salmon River watershed, generally, and in particular the standards by which risk priority ratings were derived and the implied cause and effect relationship between noted areas of concern and past harvesting and road construction activity. These concerns lead to few if any restoration prescriptions being developed for IWRP priority sites in the Twig watershed. In short, priority demands on Watershed Restoration Program (WRP) funds were determined to be higher in other areas of the Salmon River watershed or elsewhere within the RFPL operating area.

With resource agency concerns in mind regarding IWRP priorities and planned forest development activity, the objective of this report is to answer the following questions:

- What were the results and recommendations of the various component assessments within the IWRP, and can they be used to help define the current condition of the watershed and/or help guide future forest development and restoration planning in Twig Creek?
- Where are the IWRP priority sites, what effect have they had on the condition of the watershed, and what restorative measures might be required to mitigate detrimental effects?
- What is the current condition of the watershed with respect to water quality, water quantity and the cumulative effects of past forest development on Twig Creek and the larger Salmon River?
- What are the anticipated effects of planned forest development and what recommendations can be provided to mitigate potential detrimental effects on the water resource?

2.0 METHOD

To address these questions copies of the Salmon River IWRP report and maps, and current FDP were requested from RFPL. After reviewing this information specific water related concerns and IWRP results were discussed with RFPL planning and forest development staff. A field review strategy was developed to review all SSS and CAP sites in addition to other suitable channel and sediment source locations as required to determine the current condition of the watershed and potential effects of planned development.

Past harvest and hydrologic recovery (ECA) levels were calculated for the watershed by RFPL. An H60 elevation of 1,160 m (as in the IWRP) was used in the calculations with site indices and growth rates obtained from forest cover files. Twenty-five percent of the area within beetle management settings was included in the

calculations based on beetle probe estimates available at the time of report completion. The 25 % estimate was defined by RFPL staff as a conservative measure of the net area likely to be harvested within known beetle infestation areas by 2005. It was noted in the calculations that additional harvesting would likely be required in known beetle infestation areas beyond 2005, dependent upon future beetle probe surveys.

3.0 ASSESSMENT

A summary of IWRP results and observations made at each SSS and CAP priority site is presented in the following section. The AMP was not reviewed for this report. Detailed comments and recommendations from each SSS and CAP site review are presented in tabular form in Appendix B. It is recommended that the SSS and CAP tables be reviewed with the respective IWRP maps, as well as that provided with this report *[Appendix A]*.

Following the IWRP review, the current watershed condition is discussed from a channel stability and in-stream sedimentation perspective. A review of planned FDP activity, and suitability with respect to natural drainage and sediment management characteristics of the watershed completes the section.

3.1 IWRP Review

IWAP

The Level 1 IWAP completed in 1998 reported a moderate peak flow hazard rating for Twig Creek mainly attributed to road density. The surface erosion hazard rating was reported to be high based on the number of stream crossings, road density and length of road within 100 m of a stream. The riparian buffer hazard rating was also reported to be high based on the proportion of stream harvested to the bank. The landslide hazard rating was low.

Under the then current IWAP and IWRP procedures, moderate and high hazard ratings reported in the Level 1 IWAP necessitated the completion of a channel assessment procedure to determine the cumulative effects of perceived impacts on the channel system and water resource. The sediment source survey and access management plan components were required under the IWRP process to identify road and hillslope related sediment point sources, and make recommendations for remedial action consistent with current and future watershed access requirements.

As mentioned previously, the Level 1 IWAP was designed to assess potential detrimental effects on water resources from past forest development activity only. It was not intended to be a tool to assess the potential effects of planned development nor assist in guiding future development activity.

While limited by the office-based nature of the calculations, the Level 1 IWAP results are useful for watershed condition reporting in identifying areas of potential concern to be examined in the field. In the case of Twig Creek, 1998 IWAP results suggest possible sedimentation increases in channels, a reduction in bank stability in harvested riparian areas and potential in-stream disturbance from increases in peak flow. These issues are addressed in section 3.2

SSS

The sediment source survey completed in Twig Creek identified 23 moderate, high and very high risk road related SSS sites. No landslides were identified.

