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982-2643

Attention: Morris Archibald

**Re: Preliminary Hydrologic Assessment of Forest Harvesting in Solomon Creek Basin**

Dear Morris,

We have completed our preliminary assessment of potential hydrologic impacts to Solomon Creek basin. The following letter report is a brief summary of our assessment, based on the helicopter reconnaissance and the topographic information you were able to provide. In summary, many of the potential impacts due to harvesting are naturally mitigated by the front range mountains along the western edge of the basin because the high percentage of alpine area results in high surface runoff controlling both the timing and magnitude of peak flow events. Despite the natural mitigation, some hydrologic impacts are anticipated if all of the operable area is logged. The primary source of hydrologic impacts due to harvesting will be from large scale cutting of subalpine areas, and from harvesting of the valley flat near Black Cat Ranch. Measures for minimizing these impacts are recommended herein. The assessment follows.

**1. INTRODUCTION**

Solomon Creek is located west of Hinton Alberta, where it drains areas north of the Athabasca River, in the upper foothills of the Weldwood Forest Management area (FMA). Solomon Creek also drains areas outside the FMA. The latter consist of front range mountains in the Boule Range with a high percentage of alpine habitat.

Solomon Creek receives 500 to 700 mm of precipitation annually (HydroConsult, 1997). However, precipitation measurements are made at low elevation in the Athabasca River valley. Significantly greater precipitation is expected at higher elevations.

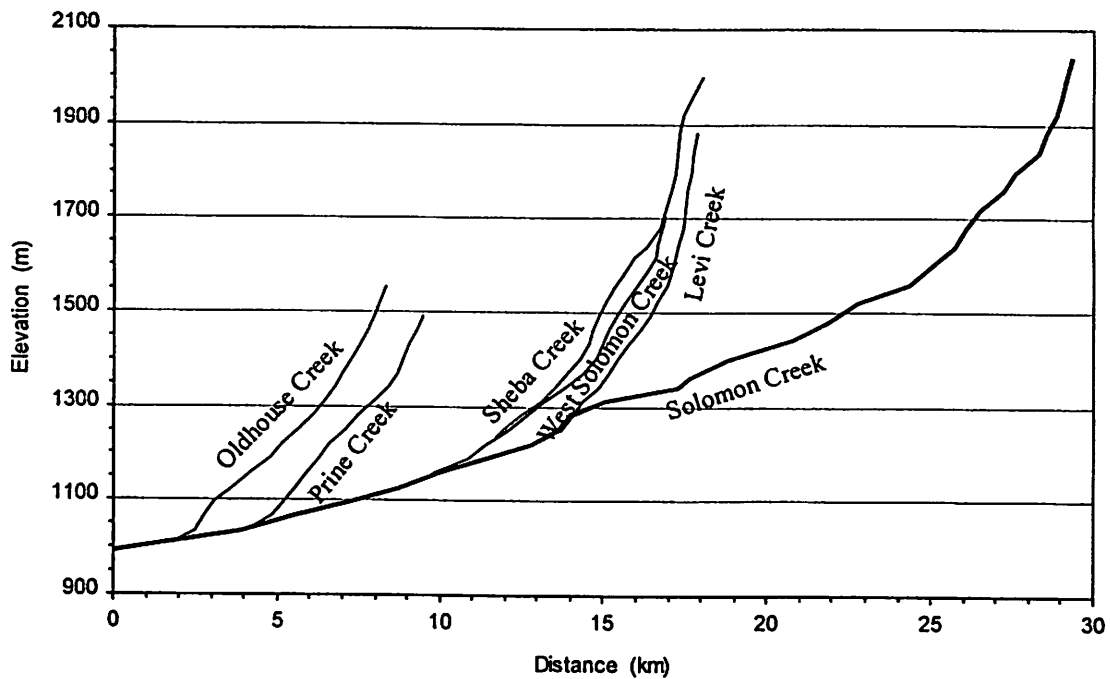
The drainage basin of Solomon Creek is 174 km<sup>2</sup>. Solomon Creek sub-basins, as summarized by Table 1, Figure 1 and Figure 2 (map showing Solomon Creek Watershed Area and relationship to F.M.A. boundary), all drain from the alpine areas of the front range. Figure 1 shows a valley profile for Solomon Creek and its major tributaries, illustrating the change in slope from the high gradient front range areas to the valley flats near the confluence with the Athabasca River. The tributaries of Solomon Creek have a significant percentage of alpine area, except for Prine Creek and Levi Creek. The valley of Solomon Creek includes several plateaus or benches, all of which appear to be previously mined or logged. Sediment discharge from Solomon Creek basin is currently dominated by erosion of coarse material from the front range mountains. The most distinct erosional feature is the large gully in the upper watershed of the Solomon Creek main channel, below the gorge near Mount Kephala.

