

## Design Memorandum CCL-CC2 - DRAFT

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**To:** Western Copper Holdings Limited - Dale Corman

**cc:** Access Mining Consultants Ltd. - Dan Cornett  
Kilborn Engineering Pacific Ltd. - Tony Wachmann

**From:** Clearwater Consultants Ltd. - Peter S. McCreath

**Subject:** Carmacks Copper Project - Site Hydrology Revisions  
Draft Design Memorandum CCL-CC2

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This memorandum presents the results of Clearwater Consultants Ltd.'s review of and revisions to the site hydrological characterization for the proposed Carmacks Copper heap leaching project located near Carmacks, Yukon. The work has been carried out in accordance with Design Memorandum CCL-CC1 dated February 10, 1998 and the Consultant Contract between Western Copper Holdings Limited and Clearwater Consultants Ltd. dated January 29, 1998. This memorandum CCL-CC2 summarizes the site hydrology analyses carried out by Clearwater Consultants Ltd. to address the hydrological issues and areas of concern identified by the RERC. The draft memorandum will be finalized after review by the project team and the RERC. The results of the hydrological analyses presented herein will be applied to the water balance analysis of the leach pad and other water management aspects of the project.

### 1. Outstanding Issues

Outstanding issues related to hydrology were discussed in Memorandum CCL-CC1 and are summarized briefly below. Resolution of the basic hydrological issues is a crucial first step that must be carried out prior to any revisions to the water balance analysis.

- Is the precipitation analysis carried out for the Williams Creek site "conservative" and how does measured site precipitation compare to precipitation measured at the regional stations at Carmacks and at Pelly Ranch? The RERC reviewers have stated that they want to see more justification for the estimated site precipitation based on regional data.
- A concern remains related to the derivation of extreme wet periods. This concern is directly connected to the item above and impacts directly on the design solution storage volume for the heap.
- The RERC reviewers have expressed a concern related to the assumed distribution of the annual snowmelt runoff in the April and May period.
- Estimated annual evaporation and evapotranspiration losses have been questioned. The relative impact on the water balance of the annual estimated evaporation depth is minor.

This Memorandum addresses the above issues.

## 2. Available Data

Sources of hydrology data used in this study are summarized in Table 1. The data include summer rainfall data collected at the Williams Creek site and long-term precipitation (rainfall and snowfall) data reported by the Atmospheric Environment Service (AES) of Environment Canada for nearby regional stations at Carmacks and at Pelly River Ranch (previously referred to as Fort Selkirk). Regional snow survey data reported by the Water Resources Division of DIAND are available for several long-term stations in the area as shown on Table 1. Snow surveys were carried out at the Williams Creek site in 1992 and from 1995 to 1997. The Water Resources Division of DIAND have been responsible for the operation of the Williams Creek meteorological station and collection of snow survey data at the site since 1995.

**Table 1 - Hydrology Data Sources**

Data Type	Station Name	Station Number	Elevation (m)	Distance from Site	Years of Record
Precipitation	Williams Creek	(Note)	850	-	1994-97
	Carmacks	2100300	525	35 km SE	1964-97
	Pelly River Ranch	2100880	454	70 km NNW	1951-97
Lake Evaporation	Pelly River Ranch	2100880	454	70 km NNW	1964-90
	Whitehorse A.	2101300	703	190 km SSE	1974-90
Snow Surveys	Williams Creek	#1	739	-	1992
	Williams Creek	#2	755	-	1992
	Williams Creek	#3	876	-	1992
	Williams Creek	09AH-SC04	914	-	1995-97
	Pelly Farm	09CD-SC03	472	70 km NNW	1986-97
	Mt. Nansen	09CA-SC01	1021	50 km SW	1976-97
	Mt. Berdoe	09AH-SC01	1035	50 km SE	1975-97
	MacIntosh	09AC-SC02	1160	80 km SW	1976-97
	Satasha Lake	09AH-SC03	1106	90 km S	1987-97
	Casino Creek	09CD-SC01	1065	120 km WNW	1977-97

NOTE : Williams Creek station reports only summer rainfall. Regional stations report rainfall, snowfall, and total precipitation.

## 3. Precipitation

### 3.1. General

Annual total precipitation in Yukon typically increases with elevation as described in the AES report "Climate of Yukon" (AES Climatological Studies Number 40). Previous studies for the Williams

Creek site area reported in the IEE and subsequent Addenda used an “orographic factor” of about 1.29 based on an assumed 8% increase in annual precipitation per 100 m increase in elevation to estimate Williams Creek precipitation at elevation 850 m from the average of regional data collected at lower elevations (Carmacks and Pelly River Ranch stations). The magnitude of the orographic factor has been questioned by RERC reviewers. Since the earlier studies, additional concurrent site and regional rainfall and snow survey data have been collected in 1995 through 1997.

The general approach used for the present study was to first compare all common periods of record for Williams Creek and the regional data to estimate orographic factors and then, using frequency analyses of the long-term regional data, estimate conditions applicable to the Williams Creek site.

Total precipitation, rainfall and snowfall data reported by AES for Carmacks and Pelly River Ranch are shown in Tables I.1 to I.6 in Appendix I. All the available climatic data recorded since 1994 at the Williams Creek station are shown on Table I.7. Concurrent Williams Creek and regional rainfall data are shown on Table I.8. Regional and site snow survey data are presented in Table I.9.

