Suspended Sediment

Telkwa River Watershed

Data Report
April to October, 1990.

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January 31, 1991

EXECUTIVE SUMMARY

- A sediment monitoring program was undertaken in the Telkwa watershed at the request of the Town of Telkwa and the B.C. Forest Service, Bulkley District Office to determine the timing of suspended sediment transport and to isolate sediment sources within the watershed.
- Water samples were collected at 18 sites once a week and immediately following large rainstorms between the period of April 1, and October 31, 1990.
- Pine Creek is the most important chronic sediment source to the lower Telkwa River during spring runoff.
- Natural sediment sources from landslides, gully erosion, and stream bank erosion dominate the sediment input in all of the major tributaries of the Telkwa River during the 1990 peak flows.
- Suspended sediment levels in the Telkwa River reached a high of 900 mg/L on May 28, 1990. The dark colour lingered on for about a month with sediment concentration levels in the range of 25-50 mg/L.
- The generally milky colour of the Telkwa river during summer and early fall is caused by high elevation glacier melt. These sediment concentrations were greater in the main stem than in the lower valley tributaries. Concentrations of the fine milky sediment reduced down stream as water volume in the main stem increased.
- Sediment levels gradually reduced to less than 1 mg/L in the main stem of the Telkwa and all tributaries with the onset of generally cooler temperatures during the months of September and October.
- Land use activities no doubt produce erosion and subsequent sediment to the Telkwa River. However, during the sampling period no direct link could be made to logging activities; natural sediment sources from landslides, gully erosion, and stream bank erosion dominate the sediment profile.
- Small amounts of sediment introduced into the Telkwa River during the summer fall period could substantially alter turbidity and thus the recreational opportunity of the rivers. As such, there must be an active program to prevent and mitigate erosion and sediment transport in the watersheds.

- Water sampling within the watershed should continue during the late summer early fall 1991 in an attempt to characterize sediment sources and concentrations during large fall storms.
- Small basin tributaries within the Telkwa watershed should be selected to undertake detailed sediment budget research. This type of research would help to focus on the sediment sources and the relative contributions of sediment from natural and land use causes.

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1.0 INTRODUCTION

The Telkwa River carries high levels of suspended sediment during spring runoff and intense fall storms(Figure 1). Telkwa River users have expressed that logging in the watershed has made the river dirtier more often and for longer periods of time. In general the concerns reflect possible water quality degradation:

i) Extended high levels of suspended sediment could create problems with the pumping and filtering system for the town of Telkwa,

ii) high levels of suspended sediment results in poor visibility (turbidity) and effectively prevents sports fishing,

iii) levels of suspended sediment in the river impair the enjoyment of a clean clear river by recreationalists, and

iv) sedimentation may potentially alter habitat for salmoid, steelhead, and resident fish species.

A sediment monitoring program was initiated in the Telkwa watershed at the request of the Town of Telkwa and the B.C. Forest Service, Bulkley District office, to respond to the concerns. In general, the study was to determine the timing of suspended sediment transport within the watershed and isolate the sediment sources. This report presents sediment data collected between April and October 1990, preliminary conclusions and suggestions for future research work. Previous work by Beaudry and Schwab (1989)[1] reviews the physical and climatological data of the watershed relevant to stream flow and Forest harvesting. Concurrently, mapping of slope stability and surface erosion potential was completed for the watershed (Weiland and Schwab, 1990)[2].

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[1] Beaudry G., and J.W. Schwab. 1989. Telkwa watershed, a forest hydrology analysis, Unpublished Research Report B.C. For. Ser., Forest Sciences Section, Smithers B.C.

[2] Weiland I., and J.W. Schwab. 1990. Telkwa watershed, Bulkley T.S.A.: slope stability and surface erosion assessment, Unpublished Research Report, B.C. For. Ser. Forest Sciences Section, Smithers B.C.

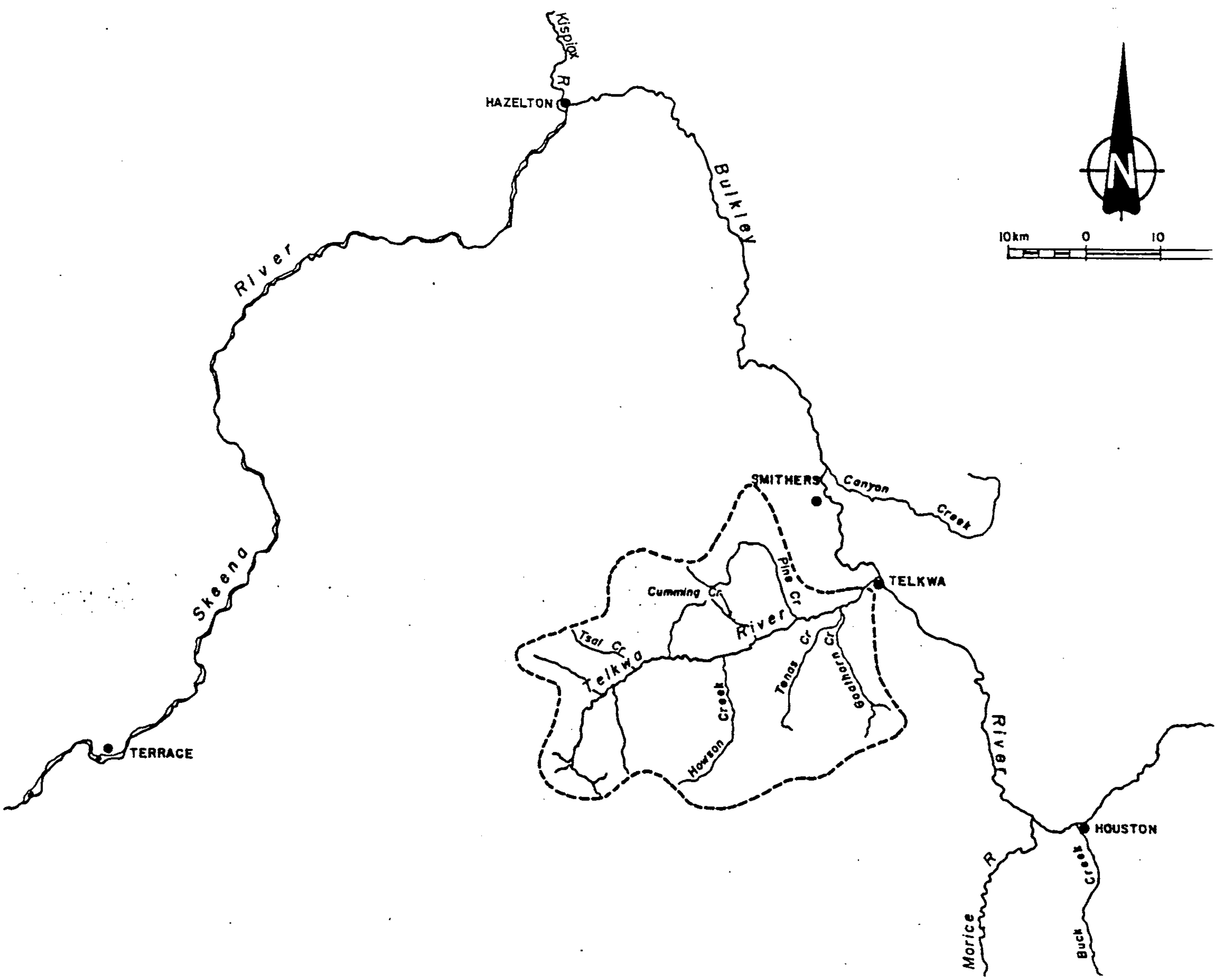

Figure 1. Location of the Telkwa River watershed.