The Solomon Creek valley is characterized by fluvial outwash deposits in the form of a broad, flat valley bottom with numerous abandoned floodplain terraces. Solomon Creek wanders through the valley, with frequent channel avulsions. Upstream of the trestle rail bridge, the avulsions are primarily due to deposition of coarse sediment. This deposition area is controlled by a narrow gorge immediately upstream of the trestle rail bridge. The gorge limits the wandering character of the channel, and provides gradient control. Downstream of the trestle rail bridge Solomon Creek splits into several branches, although the main channel meanders along the eastern edge of the valley bottom. Channel avulsions frequently occur because of debris jams. The broad floodplain downstream of the bridge is densely forested, and there appears to be significant beaver activity. Several wetland areas along the east side of the floodplain are created by beaver dams.

Table 1. Summary of Solomon Creek Drainage Basin.

Creek Name	Catchment Area (km <sup>2</sup> )	Alpine Area (km <sup>2</sup> )	Alpine Area (%)
Solomon Creek	174.3	30.3	17.4
Oldhouse Creek	17.3	3.5	20.0
Prine Creek	9.9	0.2	1.5
West Solomon Creek	28.8	10.0	34.9
Sheba Creek	12.2	4.7	38.5
Levi Creek	8.9	0.5	5.6

Figure 1 Valley profile of Solomon Creek and tributaries.



## 2. HYDROLOGIC SENSITIVITY OF THE BASIN

An evaluation of Solomon Creek sensitivity to hydrologic change was conducted based on existing physiographical and hydrological basin characteristics, a helicopter site reconnaissance, and available scientific studies on the impacts of forest harvesting on fluvial geomorphologic properties such as peak flows, low flows, and stream morphology. The evaluations follow.

- Water yield is expected to increase slightly due to reduced evapotranspiration. Model analysis for water yield (by both the Foothills Model Forest and Golder using the WRENSS model) suggest that the maximum change in water yield is less than 10%. Figure 3 illustrates water yield changes based on the Golder analysis. Note that the assumed clear-cut area is conservatively high at 100% of the operable area within Solomon Creek Basin. Water yield increases will most likely be in the form of increased seepage, and subsequent groundwater discharge in the valley bottom. Increased surface runoff should only occur in areas with shallow bedrock, or relatively impervious soils or when road cuts intercept groundwater seepage. The duration of this impact is dependent on the rate of "hydrologic greenup" (forest regeneration) and the return of evapotranspiration to pre-harvest levels.
- Low flows are expected to be somewhat higher; that is, more flow is expected during late summer and fall. This is a common hydrologic response to forest harvesting. Low flow characteristics should return to normal following "hydrologic greenup."
- Peak flows due to snowmelt are not expected to increase because peak flows in the basin are governed by surface runoff from the alpine areas that are outside of the Weldwood FMA. Logging would be conducted on the valley terraces and lower slopes where snowmelt occurs two to three weeks before the peak flow occurs. The likely result is that snowmelt runoff from the lower slopes and valley bottom will be higher and earlier, but will not contribute to the peak flow. Harvesting is expected to separate the timing of the snowmelt in the valley bottom and the alpine areas, leading to more asynchronous snowmelt involving earlier melt, longer duration snowmelt flooding, but lower peak flows.
- Peak flows due to rainfall precipitation are not expected to increase significantly. Solomon Creek exhibits signs of a "flashy" system controlled by surface runoff from relatively impervious exposed rock in the alpine areas. These areas have a high percentage of runoff compared to total precipitation. Indications of this include relatively coarse channel bed armouring, evidence of extensive gravel and cobble

deposition, and poorly-vegetated riparian zones along the main channel. Sight increases in water yield from cut blocks may slightly increase peak flows during precipitation events, but channel evolution appears to be dominated by high runoff coefficients in the alpine areas.