All of the above SSS sites were reviewed in the field and photographed where possible. In general, the combination of benign terrain and very well drained soils in the Twig Creek watershed has limited potential sediment contribution to streams from roads. Many of the priority SSS sites reviewed represented areas of exposed soil such as road cut and fill slopes with no physical connection to watercourses *[Photo 1 – Appendix C]*(i.e. no sediment can be delivered from the sites to the channel system). The identification of these types of sites represents a weakness in the IWRP process whereby aerial photographs are used to identify areas of exposed soil, or perhaps what appear to be areas of exposed soil, that may or may not be field checked. Not all potential SSS sites are required to be field checked in the IWRP process, and criteria used to assign risk and priority ratings normally include map derived slope gradient and proximity to watercourses. On numerous occasions priority sites simply could not be found, or watercourses mapped at suspect crossings turned out to be dry gullies or draws with no sediment transport potential.

In spite of the general lack of SSS concern, several sites were reviewed where some follow-up action may be required. These include a failing wood culvert at site 936 *[Photo 2]*, and running surface and ditchline erosion at site 190 (T4160 Road). The wood culvert at site 936 represents a low risk of sediment delivery to Twig Creek should the structure fail *[Photo 3]*, but could be removed or replaced for safety and/or liability reasons. In one instance at site 212, road erosion and sediment input to streams has occurred in the past but the road is now armoured and stable. Reactivation of this road section would likely reinstate erosion if drainage improvements were not made (un-named northwest branch of the Twig Road). The last area of concern is located on the distal end of the Falkland Dogsled Park access road (sites 195, 196). The road has been deactivated but ongoing sediment input is occurring from cattle use. Rehabilitation efforts at these sites would likely be futile unless cattle access is controlled. This issue could be brought to the attention of the Ministry of Forests Range Officer and Range Use Permit Holder.

CAP

The channel assessment in Twig Creek reviewed stability and sedimentation levels at six locations throughout the watershed. All channels were determined to be stable with the exception of the Upper Twig tributary on the alluvial fan between the Private Mainline crossing and Twig mainstem channel. Two sites were reviewed on the fan where past harvesting had reduced bank stability, and sediment input from bank erosion was a concern. Bank stabilization was recommended for portions of the channel where past harvesting in the riparian zone had occurred.

A review of CAP sites for this report resulted in similar conclusions with respect to stability. The sites on the Upper Twig fan are a concern but it is unlikely that rehabilitation efforts could restore stability with continued cattle use. It is important to note that while this observed disturbance likely has affected local water quality and resident fish habitat, no surface connection is present between this channel and the Twig mainstem. Stream flow is distributed over the lower fan, partly due to cattle trample and diversions, resulting in absorption into the porous fan material and deposition of entrained sediment before reaching Twig Creek. It is also important to note that is disturbance is site-specific in nature and not the result of cumulative effects from upstream or upslope harvesting. Evidence to support this conclusion comes in the stability of the channel on the upper fan, immediately upstream of the disturbance. The channel in this location shows no evidence of un-natural bank erosion, bed scour, or sedimentation, and the riparian zone is intact and functional.

Further discussion of the site-specific and cumulative effects of past forest development on channel stability, sedimentation and stream flows is presented in section 3.2. Additional channel information from sites not reviewed in the CAP is also presented.

3.2 Watershed Condition Assessment

Streams

In addition to CAP site reviews, the Jupiter Creek system, Upper Twig tributaries and Twig mainstem, both within the canyon and on the fan at the Salmon River were assessed.

Jupiter Creek is stable with a sand and gravel bed, moss covered banks, and no evidence of increased sedimentation or runoff effects *[Photo 4]*. The channel was assessed throughout the basin and on the lower mainstem at the Wood 200 Road crossing. The size of the main Jupiter channel is abnormally small when compared to upstream drainage area. This observation can only be explained by high soil infiltration capabilities and low drainage density (length of stream per km^2) that is present in the watershed. These characteristics permit a large

proportion of snowmelt or rainfall to enter the soil and move downslope either as sub-surface flow or ground water, rather than streamflow. The result is a natural buffering effect on runoff rates and streamflow volume, which translates into a low sensitivity to potential runoffs effects that can be realized by natural fluctuations in snow pack and precipitation, as well potential effects from forest harvesting and road construction. To support this conclusion, no disturbance was noted in the Jupiter channel despite abnormally high natural stream runoff throughout the Okanagan valley in the spring of 1996 and 1997. In addition to the buffered runoff effects, the Jupiter channel enters the broad Twig mainstem valley in a marsh from which sediment transport into lower Twig Creek is not possible.