2.0 STUDY OBJECTIVES

1) To determine the relative amount and distribution (spatially and temporally) of suspended sediment in the Telkwa River watershed throughout the ice-free period.

2) To isolate sediment source areas that are contributing to water quality degradation.

3) To produce a slide and video show (extension and demonstration) which will show sources of sediment in the watershed at different times of the year.

4) To evaluate the possibility of using sub-basins within the Telkwa watershed for the development of a sediment budget model for northern transition (coastal/interior) watersheds.

3.0 METHODS

3.1 Suspended Sediment Sampling.

Water samples were collected once a week and immediately following large rain storms between the period of April 1 and October 31, 1990. Sampling progressed up the watershed following snow melt retreat. Additional Sample sites were added to the sampling network as new tributary sediment sources to the main Telkwa were recognized (eg. Goathorn Creek samples taken at the bridge were separated into Goathorn and Tenas Creek after we recognized that Tenas creek was a major contributing sediment source). Sample sites were restricted to locations with road access (Table 1 and Figure 2). The water samples were collected in 4 litre wide mouth containers -a grab sample drawn through the water profile. A water turbidity measurement was made at each sample location by visual depth observation using a numbered staff gauge to record visibility depth. The stage height (flow conditions) of the Telkwa River was monitored at the time of sample collection using a permanently fixed staff gauge located at the old bridge site. The hydrological conditions of the watershed and atmospheric conditions (at the time of and prior to) were also described during each sampling session (data collection form, Appendix 1). A total of 30 field trips were made for sample collection between April 1 and October 31, 1990.

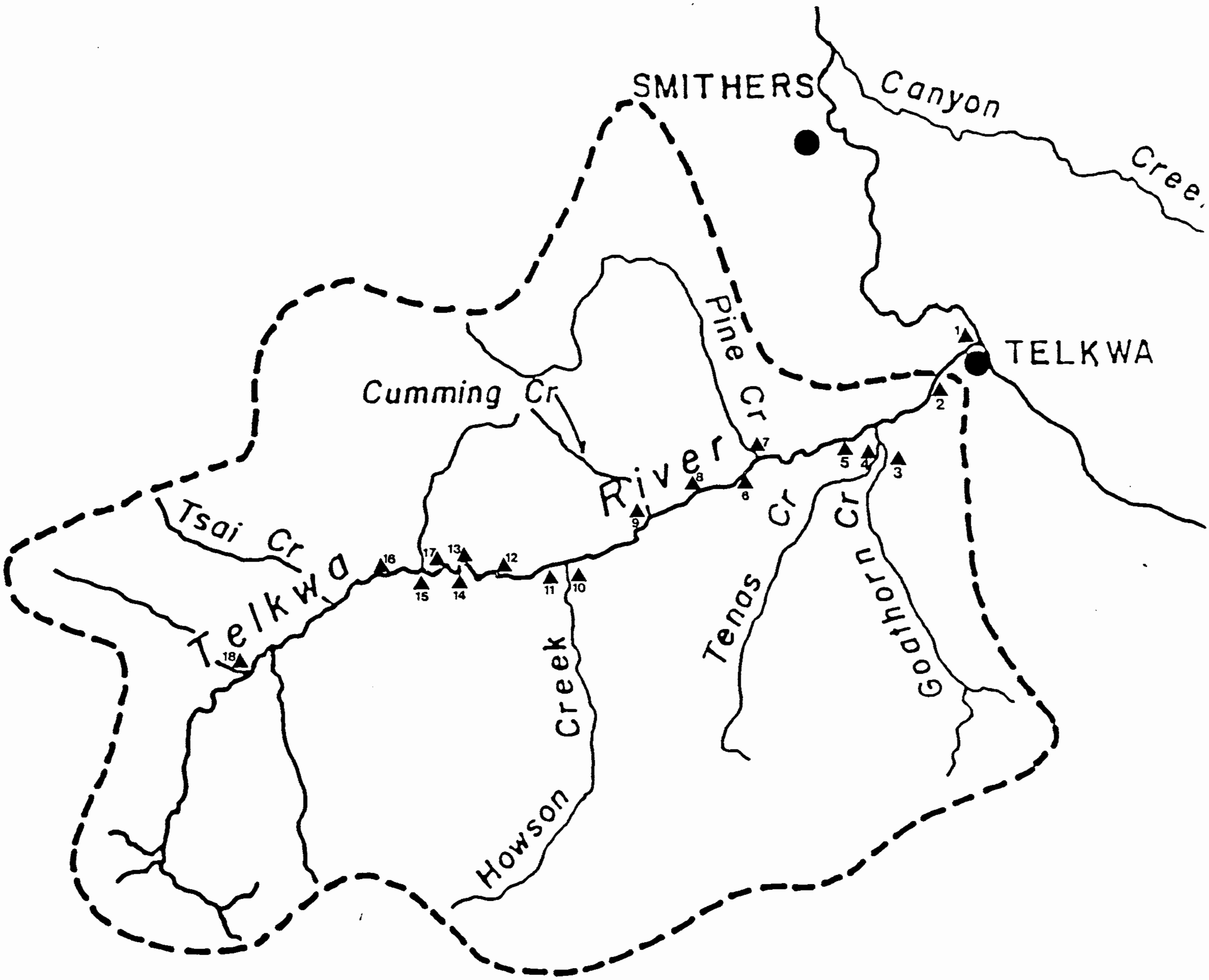

Figure 2. Sediment Sampling sites, Telkwa River Watershed

Table 1. Sampling sites Telkwa River Watershed (refer: Figure 2).

1- Telkwa River at the mouth (visual assessment)

2- Culvert on Coal Mine road

3- Goathorn Creek

4- Tenas Creek (1930 map name Mud Creek)

5- The old bridge site (staff gauge location)

6- The Main bridge across the Telkwa River

7- Pine Creek

8- Small creek at 1012.9 km (drains a cut block)

9- Cumming Creek

10- Howson Creek (visual assessment)

11- Telkwa River above Howson

12- Small creek at 1019.5 km (drains a cut block)

13- Jonas Creek

14- Telkwa River above Jonas Creek

15- Winfield Creek

16- Sinclair Creek

17- Small creek at 1024.9 km

18- Water Survey of Canada gauge site

3.2 Photographic Record of Suspended Sediment Sources

Photographs (35 mm slides) were taken during field sampling trips to document the sources of sediment. These 35 mm slides have all been dated and catalogued. Also, a video camera was used to document sediment sources identified during a helicopter trip over the watershed on May 28, 1990 (peak spring runoff). A second flight was to be taken in early fall to identify and document sediment sources associated with large fall rainstorms; however, a large fall storm did not occur over the watershed in 1991.