Although Carmacks is slightly closer to the Williams Creek site, Pelly River has the longest and most complete regional database, including concurrent data for precipitation, rainfall, snowfall (Pelly River Ranch) and snow surveys (Pelly Farm). The Pelly stations were, therefore, adopted as the “base” stations for estimating conditions at the Williams Creek site. Carmacks data are presented in this report for completeness.

### **3.2. Average Annual Rainfall, Snowfall and Total Precipitation**

Table 2 summarizes long-term average precipitation, rainfall and snowfall for Carmacks and for Pelly River Ranch.

**Table 2 - Regional Average Precipitation**

Item	Carmacks	Pelly River Ranch
Elevation (m)	525	454
Years of Data	1964 - 1997	1951 - 1997
Average Annual Precipitation (mm)	282	300
Average Annual Rainfall (mm)	180	185
Rainfall % of Total Precipitation	64%	62%
Average Annual Snowfall (mm)	101	115
Snowfall % of Total Precipitation	36%	38%

(Precipitation = Rainfall plus Snowfall, all as mm water)

Rainfall at Pelly River Ranch usually occurs from May through September with minor amounts occasionally recorded in April, October and November. Snowfall typically occurs in October through March with minor amounts recorded in September and April.

For both Carmacks and Pelly River Ranch, snowfall water equivalent in millimetres has been calculated based on the measured depth of snowfall in centimetres and an assumed constant snowfall density of 10%. Table I.10 compares concurrent snow survey and snowfall data for Pelly River. The data indicate that, on average over the 1986 to 1997 period for the maximum measured snowpack, either

snowfall density has averaged about 8% with no sublimation losses or, with a 10% density, an average of about 20 mm of snowfall may have been lost to sublimation during the winter months.

Table 2 indicates that, for these two stations, annual precipitation may in fact decrease slightly with increasing elevation in this area, an observation at odds with the general behaviour typically expected in Yukon. Table I.8, however, indicates that for the 12 months of concurrent rainfall data at Williams Creek and at Pelly River Ranch, total recorded rainfall increased at about 1.3% per 100 m increase in elevation. The orographic factor for rainfall ( $OF_R$ ) was calculated as follows:

$$\text{Rainfall Orographic Factor } OF_R = 1 + [(Elev_{WC} - Elev_{PR})/100] \times 0.013 = 1.0515$$

where Elev = elevation in metres, and subscripts WC and PR refer to Williams Creek (elevation 850 m) and Pelly River Ranch (elevation 454 m), respectively.

Orographic Factor  $OF_R$  was adopted to estimate an annual average rainfall at Williams Creek of 195 mm based on long-term average annual rainfall of 185 mm at Pelly River Ranch.

In order to estimate annual average snowfall at Williams Creek elevation 850 m, comparisons were made between the concurrent snow survey data at Williams Creek (elevation 914 m, Table I.9) and at Pelly Farm (elevation 472 m, Table I.9) for 1995 to 1997, the long-term Pelly Farm snow survey data (1986 to 1997) and the long-term cumulative winter snowfall data at Pelly River Ranch (1955 to 1997 at elevation 454 m, Table I.6) as shown in Table 3.

**Table 3 - Estimation of Average Annual Total Snowfall at Williams Creek**

Item	Williams Creek		Pelly Farm/Pelly River		
	1995-97	Long Term	1995-97	1986-97	Long Term
Average Maximum Snowpack	86.3	108.5 (B)	67.3	84.8	84.6 (A)
Total Snowfall	n/a	147.5 (C)	93.8	115.3	115.0

(Note - average maximum snowpack in mm water equivalent, total snowfall from the previous Fall through April period, maximum snowpacks measured on April 1 each year)

The calculation methodology for items **A**, **B**, and **C** is described following:

- Pelly Farm 1986-97 average maximum snowpack represents 126% of the 1995-97 average (= 84.8 / 67.3);
- Pelly River long term (1955 to 1997) average snowfall at elevation 454 m represents 99.7% of the 1986 to 1997 average snowfall (= 115.0 / 115.3);
- Pelly Farm 1986-97 average maximum snowpack represents 73.5% of the average total snowfall (= 84.8 / 115.3); therefore,
- Item **A** (estimated long term average Pelly Farm maximum snowpack) equals (67.3 x 1.26 x 0.997) = 84.6 mm;
- Item **B** (estimated long term Williams Creek average maximum snowpack) equals (86.3 x 1.26 x 0.997) = 108.5 mm;
- Item **C** (estimated long term average Williams Creek total snowfall at elevation 914 m) equals (108.5 / 0.735) = 147.5 mm

From the above, annual total snowfall appears to increase at a rate of about 6.1% per 100 m rise in elevation (115 mm at elevation 454 m to 147.5 mm at elevation 914 m). The orographic factor for snowfall ( $OF_S$ ) was calculated as follows:

$$\text{Snowfall Orographic Factor } OF_S = 1 + [(Elev_{WC} - Elev_{PR})/100] \times 0.061 = 1.2416$$

where Elev = elevation in metres, and subscripts WC and PR refer to Williams Creek (850 m) and Pelly River (454 m), respectively.

Orographic Factor  $OF_S$  was adopted to estimate an annual average snowfall at Williams Creek of 143 mm based on long-term average annual snowfall of 115 mm at Pelly River Ranch.