- No increase in summer or fall water temperatures are expected. Water temperatures are relatively insensitive to disturbances by harvesting because the riparian areas would not be altered by harvesting, and harvested slopes are primarily composed of well-drained till soils. These slopes have a high permeability and most water is expected to infiltrate. One area does not appear to be well-drained. This is the montane habitat area along the lower slopes between Oldhouse Creek and Prine Creek.
- Stream morphology will be unchanged if logging is restricted to plateau and low slope areas outside active floodplains. Solomon Creek should continue to wander in the valley bottom and would be subject to channel avulsions caused by deposition of coarse sediment, or by debris jams, similar to current conditions.
- Sediment yield from individual tributaries is expected to be slightly higher for the duration of logging activities if conventional logging practices are used in high slope areas (>30%). It has been indicated that approximately 40 - 50% of the upper slope areas are inoperable and/or non-merchantable forest types. The increase in sediment yield would consist primarily of fine-grained soils eroded from road cuts, skid trails, and landings.

### 3. RECOMMENDED MITIGATION MEASURES FOR ATHABASCA 4

The following recommendations are conceptual and require refinement by harvest planners and operations managers.

- Staged and/or modified harvesting would reduce the rate of fine sediment discharge to tributaries.

- Special harvest techniques, requiring minimal roading, should be considered for slopes over 30%, to minimize sediment yield increases.

#### 4. OPTIONAL MITIGATION MEASURES FOR ATHABASCA 2

The valley bottom of Solomon Creek, downstream of the trestle rail bridge near the Black Cat Ranch, has alternative prime resource values to consider, and it is unlikely that clear-cutting would be entertained. There may, however, be benefits derived from clear-cutting with regards to minimizing flood risks and channel movement of Solomon Creek over the long-term. The following harvesting options could be considered for the valley flat near the Black Cat Ranch when Athabasca 2 comes due for harvest planning.

Currently, the wandering of the creek is controlled by debris jams. When a channel avulsion occurs, Solomon Creek moves to areas of lower hydraulic resistance. These areas include seismic survey lines, and trails where the understory has been removed. Skid trails would also provide suitable paths for new channel development. Maintaining riparian zones would result in a high potential for additional blowdown of riparian trees. The blowdown of these trees could increase the frequency of debris jams. Once a debris jam causes the existing channels to relocate, the presence of skid trails and lack of vegetation in other areas could result in the gullyng of a new channel. This could increase the existing risk of flood losses at the Black Cat Ranch. Partial cutting of the valley could also increase the risk of future avulsions due to increased blowdown potential or a lack of stabilizing vegetation. Following a major channel avulsion, the existing riparian zone would no longer provide instream cover for fish or protected stream access to ungulates because the new channel location would be at a cleared area.

The recommended harvesting procedures for the valley bottom, downstream of the trestle rail bridge, are illustrated by Figure 4. They consist of strip clear-cutting across the valley. The clear-cut strips should be conducted during the winter to reduce disturbances to the understory. The clear-cuts should remove existing riparian areas. Although removal of sensitive riparian zones is normally detrimental, it is desirable in this area because clearing of the riparian area would reduce the potential for major channel avulsions caused by blowdown and debris jams.

The clearing strips should be narrow to prevent any impacts on fish or wildlife. That is, the remaining riparian areas are sufficient to maintain the integrity of the habitat. The 150 m strip width should be considered as a maximum cut block width.

Access to the valley flat should be on a single road parallel to Solomon Creek, with skid trails running across the valley.

*Option I* is a road along the edge of the valley flat. This would minimize any impacts due to road construction but would result in long skid trails.

*Option II* reduces skid trail length but requires road construction designed to prevent channel avulsions from washing out the road.

*Option IIa* involves an elevated roadway with no ditch, and a distinct crown to shed water quickly. Regular cross-drain culverts are recommended to prevent hydraulic restrictions during high flows. Gravel spurs should also be placed at 100 m intervals to prevent the formation (gullying) of a road ditch.