Upper Twig Creek is also proportionally small with respect to drainage area, and the basin possesses similar well-drained soils and a low drainage density. The entire Upper Twig tributary system has remained stable with past forest harvesting and road construction, with the exception of the site-specific effects on the fan channel *[Photo 5]*. As discussed previously, the disturbance on the fan is not related to cumulative effects, but rather ongoing site-specific disturbance initiated by past harvesting, and exacerbated by ongoing cattle access *[Photo 6]*.

Vast marsh, wetland and beaver pond complexes dominate the Twig mainstem system in the middle watershed area. The presence of these low gradient features on the mainstem has the effect of increasing runoff lag time (i.e. time to peak flow) and reducing peak discharge volume, effectively reducing potential runoff effects on the lower mainstem system that can be realized in high snow accumulation years or with intensive upstream forest harvesting and road construction. The mainstem channel was inspected throughout this area and no evidence of bank erosion, bed scour or beaver dam release was noted. These observations are considerable in light of abnormal runoff levels in 1996 and 1997, and support a low sensitivity of the watershed to changes in snow accumulation and runoff.

The Twig mainstem is well incised through the canyon reach between the wetlands and the fan on the Salmon River. The canyon is characterized by natural rock falls associated with columnar basalt outcrops whereby large blocks are introduced to the stream on a regular basis *[Photo 7]*. At the apex of the fan boulder and cobble deposits in the form of small fans, terraces and levees are present likely from sporadic natural rockfall events in the canyon *[Photo 8]*. These rockfalls are not related to harvesting or other land-use practice and represent the main source of sediment to the lower system.

On the fan the Twig mainstem is stable with a functional riparian zone and no evidence of scour or erosion that could be attributable to peak flow increases or elevated sedimentation levels *[Photo 9]*. Some historic selective harvesting has taken place on the fan but the riparian zone remains intact. Well drained soils, low drainage densities and extensive marsh and wetlands in the middle and upper watershed have undoubtedly buffered any runoff or sedimentation effects that

might have been realized on the fan by abnormal snowpack levels in 1996 and 1997, or upstream forest harvesting. Based on observations of stability throughout the Twig watershed and on the fan, it does not appear that the Twig system or land-use activity within has been the source of any detrimental effect on the Salmon River in recent history (last 30 years).

Sediment Sources

In total approximately 90% of all roads were traveled in the Twig watershed either en route to SSS sites or otherwise. No additional sediment source concerns related to roads or harvesting activity were noted. In general, road running surfaces appeared stable, cross-drain frequencies were adequate, cross-drain placement was appropriate, and sediment controls such as grass seeding have effectively stabilized exposed soils associated with roads and cutblocks.

The large natural rock falls in the Twig Canyon represent the most significant source of coarse sediment to the lower Twig system. These sediment source locations were not identified in the SSS report, which may represent an oversight or mapping error. In the adjacent drainage of Weyman Creek, numerous slides were mapped in the IWRP along the lower canyon reaches, yet a review of the canyon revealed that no slides are present. These observations would support the theory of a simple mapping error between drainages.

Watershed Condition Summary

Past harvesting and road construction in the Twig watershed has been significant based on a simple review of the FDP map, yet the Twig Creek watershed is in very good condition with respect to water quality and quantity. Based on forest cover files, the current (December 2000) equivalent clearcut area (ECA) was calculated to be 29% for the watershed and 15% above the H60 elevation. Many of the old openings in the Twig drainage show regeneration less than 3.0 m in height, but field reviews of the area revealed well-established coverage in these blocks, with heights approaching 3.0 m. This indicates a positive hydrologic recovery trend in the near future as the well-established seedlings enter a period of more rapid growth beyond approximately 3.0 m in height.

Noted disturbance in the watershed is related to site-specific riparian management and road erosion, and not attributable to cumulative forest harvesting effects such as increases in peak discharge, widespread road erosion, or mass wasting impacts. Evidence to support this conclusion comes from observed stability throughout the watershed and no obvious sedimentation increases in tributary and mainstem channels.