The estimated annual average total precipitation at the Williams Creek site is thus 338 mm comprised of 195 mm rainfall (58%) and 143 mm snowfall (42%). Overall based on the above analysis, average annual total precipitation appears to increase at a rate of about 3.2% per 100 m between Pelly River Ranch (300 mm at elevation 454 m) and Williams Creek (338 mm at elevation 850 m). The orographic factor for annual total precipitation ( $OF_P$ ) was calculated as follows:

$$\text{Total Precipitation Orographic Factor } OF_P = 1 + [(Elev_{WC} - Elev_{PR})/100] \times 0.032 = 1.1267$$

The above analysis indicates that the assumed 8% increase in annual total precipitation per 100 m increase in elevation (equivalent orographic factor  $OF_P = 1.3168$ ) used in the previous studies was perhaps overly conservative. The orographic factors and average Williams Creek rainfall, snowfall and total precipitation derived herein were based on assessment of all available concurrent and long-term site and regional precipitation data.

### **3.3. Wet and Dry Year Precipitation**

Precipitation data for Pelly River Ranch were selected as the primary database. Values for Williams Creek were estimated using the factors developed in Section 3.2. Frequency analyses of the Pelly River Ranch data were carried out using the Consolidated Frequency Analysis (CFA) computer program Version 3.1 developed by the Surveys and Information Systems Branch of Environment Canada. Analyses were carried out using various frequency distributions including the generalized extreme value (GEV), three parameter log-normal, log-Pearson Type III, and non-parametric distribution. Results did not differ significantly (about 2% variation at the 100 year return period level) among the various frequency distributions and the GEV distribution was selected as an appropriate frequency distribution.

Table I.11 presents the results of the frequency analysis of annual total precipitation for Pelly River Ranch for annual events ranging from a 20 year return period dry year to a 500 year return period wet year. Also shown on the Table are the corresponding values of estimated annual total precipitation, annual rainfall and annual snowfall for the Williams Creek site at an elevation of 850 m.

### **3.4. Wet Periods**

#### **3.4.1. One to Three Month Rainfall**

Analyses were carried out of the maximum one month and consecutive two and three month duration periods of rainfall that could occur during the May to September period. The analyses were based on the common data in 1996 and 1997 for Williams Creek and Pelly River Ranch shown on Table I.8 and the long term data for Pelly River Ranch shown on Table I.13. The data indicate that orographic factors may be higher for one and two month duration rainfall than for annual total rainfall as shown in

Table I.14. Based on the number of occurrences of maximum events (Table I.13) and the concurrent data, the following conclusions were drawn:

- the maximum individual rainfall month is most likely to be July although annual maxima have occurred in each of the five months;
- maximum two month and three month duration wet periods are most likely to start in either June or July but could start in any of the five months;
- maximum one, two and three month duration rainfall recorded during the summer of 1996 and 1997 were above average at Pelly River Ranch with the 1997 three month rainfall (May, June and July) of 223.2 mm having an estimated return period in the order of fifty years. Data recorded at Williams Creek for these years displayed similar behaviour.

Frequency analysis of the Pelly River Ranch multi-month rainfall data were carried out and the orographic factors (Table I.14) applied to estimate the corresponding rainfall depths for the Williams Creek site. The results are presented in Table I.15.

### **3.4.2. Winter Snow Accumulation**

Frequency analyses were carried out of total cumulative precipitation at Pelly River Ranch over six month (October through March) and seven month (October through April) periods. The results were projected to Williams Creek using the estimated orographic factor for annual average snowfall (Section 3.2). This analysis, therefore, conservatively assumes that all precipitation falling in the six or seven month periods was snowfall. The results for Pelly River Ranch and for Williams Creek are presented in Table I.15.

### **3.5. Monthly Precipitation Distribution**

Average monthly precipitation (rainfall, snowfall and total precipitation) conditions were estimated for Williams Creek based on conditions at Pelly River Ranch modified in accordance with the estimated annual Williams Creek rainfall and snowfall values derived previously. The results are shown on Table I.16. Total rainfall is expected to be zero from November through March with zero snowfall in the May through September period. The spring and fall transition months of April and October may experience a mixture of rainfall and snowfall.

## **4. Maximum Annual Snowpack and Snowmelt Runoff**

### **4.1. Timing of Snowmelt**

For all the data for snow survey stations within 100 km of the site (Table I.9), annual maximum snowpacks have been reported on April 1 more than 80% of the time. Maximums on May 1 have occurred less than 5% of the time. Based on the regional and site snow survey data, the annual maximum snowpack for the Williams Creek site is, therefore, most likely to occur on or about April 1 each year. The data also show that, based on the rate of depletion of the snowpacks, on average about 70% of the snowmelt has occurred during April with the remainder in May. However, about one-third of the time 100% of the snowmelt has occurred during April. The Williams Creek data for 1995 to 1997 averaged about 60% melt during April and 40% melt in May with maximum snowpack on April 1 for each year. For design purposes it is recommended that the following timing of the snowmelt be assumed:

- for the design of the heap leach pad maximum solution storage volumes, 100% of the annual snowmelt will occur during April. Based on the magnitude of the snowpacks and typical maximum daily rates of snowmelt, the entire snowpack could melt and runoff could occur over a period of about two weeks under extreme design conditions;
- for average conditions in the heap leach pad water balance the snowmelt will be distributed 70%/30% between April and May;
- for conditions in receiving waters downstream of the leach pad, 70% of the area snowmelt will occur during April with the remaining 30% during May.