4.0 LABORATORY PROCEDURES

Standard filtration procedures described in Nip and Hursey (1988)[3] were used to obtain by weight the volume of total suspended solids in the collected water samples (The laboratory work was undertaken in the lab in the Forest Service Regional office Smithers). In summary, standard 1 micron Whatman 934-AH glass microfibre filters were rinsed wih distilled water, dried at 105 C in a drying oven for two hours, weighed, and the water sample volume measured and filtered through the filters. The filters were then dried for two hours at a temperature of 105 C and re-weighed. The weight of the residue was obtained by subtracting filter weight from filter plus residue weight. The concentration of residue (suspended solids or sediment) was calculated in milligrams per litre (mg/L) by multiplying the weight of the sediment sample found by 1000, and then dividing it by the recorded water sample volume.

The water samples collected on May 28 were analyzed for fines smaller than 1 Micron (clay particles). After filtering the sample using the 1 micron filter the filtered water was run through a 0.45 micron MSL cellulose filter.

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[3] Nip A.M.K. and R.A. Hursey. 1988. Alberta forest service watershed management field and laboratory methods Rep. No. RRTAC 88-8, The Alberta Land conservation and reclamation council, Alberta Forest Research Branch. Edmonton, Alberta

5.0 RESULTS

5.1 General Overview

Environmental variables of precipitation, air temperature, and river height for the data collection period are presented in figure 3.[4] Natural sediment production is reflected by the changes in these environmental variables on an annual basis (Figure 4). The distribution of sediment and the relative concentration at the old bridge site (staff gauge site) reflects sediment concentration changes in the lower Telkwa over the sampling period. Pine and Cumming creeks show how sediment input change for two main mid channel tributaries over the period. Points to note (figure 4):

- The "bell" shaped distribution of the data in all three graphs, and the increase in sediment concentrations with increased stream discharge.
- The peak sediment concentration for May 28 in the Telkwa River far exceeds any other event. This event resulted from a combination of localized heavy rainfall and rapid snow melt.
- The peak concentration of sediment in Pine Creek occurred several weeks earlier. This happens because naturally unstable terrain in the Pine Creek watershed is influenced by early spring seasonal snow melt. These unstable slopes bleed directly in to Pine Creek.
- Levels of suspended sediment decreased rapidly after the May 28 peak flows and continued to decrease until July 19. The Telkwa River cleared-up by mid July which represents a sediment concentration of approximately 20 mg/L. However, the Telkwa River never became crystal clear untill late fall as it continued to carry fine suspended sediments derived from high elevation snow and ice melt through out the summer months.

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[4] Telkwa River stage height, rain fall, and air temperature are used to interpret sediment concentrations. Numerous rain gauges would be needed throughout the watershed to evaluate rainfall distribution for a intensive study. However, for this study, daily rainfall from Quick, Smithers airport and Terrace airport were deemed sufficient. Snow melt was described during field visits and using the temperature data obtained from the Quick station. Telkwa River discharge and stage height were obtained from the Environment Canada gauging station located between Sinclair and Windfield creeks and a staff gauge installed at the old bridge site.

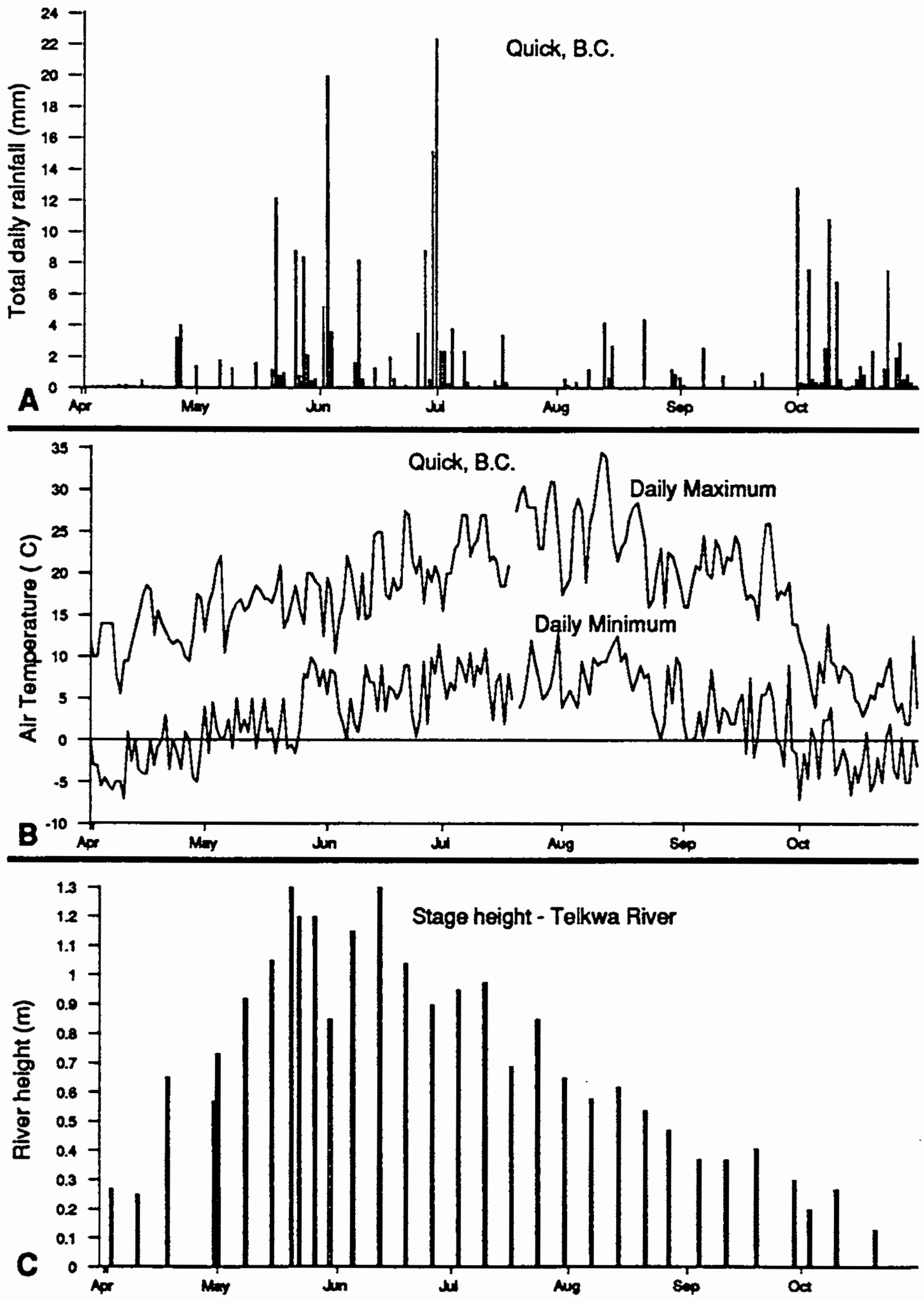

Figure 3. Environmental variables associated with sediment production.