As mentioned previously, well-drained soils, low drainage density, extensive marsh and wetlands, and relatively benign terrain appear to be key factors in minimizing potential road and harvesting related disturbance. These terrain and

soils characteristics tend to reduce runoff volume and rates, and subsequently both erosion and sediment transport capabilities. The presence of the broad low gradient mainstem valley, dominated by porous soils, and marsh and wetland complexes prolongs runoff time, effectively reducing potential peak flow magnitudes as vast areas of the valley bottom required flooding before peak discharge can be reached on the outlet channel. All inlet and outlet channels from the marsh, wetland and beaver dam complexes are stable, and beaver dams were intact at the time of the field review.

3.3 FDP Review

Development planned in the current FDP is concentrated in a large aggregate beetle salvage effort along both sides of the broad mainstem valley, with several green wood and smaller salvage proposals at higher elevations in both the Jupiter and Upper Twig basins. With planned development, including all category I blocks, the watershed ECA is expected to increase to 39%, with 20% above the H60 elevation. It is important to note that development shown on the current FDP map represents planned harvesting over a period in excess of five years. Most of the development is planned around the H60 elevation on relatively uniform well-drained slopes leading directly to the marsh and wetland dominated mainstem system. While this level of planned harvesting, albeit significant in general watershed management terms, simply does not represent a significant hydrologic risk with respect to increases in mainstem stream discharge based on the soil, drainage and wetland characteristics of the Twig system as described in the preceding sections. The broad low-lying mainstem valley of Twig Creek, represents perhaps the most appropriate location reviewed by the author to date in the Vernon Forest District for the situation of a large aggregate clearcut proposal.

In the Upper Twig basin, greenwood and salvage proposals above the H60 elevation are limited (based on FDP map review) and are not expected to affect stream flow or exacerbate disturbance on the lower fan area. The Upper Twig system upstream of the fan is stable and should remain so with greenwood and salvage harvest above the H60. Most of the planned development in the Upper Twig basin is concentrated on lower slopes adjacent to the mainstem where snow accumulation levels are low, the soils are porous and drainage density is low. Development in these areas should not affect peak discharge in Upper Twig Creek and represents a low risk from a hydrologic perspective.

In the Jupiter basin the bulk of planned development is located below the H60 elevation with several greenwood blocks planned in the upper east side of the drainage. The maximum elevation in upper Jupiter Creek is approximately 1,300 m, which is not representative of an elevation where high snow accumulation levels can be expected. Terrain in the Jupiter basin is very benign and the low drainage density can be seen on the FDP map. These characteristics in addition to sandy well-drained soils throughout the basin should limit any potential effects that harvesting might have on stream discharge. As in the Upper

Twig basin, lower elevation harvesting proposals should not affect spring runoff levels, or reduce channel stability.

Past road related effects on sedimentation and runoff are site-specific in the Twig watershed and can be addressed through minor drainage improvements. Low drainage densities throughout the watershed have minimized road related drainage diversions and sediment input to channels. Based on these characteristics, planned road construction and use is not expected to have a significant effect on stream sedimentation or runoff with application of standard Forest Practices Code (FPC) requirements.

Streams and riparian areas associated with planned development in the Twig watershed can also be adequately managed with FPC requirements. Ongoing disturbance on the Upper Twig fan will continue despite upstream development until range management issues are resolved.

In summary, planned greenwood and salvage development in the Twig watershed is acceptable from a hydrologic perspective for the following reasons:

- The watershed has low sensitivity to increases in peak discharge and detrimental effects of forest harvesting, generally, as a result of well-drained soils, low drainage densities, and extensive marsh, wetland and beaver pond complexes on the Twig mainstem.
- The Twig mainstem channel is stable on the fan and throughout its lower, middle and upper reaches. It does not appear that the Twig system or land-use activity within the drainage has been the source of any detrimental effect on the Salmon River in recent history (last 30 years).
- Past disturbance from forest harvesting and road construction is site-specific and not related to cumulative effects on peak discharge or stream sedimentation.
- Upstream harvesting or road construction should not affect observed disturbance on the Upper Twig fan, but recovery will be delayed until cattle access is restricted.
- Potential road related effects on water quality and runoff are also site-specific in the watershed and can be addressed through minor drainage modifications on existing roads, and continued application of FPC standards for maintenance and new road construction.