#### **4.2. Annual Maximum Snowpack**

As presented in Table 3, the estimated average annual maximum snowpack at Williams Creek is 108.5 mm of water equivalent occurring on April 1. This depth is essentially equivalent to the cumulative average six month (October to March) snowfall depth of 114 mm for Pelly River Ranch. Thus, one method of estimating the maximum April 1 snowpack for extreme years would be to assume that the Williams Creek maximum snowpack is equal to the six month October to March cumulative precipitation at Pelly River Ranch as shown in Table I.15A.

Another method would be to estimate Williams Creek maximum snowpack as equal to the six month October to March cumulative precipitation at Williams Creek as shown in Table I.15B minus an allowance for winter sublimation losses from the snowpack. Table I.10 indicates that an average of about 20 mm of snowpack water equivalent may be lost during the winter due to sublimation, although the actual loss may vary from zero to about 60 mm. Assuming a nominal average sublimation loss of 20 mm, this method yields a higher, more conservative estimate of the annual maximum snowpack water equivalent for Williams Creek for extreme years than the method discussed in the previous paragraph. Therefore, it is recommended that the maximum April 1 snowpack water equivalent for extreme years at Williams Creek be estimated as follows:

- Maximum Snowpack = Total October to March precipitation *minus* 20 mm sublimation loss  
(total October to March six month precipitation for extreme years shown in Table I.15B)

#### **4.3. Snowmelt Runoff Volume**

The total runoff volume each spring will consist of the runoff depth from the melting snowpack plus runoff from concurrent precipitation occurring during the snowmelt period, both applied to the catchment area of interest. For design solution storage conditions it is appropriate to assume that no losses will occur during the April snowmelt runoff period. Thus, the total runoff during April will be equal to 100% of the maximum snowpack plus 100% runoff of the concurrent April total precipitation.

### **5. Evaporation**

Previous reviews of reports by the RERC and their consultants have questioned the magnitude of annual evaporation and evapotranspiration applied to the Williams Creek area and, in particular, whether the estimates are conservative. Table I.16 summarizes the monthly and annual lake evaporation reported for Pelly Ranch and Whitehorse as well as estimates of lake evaporation and evapotranspiration prepared by the Water Resources Division of DIAND. Also shown in the Table are estimated values for Williams Creek based on the 10% decrease per 350 m elevation increase factor reported in the Manual of Operational Hydrology in BC.

The use of a “conservative” evaporation rate will be a function of the application. The following are recommended based on the information contained in Table I.16:

- for the determination of maximum design solution storage volumes, a conservative evaporation rate would correspond to a low estimate, for which a value of 402 mm per year is appropriate. This is the same value used in the previous water balance studies;
- for the determination of maximum likely make-up water requirements, a conservative evaporation rate would correspond to a high estimate, for which a value of 521 mm/year is appropriate;
- for average conditions a value of 460 mm/year is suggested, the average of the above two values. This value also corresponds essentially to the average Pelly Ranch lake evaporation without allowing for any adjustment due to elevation difference.

Monthly rates of evaporation should be determined using the above annual values distributed between May and September based proportionally on the Pelly Ranch monthly evaporation rates.

## 6. Conclusions

Based on the hydrological analyses presented in this Design Memorandum CCL-CC2, the following conclusions are drawn:

- 1) Available regional and site hydrological data are summarized on Table 1. Concurrent site and regional rainfall and snow survey data exist for 1995 to 1997. Concurrent data were used to estimate appropriate orographic factors. Frequency analyses of long term data at Pelly River Ranch were used in conjunction with the orographic factors to estimate extreme conditions at the Williams Creek site;
- 2) Orographic factors for rainfall, snowfall and total precipitation were estimated using the long term Pelly River Ranch data as follows;

Item	% per 100 m increase	Orographic Factor
Annual Rainfall	1.3%	$OF_R = 1.0515$
Annual Snowfall	6.1%	$OF_S = 1.2416$
Annual Total Precipitation	3.2%	$OF_P = 1.1267$

The orographic factors apply between Pelly River Ranch at elevation 454 m and the Williams Creek site at elevation 850 m. Based on the available data, these factors are felt to be conservative and suitable for application to the leach pad water balance analysis.

- 3) Estimated annual average total precipitation at Williams Creek is 338 mm comprised of 195 mm rainfall (58%) and 143 mm snowfall (42%).
- 4) Extreme wet and dry year precipitation, rainfall and snowfall estimates for Williams Creek are presented in Table I.11.
- 5) Wet period rainfall for Williams Creek for durations from one to three months and a range of return periods are presented in Table I.15;



- 6) Winter snow accumulation at Williams Creek for six (October to March) and seven (October to April) month periods and a range of return periods are presented in Table I.15;
- 7) The estimated monthly distribution of rainfall, snowfall and total precipitation at Williams Creek for average conditions is shown in Table I.16;
- 8) The following timing for the annual snowmelt is recommended;
  - for the design of the heap leach pad maximum solution storage volumes, 100% of the annual snowmelt will occur during April;
  - for average conditions in the heap leach pad water balance the snowmelt will be distributed 70%/30% between April and May;
  - for conditions in receiving waters downstream of the leach pad, 70% of the area snowmelt will occur during April with the remaining 30% during May.
- 9) The annual maximum snowpack at Williams Creek elevation 850 m may be conservatively estimated as equal to the total October to March precipitation minus a 20 mm sublimation loss. Total runoff during snowmelt will be equal to 100% of the maximum snowpack plus 100% runoff of the concurrent total precipitation;
- 10) The following annual evaporation depths are recommended;
  - for the determination of maximum design solution storage volumes, a low estimate of 402 mm per year is appropriate;
  - for the determination of maximum likely make-up water requirements, a high estimate of 521 mm/year is appropriate;
  - for average conditions 460 mm/year is suggested, the average of the above two values.

