# Hazard mitigation after the fact: the June 1990 debris flow accident on Philpott Road Okanagan Valley

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December 3, 1998

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## 1. Introduction

In the past, there have been many studies done on the relationship between cutblocks, forestry roads, and accelerated mass erosion. (Furbish and Rice, 1983; Gray, 1970; Swanston and Swanson, 1976; Amaranthus, 1985; Kessel, 1985; Hungr et. al, 1987). The B.C. Ministry of Forests even has guidelines for logging and road construction so as to minimize the hazard of debris flows. However, they are general and subject to interpretation (Hungr et. al, 1987). Debris flows have a significant impact on the water quality of streams and on the organisms that inhabit them, such as fish (Kessel, 1985; Swanston and Swanson, 1976). In addition, substantial property loss and loss of life in B.C. due to debris flows are also significant (Hungr et. al, 1987). Mitigation methods are active or passive. Active measures include channelization, dams, dykes, and other engineered structures that try to control debris flows. Legislation is a passive measure and is usually the result of the occurrence of a hazard rather than as planning measure. Therefore, hazardous areas that have been identified are subject to community planning and zoning that restricts development. For any development to occur a geotechnical study of the area must be completed. A restrictive covenant may be entered into if a permit is denied due to the hazardness of the area (Hungr et. al, 1987).

On June 12, 1990, a major debris avalanche hit Philpott Road killing three people and destroying their property. As a result of this debris avalanche, policies were introduced affecting only Philpott Road residents.

The purpose of this paper is to: (Golder Associates Ltd., 1991) discuss the policy changes that resulted and any future changes; (Cass et. al., 1992) the justification for these policies; and (Roed et. al., 1995) the impact of these changes on Philpott Road residents.

## 2. Background

### 2.1. Site Description

The debris flow in 1990 occurred approximately 30 km east of Kelowna, B.C. in the small community of Joe Rich, above Philpott Road. The approximate elevation at which the slide occurred was between 1200-1300m with deposition occurring at approximately 975m (obtained from a 1:50 000 map; Cass et. al., 1992). Above the headscarp of the debris flow are forestry access roads and a clearcut approximately 300ha in size (Golder Associates Ltd., 1991). The topography was formed due to glaciers and their movements thus the deposits are primarily glacial moraines (Roed et. al., 1995). The bedrock is mostly granitic gneisses, which are closely jointed. This results in colluvium deposits covering much of the hillside and overlying dense silty gravelly till (Golder Associates Ltd., 1991; Roed et. al., 1995). The colluvium and glacial deposits overlying the bedrock allows for a high rate of infiltration to the groundwater (Golder Associates Ltd., 1991).

## 2.2. History of the Area

### *2.2.1. Debris Flow History*

In the final Golder Report (Golder Associates Ltd., 1991), aerial photographs of the area dating back to the 1950's were studied in order to determine if this area of Joe Rich had a history of debris flows. They discovered a number of possible debris flows. Two of these were sited as occurring north of the main debris flow of 1990. One dated back to before 1959 and the other was estimated to be before 1988. In addition, the mature cedars had deformations and were tilting, thus indicating soil creep. However, as Swanston and Swanson (1976) point out, creep is due to gravitational stress and occurs even on slopes that are a few degrees. This process can be accelerated by clearcutting and road construction (Swanston and Swanson, 1976; Hungr et. al, 1987). Another flow was observed on the south side of the main flow dating back to 1959. Five other minor debris flows were observed above Philpott Road. Two dated back to 1984 and two possibly dating as far back as post-glacial (Golder Associates Ltd., 1991).

### *2.2.2. Forest Harvesting History*

Prior to 1959, much of the slopes had been selectively logged and two mid-slope areas were 50-75% clearcut. Between 1974 and 1984 clearcut logging occurred. The main cutblock above Philpott Road on the plateau occurred between 1983 and 1988 and constituted approximately 300 ha of forests. The forestry access roads have been in place in this area for over 25 years with more ditches and culvert upgrades occurring for the logging in the 1980's. Most of the area was grass seeded and replanted to limit erosion after the clearcutting (Golder Associates Ltd., 1991).