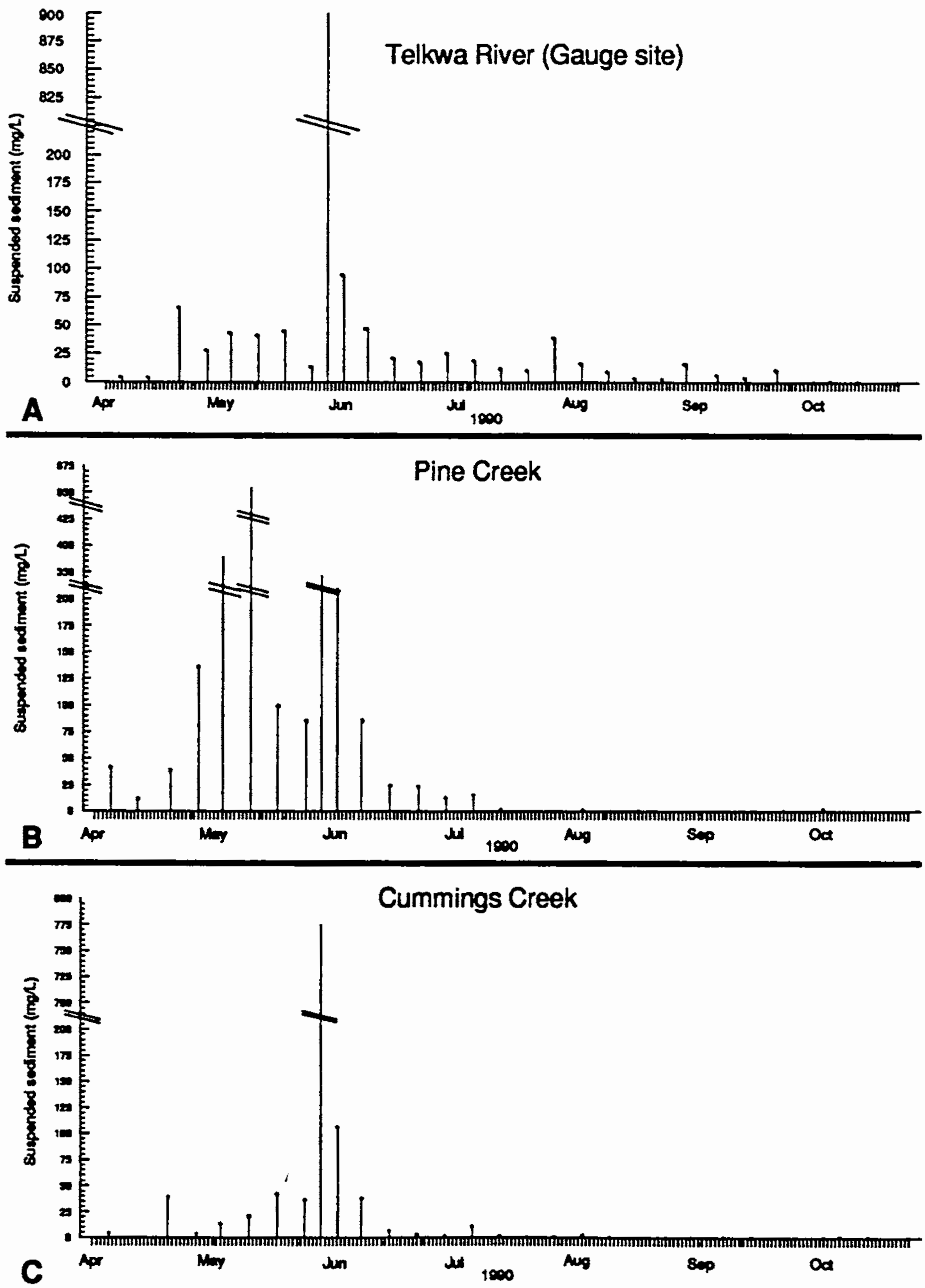

Figure 4. Annual distribution of sediment Telkwa River, Pine and Cumming creeks.

- A period of dry hot weather in late July resulted in a small increase in suspended sediment in the Telkwa River. This increase was attributed to high elevation glacier melt.

- Sediment levels in the lower watershed tributaries remained relatively low throughout late summer and early fall.

The contribution of the lower tributaries to the suspended sediment load of the main Telkwa River are discussed in the following section of the report (Spring/early summer, peak flow period, and late summer early fall).

5.2 Sediment Contribution, Lower Tributaries

5.2.1 Spring

Figure 5 presents data from four selected sampling periods judged to be representative of the spring runoff. The four graphs contain the suspended sediment concentrations for the stations sampled for the particular time period. The stations: Gauge, Bridge, @Howson, and @Jonas are samples taken from the main stem of the Telkwa River while the remainder of the sample locations are tributaries to the Telkwa River.

The sampling commenced on April 5, 1990. At that time, the Telkwa River was crystal clear above Pine Creek containing sediment concentrations of 3 mg/L. Pine Creek was already chocolate brown (42 mg/L) which provided a significant amount of sediment to the Telkwa River, as evidenced by a distinct sediment plume that entered the main stem from Pine Creek (Photo appendix 2). The Telkwa River at the gauge site was light brown(4 mg/L); representative of a dilution or mixing of sediment delivered from Pine Creek into the higher volume Telkwa River. Visual records indicate that Tenas Creek started to become dirty on April 12.

Figure 5a shows that several tributaries had become turbid by April 27 and were providing low levels of suspended sediment to the Telkwa River (Cumming, Howson and Jonas). However, the main stem of the Telkwa River remained only slightly turbid (approximately 5 mg/L) until Pine Creek was reached at 135 mg/L where the turbidity increase resulted in a chocolate brown colour of the main stem