*Option IIb* consists of a cleared road surface with elongated crossroad fills similar to speed bumps. This would prevent a channel avulsion from washing out a long stretch of road.

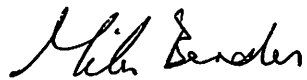
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5. CLOSURE

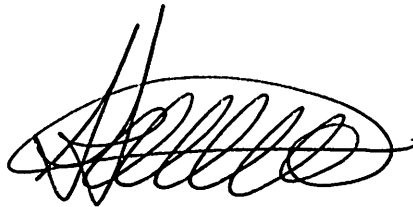
We trust this draft report addresses all of your concerns regarding hydrologic implications of future harvesting of the Solomon Creek drainage basin. Please feel free to contact the undersigned to further discuss these issues.

Sincerely,

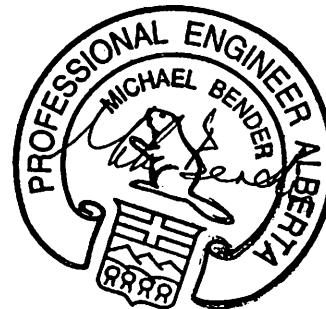
**GOLDER ASSOCIATES LTD.**



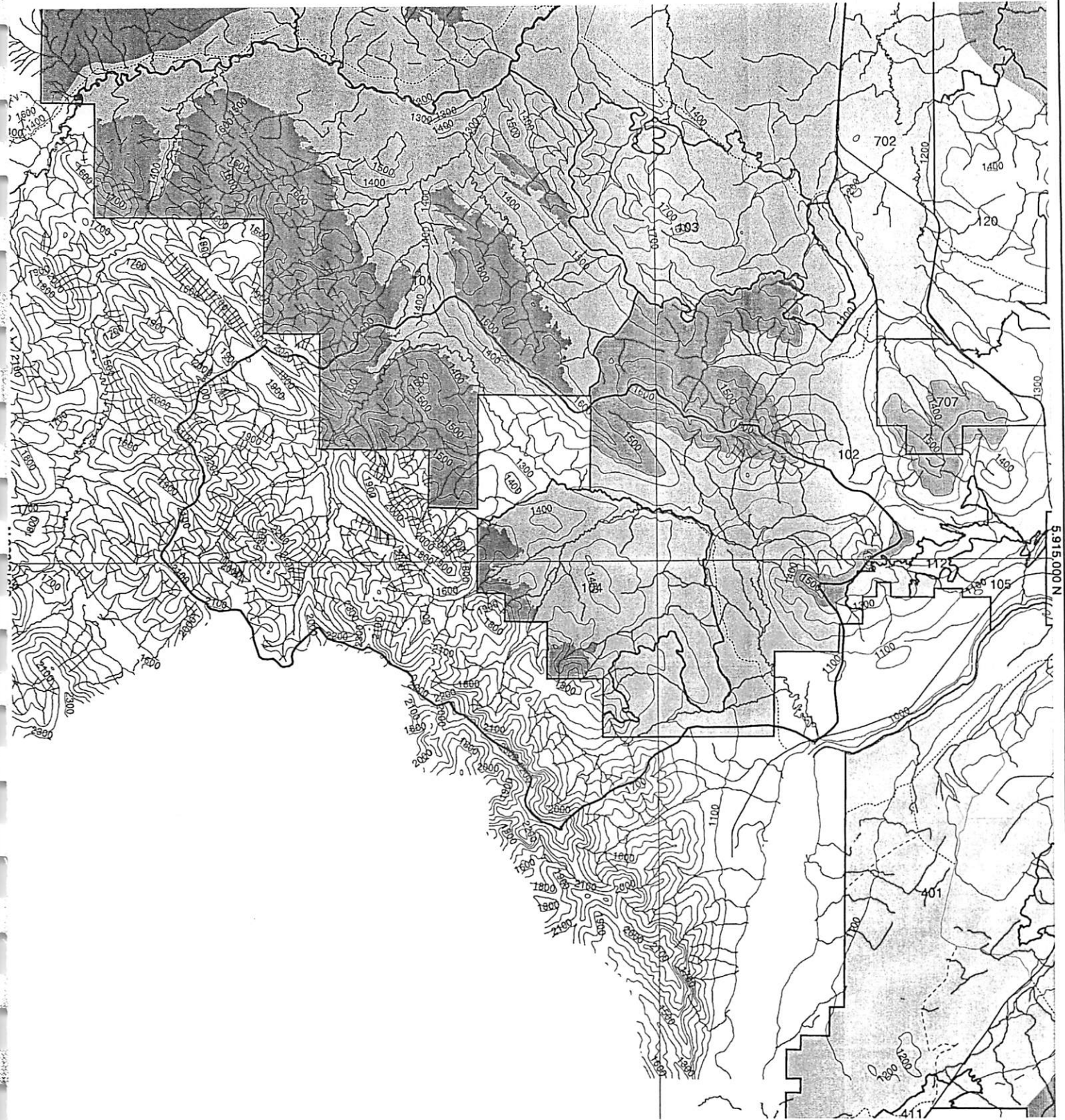
Michael Bender, Ph.D., P.Eng.  
Water Resource Engineer