## 2.3. Causes of the Slide

### *2.3.1. Climatology*

Many factors lead to the major debris avalanche of 1990. May and June were two very wet consecutive months with many heavy rainfalls. The precipitation data was obtained from the McCulloch station, as the elevation is 1250m and 10km away from the avalanche. This station also has 67 years of recorded data, the longest of all stations. On an annual basis of 20 day storms ending June 12, 1990, the precipitation received ranked second with 177.3 mm. The ending date of July 15, 1982 had the most precipitation with 193.2 mm. This date precedes the cutblock on the plateau. This precipitation created saturated soil conditions even though the precipitation received was not unusual. The unusual aspect was the duration of the precipitation. In addition to these storms, heavy rainfall was reported on Philpott Road on June 12, 1990 and, between June 11 and 12 snow fell on the plateau accumulating on the cutblock and later melted (Golder Associates Ltd., 1991). Clearcuts are known to significantly increase peak flows and thus be a potential problem (Swanston and Swanson, 1976). Rain-on-snow events and the other factors previously mentioned have been known to accelerate or trigger debris flows on steep forested slopes (Swanston and Swanson, 1976). The Golder Report cited a report that pointed out five climatic factors that could lead to debris flows. The report found that only one or two could be present for a failure to occur. In the case of the Philpott Road slide, four and possibly all five of the factors were present. These factors include: locally intense short period precipitation; rain-on-snow or snowmelt event; antecedent precipitation; existence of only slight correlation with extreme 24 hour precipitation that does not have to be unusually large; and local topography constricting air flow and causing it to impinge on steep mountain slopes (this may have been a factor) (Golder Associates Ltd., 1991).

### *2.3.2. Forestry Activities*

Due to the forestry access roads and the cutblock, natural drainage patterns were altered and the soil stability reduced significantly because of root systems removed and the loss of forest cover. The loss of vegetation is a dramatic change as vegetation controls water volumes reaching the soil through interception and evapotranspiration. When evapotranspiration is reduced significantly due to clearcutting, the amount of water retained in the soils can remain at higher levels for longer periods of time thus; the potential for saturation is greatly enhanced. The roots of the trees also bring stability to the soil mantles (Swanston and Swanson, 1976).

Drainage channels from the clearcut were identified and determined to flow towards the headscarp. Poor construction of roads and drainage often leads to mass erosion because the system is unable to cope with the excess water (Swanston and Swanson, 1976; Hungr et. al, 1987). This was obviously a factor contributing to this debris flow, as there were excavators up on the road the day before the slide trying to re-route the water that was accumulating (Morrison, 1998). In the study by Swanston and Swanson (1976), they discovered that the occurrence of debris avalanches were 25 to 340 times more frequent when associated with road construction than with forested areas. Amaranthus et. al. (1985) found similar results. They determined that roads contributed to over 50% of debris flows and harvesting accounted for 34% in their study area.

In addition, the cutblock is sloped primarily towards Philpott Road and thus, it was determined that the logging roads diverted up to 20% more water into the catchment with other access roads diverting more water farther down the slope into the debris flow path (Golder Associates Ltd., 1991; Cass et. al., 1992). It is the recommendation since the late 1960's that roads should not be constructed midslope as they contribute to more water accumulation (Amaranthus, 1985; Kessel, 1985). The elevation of the plateau is 1300-1400m with the slide occurring approximately at 1250m, just below the access road. The cutblock is on a plateau but extends slightly down slope and according to a computer generated slope analysis of the hillside by Golder Associates, the slope of the cut block ranges between approximately 0° to 20°.

According to Furbish and Rice (1983) assessments of landslide risk must be included in a forest managers land-use plans. There is naturally a high risk of landslides associated with clearcuts in mountainous terrain. This is due to a loss of soil stability from root decay and increased soil moisture from reduced evapotranspiration (Furbish and Rice, 1983; Swanston and Swanson, 1976; Hungr et. al, 1987). As the roots decay over time, it has been estimated that the minimum rooting strength is attained approximately 3 to 5 years after cutting (Swanston and Swanson, 1976).