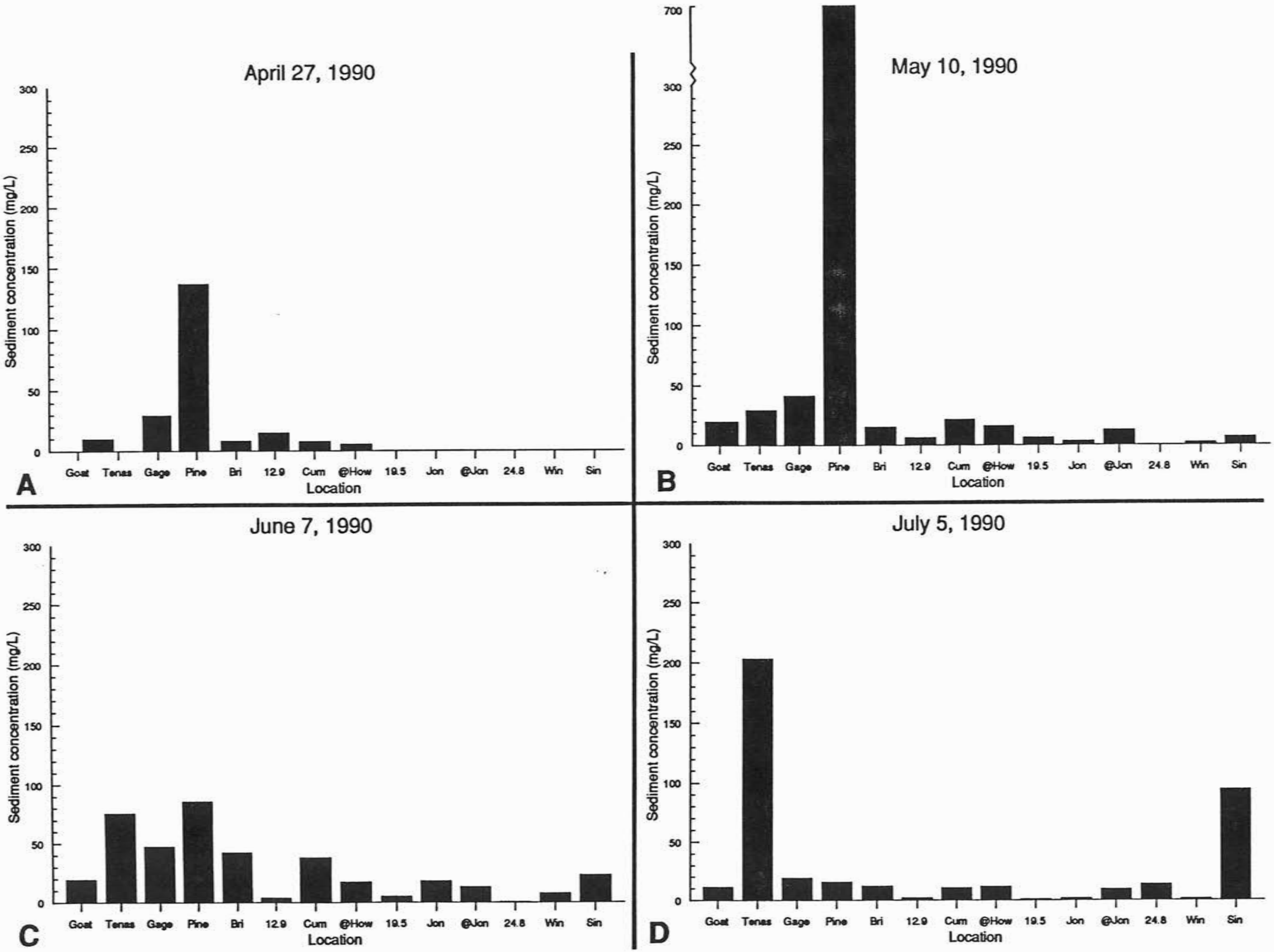

FIGURE 5. Sediment concentrations, Telkwa watershed - Spring runoff

(30 mg/L). Although not sampled on April 20, visual observations and photographs indicate that sediment was being produced by Howson and Jonas Creeks. Where as, Winfield and Sinclair Creeks were still crystal clear. The small tributary 12.9 creek, that drains a cutblock, was turbid but not carrying significant amounts of suspended sediment (7 mg/L). The other tributaries that drain clearcuts (19.5 and 24.8 creeks) were crystal clear.

A major increase in sediment load (655 mg/L) occurred in Pine Creek by May 10 (Figure 5b), while the sediment concentrations in the upper Telkwa and tributary streams remained quite low. The increased flow volumes in the main stem Telkwa River resulted in a dilution in Pine Creek sediment concentrations. Concentrations at the gauge site registered only slightly up from those recorded earlier in the season(41 mg/L).

Peak spring flow on the Telkwa River occurred on May 28, 1990. Sediment concentrations in the Telkwa River, at that time, increased to levels of 900 mg/L despite the increased flow. The peak flow effect is discussed separately in the next section.

From June 2 to June 4, 29 mm of rain fell in the vicinity of Telkwa-Quick (Figure 3a). Despite this rainfall water samples collected on June 7 showed relatively low concentrations of sediment (47 mg/L; Figure 5c). Sediment concentrations decrease with distance upstream into the watershed. Significant contributors of sediment were Tenas(76 mg/L), Pine(86 mg/L) and Cumming(38 mg/L), while the two creeks that drain cut blocks (12.9 and 19.5 creeks) were carrying only very low concentrations of sediment (4 and 5 mg/L, respectively).

Between June 5 and June 29 rainfall was generally low. However, seasonal warming caused high elevation snow to melt rapidly. This resulted in an increase in stream discharge (Figure 3c). During the period of increased stream flow sediment concentrations in the Telkwa River gradually decreased to 25 mg/L (Figure 4a). Sediment concentrations in tributaries like Tenas, Pine, Cumming, Jonas, Winfield, and Sinclair decreased substantially and became visually clear (4, 13, 2, 1, 2, 5 mg/L, respectively).

From June 30 to July 5, 46.5 mm of rain fell in the vicinity of Quick-Telkwa. This rainfall resulted in a distinct increase in stream discharge (Figure. 3C). Despite the heavy rainfall, sediment concentrations in the Telkwa River did not increase: they actually continued to drop (Fig 4a and 5d).

The only tributaries that showed an increase in sediment delivery, as a result of this rainfall, were Tenas and Sinclair creeks (203 mg/L and 94 mg/L, respectively). Sediment in the Tenas system originated at high elevations in the watershed. A ground survey of the creek located sediment sources only from natural causes (stream bank and gully erosion) none were attributed to forestry operations. The increase in sediment concentration in Sinclair Creek was attributed to the bridge construction by Pacific Northern Gas.

5.2.2 Peak Flow

The May 28, 1990 peak flow in the Telkwa River was caused by warm spring temperatures and long duration rainfall that occurred between May 26 and May 28. The snow pack was substantial at higher elevations, although most snow had melted at lower elevations. In particular snow had melted prior to the event from all clearcuts in the watershed. The clearcuts are all situated at lower elevations.

Water samples collected mid day on May 28 showed that all large tributaries carried extremely high concentrations of suspended sediment (range of 336 to 1177 mg/L; Fig 6a). However, samples collected from the two streams draining cut blocks (12.9 and 19.5 creeks) contained very low concentrations of sediment 2 and 4 mg/L, respectively. Visual observations and photographic records show that the high sediment concentrations carried by all the large tributaries commenced at high elevation. Streams were running dirty in snow covered areas and most swamps appeared dirty. The erosion contributing sediment to the streams was all derived from natural sources (stream bank erosion, gully erosion, slumps and slides).

Sediment concentrations had substantially decreased by June 1 in the main Telkwa River (@Gauge 95mg/L, @Howson 93 mg/L) and all tributaries. The major contributing tributaries being Tenas, Pine and Winfield Creeks (134, 207, 239 mg/L, respectively).