# **APPENDIX I**

## **HYDROLOGY DATA**

## **APPENDIX I - Hydrology Data**

<b><u>Table Number</u></b>	<b><u>Table Title</u></b>
I.1	Carmacks Total Precipitation (mm)
I.2	Carmacks Total Rainfall (mm)
I.3	Carmacks Total Snowfall (cm)
I.4	Pelly River Ranch Total Precipitation (mm)
I.5	Pelly River Ranch Total Rainfall (mm)
I.6	Pelly River Ranch Total Snowfall (cm)
I.7	Average Monthly Values - Williams Creek Climate Station
I.8	Williams Creek & Concurrent Regional Rainfall Data
I.9	Regional and Site Snow Survey Data (4 pages)
I.10	Pelly Farm Snow Survey & Concurrent Snowfall Data
I.11	Wet and Dry Year Precipitation, Rainfall, Snowfall - Williams Creek Site
I.12	Carmacks Wet Period Precipitation
I.13	Pelly River Ranch Wet Period Precipitation
I.14	One, Two and Three Month Duration Wet Period Rainfall - Common Data
I.15	Wet Period Precipitation - One to Seven Month Duration
I.15A	Pelly River Ranch
I.15B	Williams Creek Site
I.16	Average Monthly Precipitation Conditions - Williams Creek Site
I.17	Lake Evaporation Data and Estimates

**TABLE I.1 - CARMACKS Total Precipitation (mm)**

													Station 2100300	Lat 62o 6' N
													Elevation 525 m	Long 136o 18' W
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	
1963									40.4	17.5	12.2	10.4		
1964	14.2	13.5	6.1	0.5	29.7	56.1	39.6	41.4	14.2	12.2	6.1	4.3	237.9	
1965	18.5	5.6	5.3	1.8	16.8	23.6	32.8	15.0	23.4	23.9	6.6	13.5	186.8	
1966	3.3	10.2	3.6	8.6	11.4	35.1	42.4	43.7	18.3	22.6	51.6	6.6	257.4	
1967	42.7	23.4	23.4	7.6	42.4	45.0	54.1	25.4	12.2	20.1	14.5	7.6	318.4	
1968	42.7	11.2	4.8	16.0	21.8	20.1	59.2	33.8	50.0	10.9	24.1	6.6	301.2	
1969	13.0	2.8	4.1	4.3	11.7	5.8	55.4	32.0	27.9	6.4	16.3	9.4	189.1	
1970	11.9	16.8	7.9	11.4	29.0	11.2	25.1	18.5	51.6	44.5	24.9	22.1	274.9	
1971	5.8	4.3	3.3	1.5	0.1	9.4	37.1	39.6	23.1	22.6	13.5	21.6	181.9	
1972	24.1	8.4	0.1	14.5	15.5	65.3	34.0	25.9	43.2	23.4	16.3	18.5	289.2	
1973	13.2	2.5	3.8	7.4	5.8	35.3	28.7	63.5	9.1	19.8	41.7	17.3	248.1	
1974	7.6	33.8	15.0	2.0	6.4	36.3	52.6	68.6	19.6	14.5	10.7	34.3	301.4	
1975	23.9	5.6	9.7	18.0	5.6	13.2	60.2	57.4	38.4	23.4	15.2	19.6	290.2	
1976	33.5	4.3	8.4	2.3		30.5		6.6	0.3	4.8	8.1	12.7		
1977	14.4	9.7	14.1	8.1	24.7	49.5	57.1	52.5	63.7		10.2	5.6		
1978	0.5	3.0	1.0	7.6	15.0	46.6	56.8	39.6	13.8	9.0	14.6			
1979	5.0				23.2	47.6	104.4	23.6	23.4	3.6	9.6	28.4		
1980	28.0	17.2	13.2	5.6	20.6	24.8	72.8	53.6	55.2	24.8	37.6	6.4	359.8	
1981	7.2	13.8	3.0	7.8	8.8	27.1	105.2	27.8	37.3	22.0	16.2	4.2	280.4	
1982	19.8	14.6	13.4	2.0	33.0	11.4	86.9	46.1	26.7	48.6	14.2	11.8	328.5	
1983	17.6	5.0	5.0	5.8	35.5	53.0	71.6	69.2	37.6	17.0	2.2	9.4	328.9	
1984	23.6	17.5	3.2	2.0	27.8	37.8	42.8	32.4	12.3	17.0	17.5	23.6	257.5	
1985	31.4	21.0	0.5	5.0	4.6	30.1	79.0	48.6	24.6	27.4	22.0	12.5	306.7	
1986	30.0	2.5	22.0	16.4	24.4	27.9	47.4	31.3	37.0	11.0	18.5	11.5	279.9	
1987	2.0	34.5	1.5	0.8	40.0	30.8	26.0	36.0	34.2	13.6	18.5	19.0	256.9	
1988	10.2	10.5	22.5	2.0	27.0	37.4	88.8	33.6	17.8	18.7	24.0	8.5	301.0	
1989	18.0	2.0		0.1	32.7	41.9	31.6	17.6	19.9	23.1	30.5	26.0		
1990	22.0	23.5	1.0	6.0	37.2	78.6	40.2	50.1	61.2	26.3	13.0	35.7	394.8	
1991	17.4	20.4	8.5	2.0	11.7	53.2	62.7	37.2	44.0	31.9	35.5	45.0	369.5	
1992	22.5	8.4	0.5	20.0	36.3	18.0	68.7	27.9	48.5	17.5	19.0	21.9	309.2	
1993	17.0	10.5	10.5	0.0	52.0	29.4	35.0	56.3	38.8	34.3	35.5	15.5	334.8	
1994	25.0	8.0	20.0	3.0	16.3	27.4	25.4	21.9	27.6	29.0	20.9	4.0	228.5	
1995	5.5	12.8	8.5	4.5	11.2	6.6	60.2	56.9	26.4	12.1	26.0	16.6	247.3	
1996	9.2	8.0	13.0	4.0	11.4	10.2	87.3	55.7	14.1	41.0	5.7	17.0	276.6	
1997	9.9	13.0	11.5	11.8	32.2	39.2	45.0	17.0	15.6	25.2	19.5	18.0	257.9	
# years	34	33	32	33	33	34	33	34	35	34	35	34	29	
Mean	17.4	12.1	8.4	6.4	21.9	32.8	55.0	38.4	30.0	21.2	19.2	16.0		
Max.	42.7	34.5	23.4	20.0	52.0	78.6	105.2	69.2	63.7	48.6	51.6	45.0	394.8	
Min.	0.5	2.0	0.1	0.0	0.1	5.8	25.1	6.6	0.3	3.6	2.2	4.0	181.9	
Std. Dev	10.81	8.40	6.81	5.53	12.77	17.39	22.42	16.19	15.69	10.51	10.97	9.73	52.98	
													Sum of Average Months =	278.8
													Average of Complete Years =	282.6