Gray (1970) cited a report that found an increased frequency in slides after an area had been logged. Glacial till covered the slopes of the slides studied. Another idea posed, was a lag time occurs between logging activities and debris flows. This was based on the evidence that there were fewer flows in 1959 than 1961 even though the rainfall intensity was much higher in 1959. It has also been noted that cutblocks should not take place on slopes greater than 20% (Gray, 1970).

### 2.4. Facts about the Slide

Between June 11 and June 13, 1990, five debris flows occurred above Philpott Road and another area noted as a potential debris flow site. The main flow had a magnitude of approximately 23 000 $m^3$ and inundated an area of about 12 ha. The area in which the avalanche occurred had no previous history and was an unusual location as there was no channel of any sort. The slide was triggered on a 35° slope, just above the forestry access road at 1250m. The flow traveled down a slope of 18° on average for 800m. Deposition began immediately after crossing Philpott Road as the slope decreased to 5°. One hundred and thirty four meters of Philpott road was covered with 1-2 m of debris. Three people were killed, a two story house and outbuildings were destroyed, as were 3 vehicles and a motorhome. Four hectares of forest were also destroyed. The slide was estimated to be travelling 10 m/s or greater for 45-60 seconds (Golder Associates Ltd., 1991; Cass et. al., 1992).

## 3. Mitigation

### 3.1. Proposed Mitigation

The Golder Report cited a number of proposed hazard mitigation measures. These included land-use zoning, which prohibits building in high risk zones and limits habitation in the area and thus bylaws and regulations should be implemented. Warning systems were noted but not recommended for Philpott Road over the long term as their effectiveness is questionable (Golder Associates Ltd., 1991; Hungr et. al, 1987). Protective and remedial measures were also proposed. Barrier dykes and channel constructions prevent long run-outs and divert the flows. The remedial measures include water management strategies that manage and control water and to restore good drainage systems. The remedial measures apply to the clearcut, forestry access road, Philpott Road, and Cardinal Creek Road (Golder Associates Ltd., 1991).

## 3.2. Actual Mitigation

### *3.2.1. Active Mitigation*

The mitigation that resulted from the Golder Report is channel constructions at four locations on Philpott Road. The major channelization occurred at the main slide and burms were recommended to some residents with a few actually building them. However, the channels are not intended for debris flow mitigation. Their purpose is to reduce the potential flood risk (Lindsay, 1992).

### *3.2.2. Passive Mitigation*

Initially, the Regional District did not perceive the area as unsafe and were not aware of the hazard. This is the rationale for allowing people to build on Philpott Road. However, after the debris flows that occurred in 1990, this perception changed and the Regional District believed it was necessary to implement policies to protect people and property (Roth, 1998). The Golder Report identified most properties at some level of risk from debris flows and thus, the Regional District was advised by the Provincial Emergency Program to receive individual geotechnical assessments prior to issuing permits (Roth, 1992).
This power of authority by the Regional District is due to amendments made to the Municipal Act in 1985. Section 945 (2) (d) states: all community plans "shall include statements and map designations… restrictions on the use of land that is subject to hazardous conditions…". Section 734 (2) of the Municipal Act states: "Where a building inspector considers that construction would be on land that is subject to or is likely to be subject to flooding, mud flows, debris flows, debris torrents, erosion, landslip, rockfalls, subsidence or avalanche, he may require the owner of land to provide him with a report certified by a professional engineer with experience in geotechnical engineering that the land may be used safely for the use intended" (Roth, 1992). This amendment requires local governments to

address matters related to geotechnical safety in planning and development approval (Cave, 1992a; Cave, 1992b).

Thus, the policies that resulted are (RDCO, 1991):

a.) That a map be prepared of the Philpott Road study area for review and reference in the Building Inspection Department and Planning Department.

b.) That a geotechnical study be required with each subdivision application and building permit application.