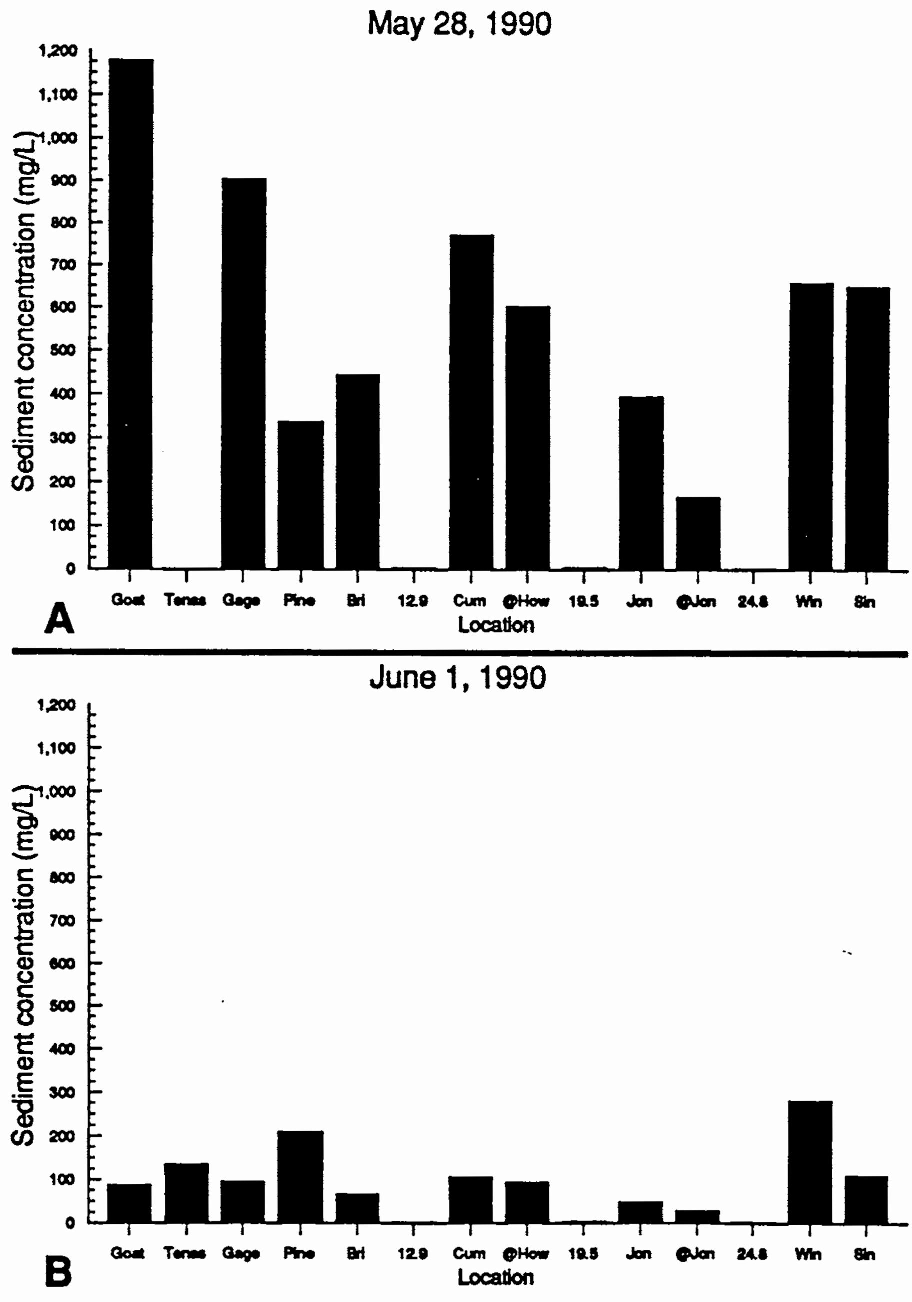

FIGURE 6. Sediment concentrations, Telkwa watershed - peak flows

5.2.3 Summer/fall

The sediment concentrations for the summer/fall period for four representative dates are presented in Figure 7. Note that the scale used on the graphs for the sediment concentration has been changed to a range of 0-60 mg/L from the previously used scale of 0-300 mg/L.

The Telkwa River had completely cleared up from the effects of spring runoff by July 19, 1990. Thus, July 19 provides a good transition date to study the effects of summer/fall rains independently of snow melt runoff.

Sediment concentrations in all the lower tributaries remained low throughout the summer and early fall (Figure 7). However, sediment concentrations in the main stem of the Telkwa River changed significant, ranging from 38 mg/L in late July down to 2 mg/L in October. During the summer/fall period dark coloration in the river was never observed, rather, the river was always "milky" in appearance. This milky coloration is caused by very fine sediment derived from glacier erosional/melt processes. The sediment concentration was generally higher in the main stem of the Telkwa than from the lower valley tributaries (Sediment levels for September 21,1990: @ Water Survey of Canada 56 mg/L, @ Howson 22 mg\L, @ Jonas 16 mg\L, @ Bridge 14mg\L, @ gauge 11 mg/L). The down stream trend simply shows reduced concentration of the fine milky sediment with increased water volume.

A small peak in summer sediment concentrations occurred on July 26 (Figure 4 and 7a). This increase resulted during a week of very hot weather (Figure 3) and associated high elevation snow and ice melt. All sampled tributaries on the lower Telkwa remained relatively clear (less than 5 mg/L). The main Telkwa River was "cloudy and grey" carrying an average of 30 mg/L.

The first substantial rainfall in the summer/fall period was in mid-august. This rainfall did not increase sediment levels in the Telkwa River or any of the sampled tributaries, sediment concentrations actually continued to decrease from the late July highs (Figure 4).

Precipitation records from Quick showed abundant rainfall during October 1990 (Figure 3). This precipitation however did not result in a significant increase in sediment concentration in the tributaries and the main stem of the Telkwa River. Air temperatures in October were cold (Figure 3). This resulted in the precipitation accumulating as snowfall at mid to high elevations. Sediment concentrations