4.0 RECOMMENDATIONS

- Apply standard Forest Practices Code standards to all development planned in Twig Creek from 2000 to 2005.
- Consider addressing the two sediment source concerns in the Upper Twig basin while accessing salvage and greenwood development in the area.
- Notify the Ministry of Forests Range Specialist and Range Use Permit holder regarding cattle access concerns on the Upper Twig fan and at the distal end of the Falkland Dogsled Park access road. If cattle access can be controlled on the fan consider WRP riparian and bank restoration effort to expedite channel recovery.

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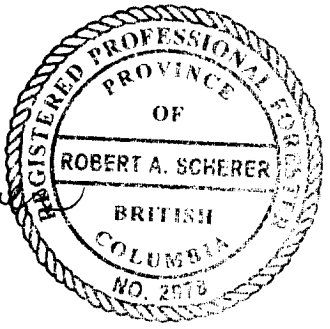

APPENDICES

APPENDIX A

Project Map

APPENDIX B

IWRP Site Review Tables

Twig Creek - Sediment Source Survey - Review Summary Table

IWRP SSS Site #	Sediment Source Type	IWRP SSS Risk	IWRP SSS Priority	Review Comments	Recommendation
3	Road	M	M	Drains onto grass below the road with no connection to a watercourse	No action required
27	Road	M	M	Flat road, fine textured surface but no sediment transport from site	No action required
28	Road	M	M	No visible erosion and not connected to a watercourse	No action required
29	Road	M	M	Exposed cutslope, no visible erosion and not connected to a watercourse	No action required
30	Road	VH	L	Minor surface erosion, not connected to a watercourse	No action required
35	Road	M	M	Old road cutslope, coarse textured and seeded, not a concern	No action required
36	Road	M	L	Old road cutslope, coarse textured and seeded, not a concern	No action required
37	Road	VH	M	Minor ditch erosion, not connected to a watercourse	No action required
38	Road	VH	M	Minor ditch erosion, not connected to a watercourse	No action required
39	Road	M	M	Exposed cutslope, no visible erosion and not connected to a watercourse	No action required
78	Road	VH	M	No cross drain present, dry ditchlines, no connectivity to watercourses, no site found	No action required
80	Road	M	M	No exposed soil site visible on the mainline at this location	No action required
189	Road	M	M	Flat road, no source of sediment found, no connection to a watercourse	No action required
190	Road	M	M	Road rutting and erosion into small tributary	Waterbars or more intensive deactivation
194	Road	M	L	Minor ditch erosion, not connected to a watercourse	No action required
195	Road	VH	H	Deactivated road, erosion and sediment input to tributary from cattle use	Notify MoF and range use permit holder
196	Road	M	L	Deactivated road, erosion and sediment input to tributary from cattle use	Notify MoF and range use permit holder
197	Road	M	M	Flat road, no sediment delivery to a watercourse	No action required
198	Road	M	M	Flat road, no sediment delivery to a watercourse	No action required
199	Road	M	M	Rutting and minor erosion on flat road, sediment input to dry draw with no connectivity	No action required
200	Road	M	M	Minor ditch and running surface erosion, not connected to a watercourse	No action required
212	Road	M	L	Old running surface and ditch erosion with input to tributary channel. Now armoured.	Improve drainage if reactivated.
936	Road	VH	M	Failing wood culvert on overgrown road. Low risk of sediment delivery to Twig Creek. May represent safety and liability risk.	Remove or replace.

Twig Creek - Channel Assessment - Procedure Review Summary Table

IWRP CAP Site #	Site Location	IWRP CAP Channel Descriptor	Review Comments	Recommendation
78	Twig Mainstem	Stable	Low gradient marsh channel, stable	No action required
79	NW channel - lower fan	Minor aggradation - A1	Cattle trample, localized water quality and fish habitat disturbance	Notify MoF and range use permit holder
80	NW channel - upper fan	Moderate aggradation - A2	Active bank erosion initiated by past RMA harvesting, exacerbated by cattle use - preventing recovery	Notify MoF and range use permit holder
81	Tributary to NW channel	Minor aggradation - A1	No channel disturbance noted	No action required
106	Twig Fan at Salmon River	Stable	Stable fan channel with functional riparian zone	No action required
152	Tributary to NW channel	Stable	No channel disturbance noted	No action required