Les Sawatsky, M.Sc., P.Eng.  
Principal, Director of Water Resources



440,000 E



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**LEGEND**

- Hydrology
- All Weather Road
- Major Haul Road
- Major Road
- Summer Road
- Winter Road
- Compartment Boundary

**Natural Regions**

- Alpine
- Lower Foothills
- Montane
- Sub-Alpine
- Upper Foothills

**KEY MAP**



**REFERENCE**

Source: Weldwood of Canada Ltd.,  
Hinton Division  
Golder Associates Ltd.

Map Projection: UTM  
Zone 11U  
NAD27 (Clarke1866)

Contour Interval: 100 metres



SCALE 1:150,000

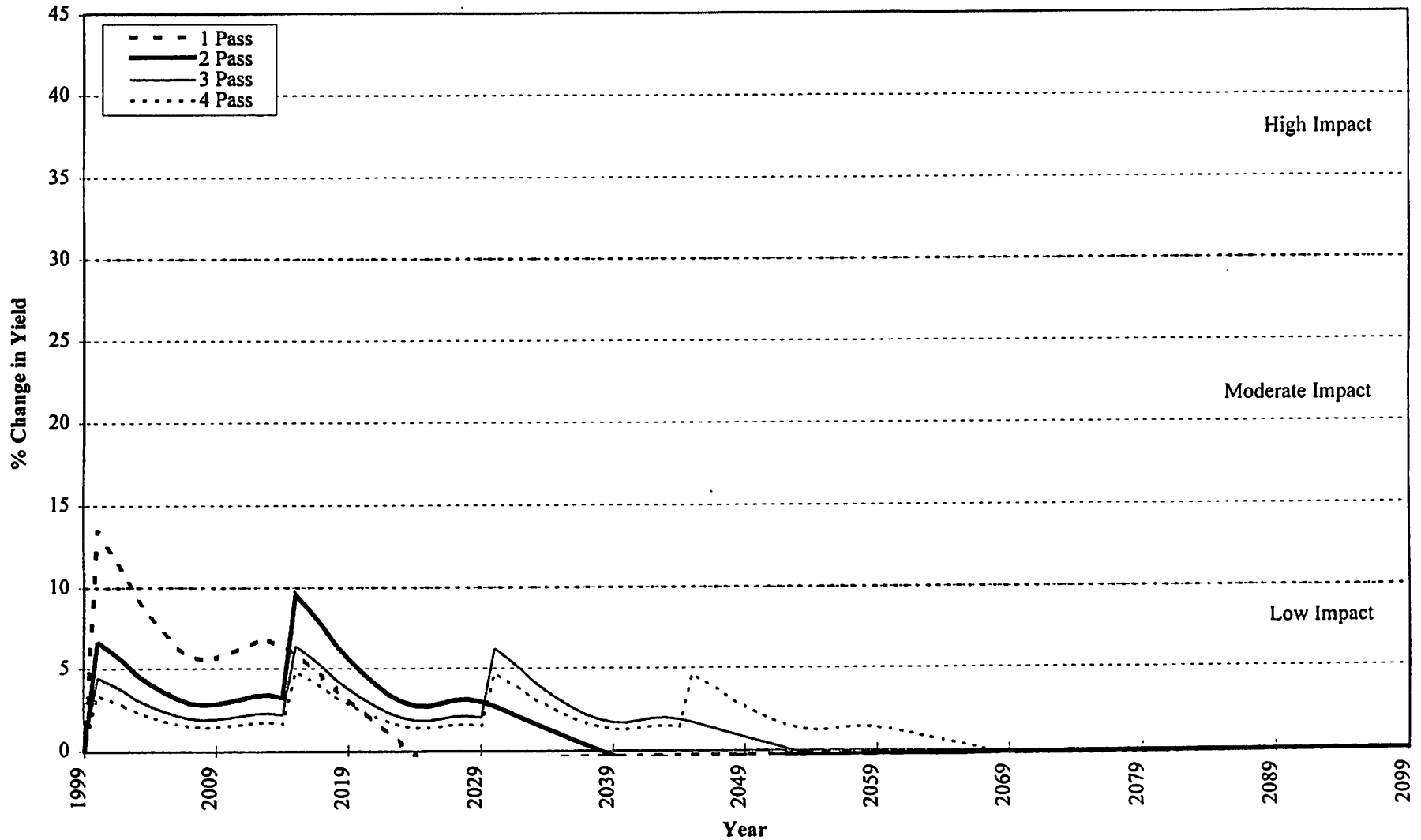
**Weldwood**



**SOLOMON WATERSHED**

DRAWN: JH	APPROVED:	DATE: 26 Nov. 1998
PROJECT: 982-2442.2000	FIGURE: 2	

**Figure 3. Potential water yield changes for Solomon Creek basin due to 22 ha blocks, for different harvest systems**

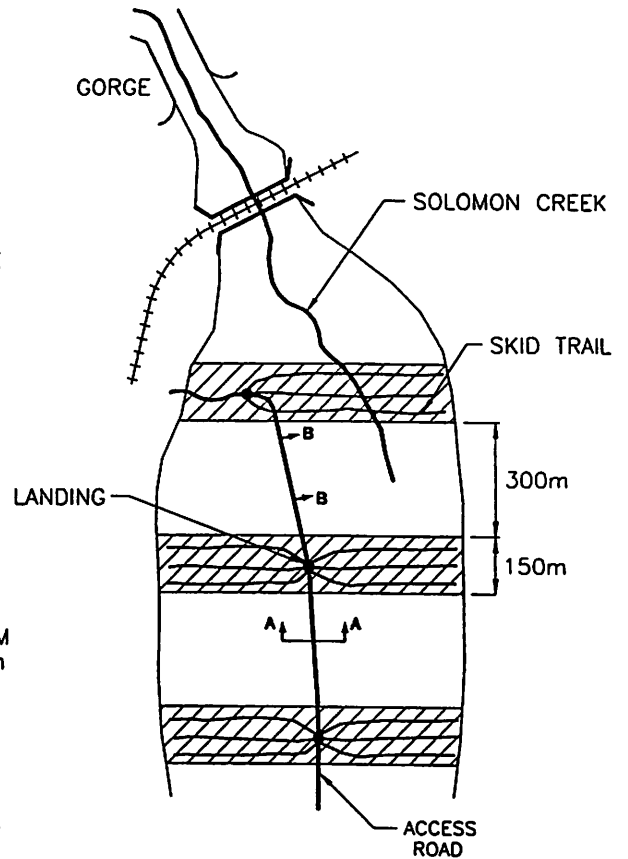
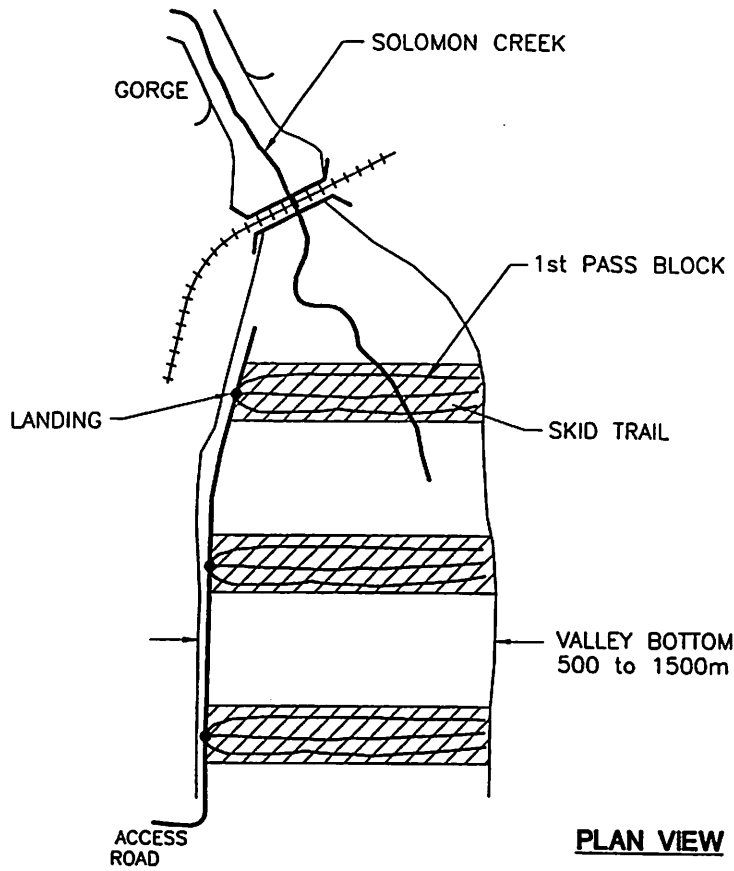