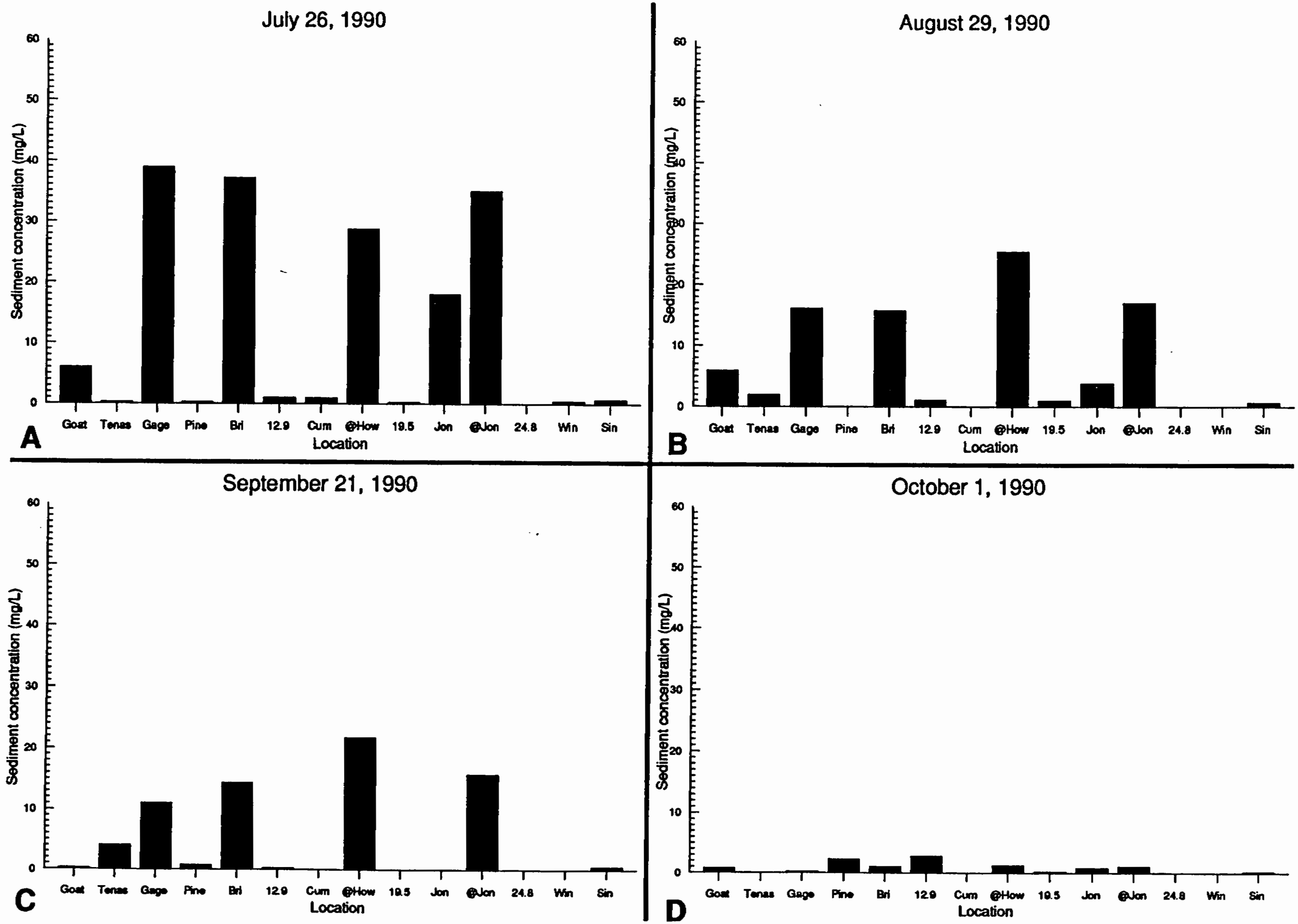

FIGURE 7. Sediment concentrations, Telkwa watershed - summer/fall

sampled on Oct 1 (Fig. 7c) were generally less than 1 mg/L in the main stem of the Telkwa. Sediment levels gradually reduced to 0 in the tributaries with general cooling temperatures in the watershed throughout the month of October. Tributaries at lower elevation continued to carry small amounts of sediment longer than streams that originated at higher elevation.

5.3 Very Fine Sediments

Water samples collected during the May 28 storm after being filtered through the 1 micron filters were still very brown in colour. In an attempt to find out how much very fine sediments were passing through the 1 micron filter the samples were re filtered through a .45 micron filter. The residue retained on the filters showed that a large amount of very fine sediments were being carried by the river. The concentration of the very fine sediments reduced with an increase in water volume in the main stem of the River (240 mg/L @ Howson, 123 mg/L @ Jonas, 176 mg/L @Bridge, and 26 mg/L @ the Gauge). Winfield, Sinclair and Goathorn Creeks carried the highest levels of very fine sediments (260, 200, 570 mg/L, respectively). Additional sampling is required to determine the values of very fine sediments during low flows in the summer and fall. The very fine sediments are possibly what cause much of the turbidity concerns during low flows.

5.4 Turbidity

Turbidity is caused by the presence of suspended sediment in the water. A crude measure of turbidity was made during each field inspection by estimating how far down into the water the staff gauge could be read. In summary, there is a rapid increase in water turbidity with an increase in suspended sediment. At suspended sediment values of less than 5 mg/L the staff gauge could be read down approximately 60+ cm; at 40 mg/L, 20 to 25 cm; at 100 mg/L, 5 to 10 cm; where as at sediment concentrations close to 1000 mg/L values of less than 2 cm can be read.

6.0 SUMMARY

6.1 Spring

Pine Creek is the most important chronic suspended sediment source to the lower Telkwa River during spring runoff. The creek begins to deliver large quantities of sediment in early April with the onset of snow and ice melt on massive slump earth flows located in the canyon section of the creek (Appendix photo). The creek did not clear until late July (In 1989 the creek probably never cleared up because of active earth flow movement).

Cumming, Jonas and Winfield creeks contribute to the spring sediment load of the Telkwa River, but in generally at lower concentrations and over a shorter time period than Pine Creek. These tributaries, do run very dirty during peak flows, but clear by mid to late June. Goathorn/Tenas Creek system, adds considerable sediment to the Telkwa River during peak flows. Tenas Creek appears to respond readily to small rainfall events showing increased turbidity.

The high levels of suspended sediment in the Telkwa River that are associated with spring runoff drop very quickly from a peak of about 900 mg/L. The dark coloured water associated with the spring freshet lingers on for about a month with sediment concentration levels in the range of 25-50 mg/L.

The small streams (12.9 and 19.5 creeks) that drain recent cut blocks ran slightly dirty with low sediment concentrations for a short period in early April and remained relatively clear during the remainder of the sampling period.

The source of the large sediment loads carried by the Telkwa River during spring runoff are dominated by natural sources in all of the major tributaries to the river. These sources from natural erosion are large active slump earth flows, gully erosion in alpine and subalpine areas, and stream bank undercutting. Man related activities in the watershed no doubt do contribute sediment to the river. This is evident by some of the man caused erosion related to roads, pipelines and hydro right of ways in the watershed. However, the natural sources of sediment overwhelmingly dominated the sediment input to the Telkwa River during the 1990 spring freshet.

6.2 Summer/fall

Sediment concentrations in all tributaries sampled remained relatively very low throughout the summer/fall period. In the main stem of the Telkwa River sediment concentrations ranged from a summer high of 40 mg/L in late July to less than 1 mg/L by late October. The generally "milky" colour of the Telkwa River during August and September is a result of sediment eroded and transported from high elevation glacier ice melt. In spite of a few significant rainfall events, the lower tributaries remained relatively clear throughout the summer and fall. No logging induced sediment activity was observed. A general rainfall over the watershed during late fall as occurred in 1974 and 1978 would likely produce sediment levels that would rival levels obtained during spring runoff.