**TABLE I.2 - CARMACKS Total Rainfall (mm)**

													Station 2100300	Lat 62o 6' N
													Elevation 525 m	Long 136o 18' W
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	
1963									40.4	10.7	0.0	0.0		
1964	0.0	0.0	0.0	0.0		56.1	39.6	41.4	14.2	3.3	0.0	0.0		
1965	0.0	0.0	0.0	0.0	0.1	23.6	32.8	15.0	23.4	2.0	0.0	0.0	96.9	
1966	0.0	0.0	0.0	1.5	11.4	35.1	42.4	43.7	18.3	7.9	0.0	0.0	160.3	
1967	0.0	0.0	0.0	0.1	39.9	45.0	54.1	25.4	12.2	4.6	8.6	0.0	189.9	
1968	0.0	0.0	0.1	1.0	21.8	20.1	59.2	33.8	43.7	0.0	0.0	0.0	179.7	
1969	0.0	0.0	0.0	4.1	11.7	5.8	55.4	32.0	27.9	5.8	2.5	0.0	145.2	
1970	0.0	0.0	5.1	0.1	29.0	11.2	25.1	18.5	47.5	0.0	0.0	0.0	136.5	
1971	0.0	0.0	0.0	0.0	0.1	9.4	37.1	39.6	23.1	5.8	0.0	0.0	115.1	
1972	0.0	0.0	0.0	0.0	13.7	65.3	34.0	25.9	43.2	8.6	0.0	0.0	190.7	
1973	0.0	0.0	0.0	0.0	5.8	35.3	28.7	63.5	9.1	1.0	0.0	0.0	143.4	
1974	0.0	0.0	0.0	1.3	2.8	36.3	52.6	68.6	18.0	8.4	0.0	0.0	188.0	
1975	0.0	0.0	0.0	0.0	5.1	13.2	60.2	57.4	38.4	9.1	0.0	0.0	183.4	
1976	0.0	0.0	0.0	0.0		30.5		6.6	0.3	2.5	0.1	0.0		
1977	0.0	0.0	0.0	0.1	24.7	49.5	57.1	52.5	59.7		0.0	0.0		
1978	0.0	0.0	0.0	0.0	15.0	46.6	56.8	39.6	13.8	9.0	0.0	0.1	180.9	
1979	0.0				23.2	47.6	104.4	23.6	23.4	2.2	0.0	0.0		
1980	0.0	0.0	0.0	5.6	20.6	24.8	72.8	53.6	51.6	14.8	0.0	0.0	243.8	
1981	0.0	0.0	0.1		8.8	27.1	105.2	27.8	33.3	14.4	0.0	0.0		
1982	0.0	0.0		0.0	30.0	11.4	86.9	46.1	26.7	3.4	0.0	0.0		
1983	0.0	0.0	0.0	5.8	35.5	53.0	71.6	69.2	37.6	3.4	0.0	0.0	276.1	
1984	0.0	0.0	0.0	1.0	27.8	37.8	42.8	31.4	12.3	2.0	0.0	0.0	155.1	
1985	0.0	0.0	0.0	0.0	4.6	30.1	79.0	48.6	24.6	2.2	0.0	0.0	189.1	
1986	0.0	0.0	0.0	0.1	24.4	27.9	47.4	31.3	32.0	11.0	0.0	0.0	174.1	
1987	0.0	0.0	0.0	0.1	40.0	30.8	26.0	36.0	34.2	6.6	0.0	0.0	173.7	
1988	0.0	0.0	0.0	0.0	27.0	37.4	88.8	33.6	17.8	0.2	0.0	0.0	204.8	
1989	0.0	0.0	0.0	0.1	32.7	41.9	31.6	17.6	19.9	11.1	0.0	0.1	155.0	
1990	0.0	0.0	0.0	6.0	37.2	78.6	40.2	50.1	61.2	2.3	0.0	0.0	275.6	
1991	0.0	0.0	0.0	0.1	11.7	53.2	62.7	37.2	44.0	19.9	0.0	0.0	228.8	
1992	0.0	0.0	0.1	0.1	34.3	18.0	68.7	27.9	37.0	5.0	0.1	0.0	191.2	
1993	0.0	0.0	0.0	0.0	52.0	29.4	35.0	56.3	37.8	1.2	0.0	0.0	211.7	
1994	0.0	0.0	1.0	0.1	16.3	27.4	25.4	21.9	27.6	21.1	0.0	0.0	140.8	
1995	0.0	0.0	0.0	4.5	11.2	6.6	60.2	56.9	26.4	10.6	0.0	0.0	176.4	
1996	0.0	0.0	0.0	4.0	11.4	10.2	87.3	55.7	14.1	0.0	0.0	0.0	182.7	
1997	0.0	0.0	0.0	6.0	32.2	39.2	45.0	17.0	15.6	0.2	0.0	0.0	155.2	
# years	34	33	32	32	32	34	33	34	35	34	35	35	28	
Mean	0.0	0.0	0.2	1.3	20.7	32.8	55.0	38.4	28.9	6.2	0.3	0.0		
Max.	0.0	0.0	5.1	6.0	52.0	78.6	105.2	69.2	61.2	21.1	8.6	0.1	276.1	
Min.	0.0	0.0	0.0	0.0	0.1	5.8	25.1	6.6	0.3	0.0	0.0	0.0	96.9	
Std. Dev	0.00	0.00	0.91	2.14	13.34	17.39	22.42	16.20	14.52	5.59	1.50	0.02	45.10	
Sum of Average Months =													183.8	
Average of Complete Years =													180.1	