**OPTION 1**

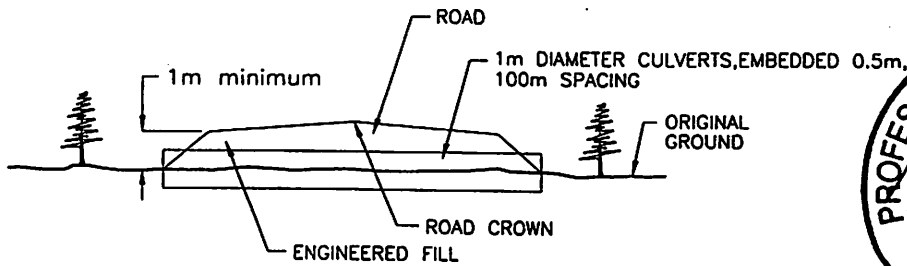
advantage: LOW COST/LOW IMPACT ROAD  
 disadvantage: LONG SKID TRAILS

**OPTION 2**

disadvantage: HIGHER COST ROAD  
 advantage: SHORTER SKID TRAILS

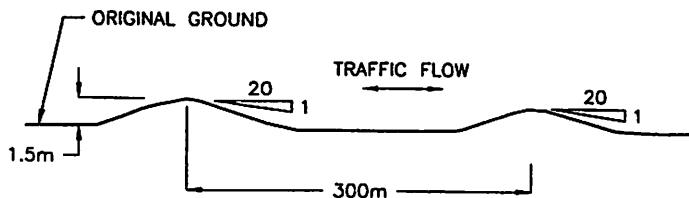
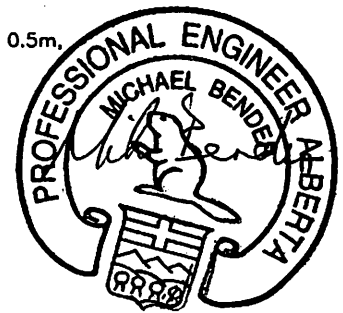


**PLAN VIEW**



**OPTION 2a**

**SECTION A-A**



**OPTION 2b**

**SECTION B-B**

**NOTE:**  
 ALL DRAWINGS ARE SCHEMATIC ONLY.

<b>SOLOMON CREEK                  HARVEST OPTIONS NEAR THE RIVER MOUTH</b>		
DRAWN: VS	APPROVED:	DATE: 04 DEC. 1998
PROJECT: 982-2643		FIGURE: 4