7.0 Management and Research Recommendations

7.1 Management

The seasonally high spring sediment levels derived from natural sources overwhelm sediment inputs caused by land use practices within the Telkwa watershed. The period of clean clear water and lower river flows coincide with recreational opportunities on the Telkwa and Bulkley Rivers. Small amounts of sediment introduced into the Telkwa River during the summer fall period could substantially alter turbidity and thus the recreational opportunity of the rivers. This becomes particularly important with the movement of harvesting activities into the steeper and wetter areas within the watershed. As such, there must be an active program to prevent and mitigate erosion and sediment transport in the watersheds. This could be accomplished through an awareness in erosion prevention, avoidance of problem sites and an active attack on erosion problems.

7.2 Research

Water sampling within the watershed should continue during the late summer early fall 1991 in an attempt to characterize sediment sources and concentrations during large fall storms; a large fall storm did not occur during the 1990 sampling period.

Small basin tributaries within the Telkwa watershed should be selected to undertake detailed sediment budget research. This type of research would help to focus on the sediment sources and the relative contributions of sediment from natural and land use causes. The ease of access within the Telkwa River watershed provides an excellent location to undertake such a study.

Appendix 1. Example field data collection form

TELKWA WATERSHED STUDY page 2

DATE: ____________ Atmospheric conditions: ______________________________

Station	Water Sample		Visual Turbidity	Comments i.e.: flow,debris, etc.	Snowpack and soil moisture (note aspect & elevation)
Cummings Creek	*				
Howson Creek					
Telkwa @ Howson	*				
19.5 Creek	*				
Jonas Creek	*				
Telkwa above Jonas	*				
Winfield Creek	*				
Sinclair Creek	*				

TELKWA WATERSHED STUDY page 1

DATE: ____________ Atmospheric conditions: ______________________________

AIR TEMP: ____________ ______________________________

RIVER HEIGHT: ____________ Time (start): ____________ (finish): ____________

Station	Water Sample		Visual Turbidity	Comments i.e.: flow,debris, etc.	Snowpack and soil moisture (note aspect & elevation)
Telkwa @ town					
Highway Culvert	*				
Goathorn	*				
Gauge site	*				
Bridge site	*				
Pine Creek	*				
1012.9 creek	*				

Appendix 2. Photographs within the Telkwa watershed

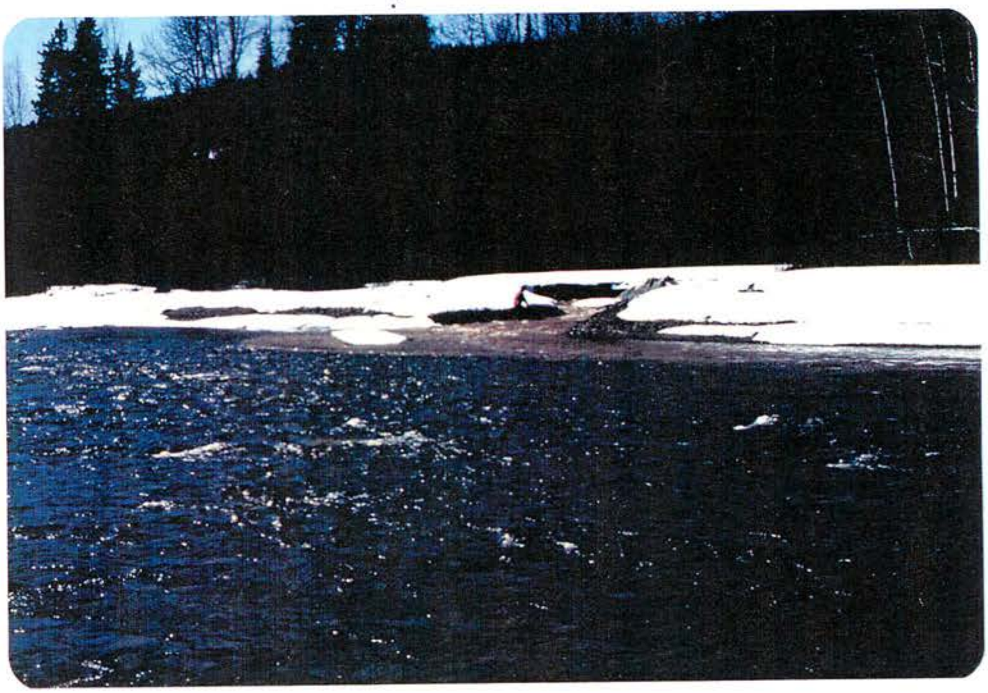

Photo 1. Pine Creek plume entering the Telkwa River April 5, 1990.

Photo 2. Pine Creek plume entering the Telkwa River April 20, 1990.

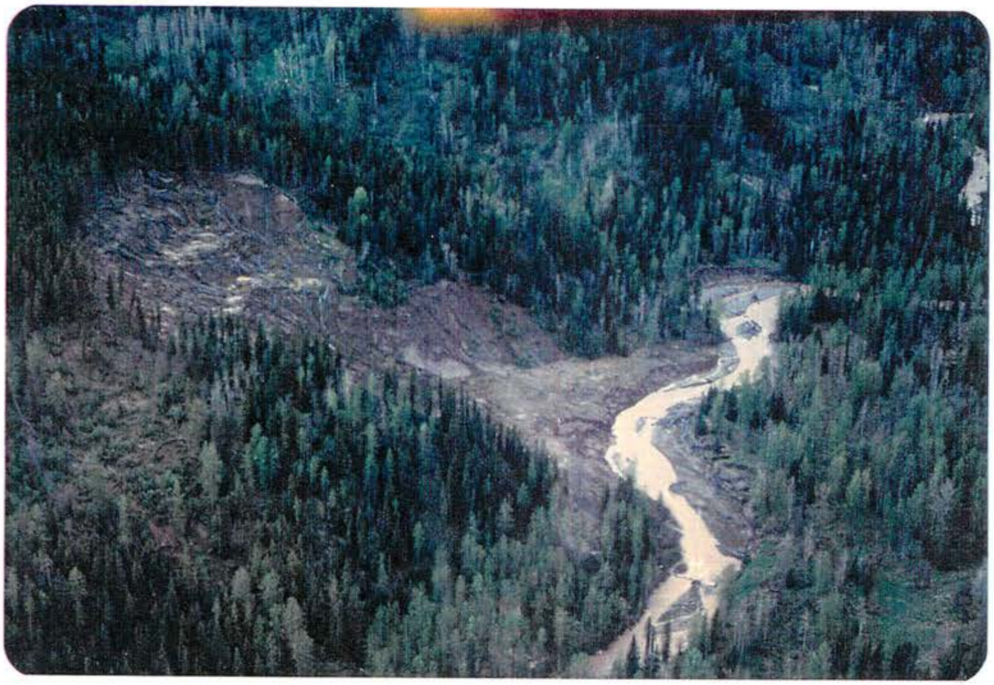

Photo 3. Slump earth flow terrain Pine Creek May 28, 1990.

Photo 4. Telkwa River flow May 28, 1990.

Photo 5. Windfield Creek May 28, 1990.

Photo 6. Howson entering the Telkwa River August 9,1990 (note milky color of the Telkwa River)