**TABLE I.3 - CARMACKS Total Snowfall (cm)** Station 2100300 Lat 62o 6' N  
 Elevation 525 m Long 136o 18' W

(Note - Calculation of Total Precipitation (Table I.1) assumes constant 10% density for snowfall)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1963								0.0	0.0	6.9	12.2	10.4	
1964	14.2	13.5	6.1	0.5		0.0	0.0	0.0	0.0	8.9	6.1	4.3	
1965	18.5	5.6	5.3	1.8	16.8	0.0	0.0	0.0	0.1	21.8	6.6	13.5	90.0
1966	3.3	10.2	3.6	7.1	0.1	0.0	0.0	0.0	0.0	14.7	51.6	6.6	97.2
1967	42.7	23.4	23.4	7.6	2.5	0.0	0.0	0.0	0.0	15.5	5.8	7.6	128.5
1968	42.7	11.2	4.8	15.0	0.0	0.0	0.0	0.0	6.4	10.9	24.1	6.6	121.7
1969	13.0	2.8	4.1	0.3	0.0	0.0	0.0	0.0	0.0	0.5	13.7	9.4	43.8
1970	11.9	16.8	2.8	11.4	0.0	0.0	0.0	0.0	4.1	44.5	24.9	22.1	138.5
1971	5.8	4.3	3.3	1.5	0.0	0.0	0.0	0.0	0.1	16.8	13.5	21.6	66.9
1972	24.1	8.4	0.1	14.5	1.8	0.0	0.0	0.0	0.1	14.7	16.3	18.5	98.5
1973	13.2	2.5	3.8	7.4	0.0	0.0	0.0	0.0	0.0	18.8	41.7	17.3	104.7
1974	7.6	33.8	15.0	0.8	3.6	0.0	0.0	0.1	1.5	6.1	10.7	34.3	113.5
1975	23.9	5.6	9.7	12.4	0.5	0.0	0.0	0.0	0.0	14.2	15.2	19.6	101.1
1976	33.5	4.3	8.4	2.3	0.1	0.0		0.0	0.0	2.3	8.1	12.7	
1977	14.4	9.7	14.1	8.1	0.0	0.0	0.0	0.0	4.0		10.2	5.6	
1978	0.5	3.0	1.0	7.6	0.0	0.0	0.0	0.0	0.1	0.1	14.6		
1979	5.0				0.0	0.0	0.0	0.0	0.0	1.4	9.6	28.4	
1980	28.0	17.2	13.2	0.1	0.0	0.0	0.0	0.0	3.6	10.0	37.6	6.4	116.1
1981	7.2	13.8	3.0		0.0	0.0	0.0	0.0	4.0	7.6	16.2	4.2	
1982	19.8	14.6		2.0	3.0	0.0	0.0	0.0	0.0	45.2	14.2	11.8	
1983	17.6	5.0	5.0	0.0	0.1	0.0	0.0	0.0	0.1	13.6	2.2	9.4	53.0
1984	23.6	17.5	3.2	1.0	0.0	0.0	0.0	1.0	0.0	15.0	17.5	23.6	102.4
1985	31.4	21.0	0.5	5.0	0.0	0.0	0.0	0.0	0.0	25.2	22.0	12.5	117.6
1986	30.0	2.5	22.0	16.4	0.0	0.0	0.0	0.0	5.0	0.1	18.5	11.5	106.0
1987	2.0	34.5	1.5	0.8	0.0	0.0	0.0	0.0	0.0	7.0	18.5	19.0	83.3
1988	10.2	10.5	22.5	2.0	0.0	0.0	0.0	0.0	0.0	18.5	24.0	8.5	96.2
1989	18.0	2.0		0.1	0.0	0.0	0.0	0.0	0.0	12.0	30.5	26.0	
1990	22.0	23.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	24.0	13.0	35.7	119.2
1991	17.4	20.4	8.5	2.0	0.0	0.0	0.0	0.0	0.0	12.0	35.5	45.0	140.8
1992	22.5	8.4	0.5	20.0	2.0	0.0	0.0	0.0	11.5	12.5	19.0	21.9	118.3
1993	17.0	10.5	10.5	0.0	0.1	0.0	0.0	0.0	1.0	33.1	35.5	15.5	123.2
1994	25.0	8.0	19.0	3.0	0.1	0.0	0.0	0.0	0.0	7.9	20.9	4.0	87.9
1995	5.5	12.8	8.5	0.0	0.0	0.0	0.0	0.0	0.0	1.5	26.0	16.6	70.9
1996	9.2	8.0	13.0	0.1	0.0	0.0	0.0	0.0	0.0	41.0	5.7	17.0	94.0
1997	9.9	13.0	11.5	5.8	0.0	0.0	0.0	0.0	0.0	25.0	19.5	18.0	102.7
# years	34	33	31	32	33	34	33	35	35	34	35	34	26
Mean	17.4	12.1	8.0	4.9	0.9	0.0	0.0	0.0	1.2	15.0	18.9	16.0	
Max.	42.7	34.5	23.4	20.0	16.8	0.0	0.0	1.0	11.5	45.2	51.6	45.0	138.5
Min.	0.5	2.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.2	4.0	43.8
Std. Dev	10.81	8.40	6.88	5.68	3.01	0.00	0.00	0.17	2.51	12.00	11.21	9.73	24.51
Sum of Average Months =													94.4
Average of Complete Years =													101.4