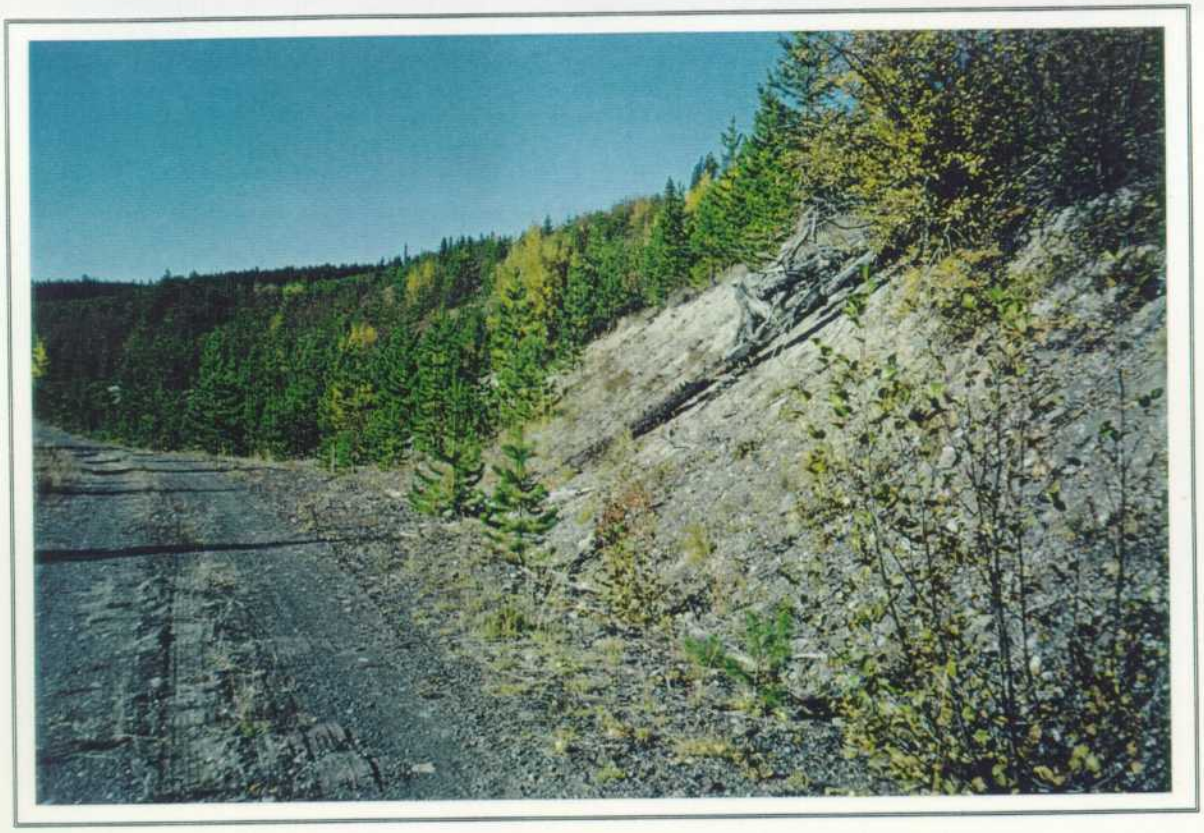

PHOTO 1. SSS site 29 on the Twig Road. Example of a typical moderate risk and priority site likely not reviewed in the field. There is no connectivity to a watercourse from this dry raveling cutslope.

PHOTO 2. SSS site 936 – failing wood culvert on small tributary stream. May represent a safety or liability issue.

PHOTO 3. Small tributary downstream of site 936. Low sediment transport potential.

PHOTO 4. Jupiter Creek downstream of the Wood 200 crossing. No sedimentation, channel or bank disturbance concerns.

PHOTO 5. Upper Twig tributary on fan initially disturbed by past harvesting in the riparian zone. Note erosion around root wads and grazing on the banks.

PHOTO 6. Upper Twig tributary on the lower fan showing past harvesting to the banks and cattle access to the stream. Sediment delivery to Twig Creek from this site is not possible, but local water quality and resident fish habitat has likely been impaired.

PHOTO 7. Natural raveling slopes directly connected to Twig Creek in the canyon. Note blocks present from upslope columnar basalts.

PHOTO 8. Twig Creek mainstem at the apex of the alluvial fan at the Salmon River. Note elevated boulder and rubble banks in the background and blocky bed material from rockfall input in the canyon.

PHOTO 9. Lower Twig mainstem approximately 20 m upstream of the Salmon River confluence. Stable channel with functional riparian zone.