However, Section 734 (6) of the Municipal Act states: " Upon the application of an owner, a council or regional district board may, by resolution, direct its building inspector to issue a building permit but subject to the condition that a covenant referred to in subsection (4) be entered into and registered." Therefore, those residents that are in a very high risk zone, signing into a restrictive covenant may be the only way to build (Roth, 1992). This covenant removes all liability from the Regional District.

These policies are only applicable to areas that may have a potential for geological hazards and will apply to other lands only when the building inspector becomes aware of a potential hazard (Cave, 1992b). As the Philpott Road area was determined to have such a potential, it is unlikely that the current policies in place will change due to the liability issue with respect to the Regional District. Even in the event that the cutblock returns to its naturally forested state, they will remain (Roth, 1998).

The Fraser-Cheam Regional District is an example of an area that is exposed to many geological hazards and thus has been employing these amendments to the Municipal Act in order to design a hazard land management strategy (Cave, 1992a; Cave, 1992b).
The Regional District of North Okanagan has also employed the power of these amendments. In June 1990, the Fall Creek area also experienced severe debris flows. A hazard assessment on the area was done and risk zones were laid out. The Regional District implemented these policies: "...building permits would be issued to risk zones zero and one [the lowest risk areas] provided the applicant for the permit indemnified the Regional District from any liability. Building permits for risk zones two to four are not issued unless the applicant

produces a report from a geotechnical engineer certifying that the area is safe for building"; this "...area has been designated as a mandatory development permit area and no building permits can be issued without a development permit, in which the permit is registered on title at the Land Titles office." (Mackiewich, 1991).

### *3.2.3. Effects on Philpott Road Residents*

For many residents today, the policy changes are not much of a concern. Most of them intend to stay and retain their property and homes they have, therefore, the time and cost for a geotechnical survey is not an issue (Axelson, 1998; McKinnin, 1998; Watson, 1998; Philpott, 1998). However, some residents have gone through the process and find it a waste of time and money (Philpott, 1998; Radomske, 1998).

For the residents whose property is one of low risk and or inherently physically different from other properties on Philpott Road, this holds true (McKinnin, 1998; Radomske, 1998; Watson, 1998). However, these residents have nothing to lose and every thing to gain. For prospective buyers, a geotechnical survey stating that the property is safe for the intended purpose may come as a comfort (McKinnin, 1998; Watson, 1998). Some residents also believe that due to the channelization work, the geotechnical survey would come out more favourably than without these mitigations (McKinnin, 1998; Watson, 1998).

Other residents in a high risk zone may have problems if they wish to sell and or subdivide. In one such case, they have no intentions of subdividing or selling but wish to replace their current home with another house on the same site. The belief is that, if the initial mitigation recommendations made for their property, such as building burms was carried out, and then they would receive a favourable outcome. However, until these recommendations are completed, no permits will be issued (Axelson, 1998).

An interesting case regarding a new resident was, although the property had a geotechnical survey done before it could be sold, another had to be done before these new residents could build their house (Steeves, 1998). Unfortunately, no explanation could be found.

## 4. Conclusion

In conclusion, it is obvious that the cutblock and forestry access roads above Philpott Road were major contributing factors to the events that occurred between June 11 and 13, 1990.

Although, the precipitation received over the course of two months, was also significant. However, precipitation of this frequency and magnitude has happened in the past without the clearcut and no significant event resulted. When the debris flow happened, everyone on Philpott Road had to cope and when the restrictive policies were implemented they all thought it was unfair that they were being punished for something that no one was liable for. The forestry industry 'passed the buck' saying they contracted the harvesting out and no one was going to take responsibility for negligent forest practices that killed three people. As stated in this paper, guidelines are set for proper forestry practices and other reports refer to protecting people and property first. However, a precedent is set. If the forest industry wants to avoid responsibility when loss of life and property are at risk, all they have to do is insist it was a beetle infestation that they were trying to control. And the people that have to take responsibility are the people most at risk, the residents. They have to pay for their property time and again whenever they wish to build, subdivide, or sell and in some cases their property may become completely worthless because of high risk zoning due to the non-negligence of the forestry industry.

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