**TABLE I.4 - PELLY RIVER RANCH Total Precipitation (mm)**

Year	Station 2100880 Elevation 454 m												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1951												48.3	
1952	48.3	5.1	6.4	2.5	6.6								
1954						6.1	40.6	17.8	23.4	2.5	18.8	32.8	
1955	22.4	5.3	8.1	0.1	7.1	43.2	14.0	86.1	10.7	4.8	26.4	23.6	251.8
1956	12.7	11.7			6.9	40.1	45.0	48.3	40.9	2.8	37.1	33.0	18.0
1957	14.7	23.9	13.7	7.9	15.2	12.7	34.8	19.6	19.8	2.3	33.3	20.8	218.7
1958	20.8	16.3	1.3	3.0	14.2	33.5	62.0	67.1	17.0	45.2	35.1	12.4	327.9
1959	10.2	21.1	24.4	10.7	19.3	46.7	29.0	37.6	25.1	6.4	20.1	14.5	265.1
1960	11.2	15.2	12.7	5.1	18.5	26.4	117.9	36.6	28.4	8.4	24.1	17.8	322.3
1961	13.5	10.9	11.2	6.6	23.4	45.0	44.5	25.9	18.3	41.9	24.4	29.2	294.8
1962	25.4	17.3	4.1	24.9	16.3	55.9	35.6	39.4	13.0	6.4	15.0	37.8	291.1
1963	47.8	7.4	10.7	10.9		47.5	58.7	18.5	35.1	27.2	14.7	47.5	
1964	24.1	19.1	16.5	16.0	26.2	53.6	88.1	30.7	21.1	19.8	19.1	20.1	354.4
1965	12.2	9.9	5.1	3.6	14.0	30.0	41.9	17.5	40.4	42.4	17.8	24.9	259.7
1966	7.6	26.2	6.6	10.2	5.8	28.2	7.1	20.3	16.0	35.3	61.0	10.4	234.7
1967	37.6	26.7	31.2	14.2	16.5	46.2	65.0	56.4	28.4	13.0	16.3	18.5	370.0
1968	30.7	12.2	19.8	15.7	25.1	21.3	29.7	25.7	59.7	14.2	27.4	10.7	292.2
1969	11.7	3.6	14.5	11.9	30.5	3.3	81.5	12.2	22.9	7.9	25.7	14.5	240.2
1970	8.4	16.0	2.0	7.6	48.8	24.4	5.3	42.7	50.3	35.3	25.7	35.3	301.8
1971	4.6	6.6	7.9	4.8	7.4	11.7	24.1	45.0	22.1	28.4	28.4	40.4	231.4
1972	23.1	13.7	7.9	12.7	14.7	70.9	47.2	23.1	23.4	54.1	20.1	12.2	323.1
1973	25.1	12.4	17.8	30.5	5.1	50.8	47.5	54.1	8.6	17.3	22.6	34.3	326.1
1974	4.6	37.3	9.7	19.1	7.4	14.7	65.8	31.8	8.6	27.9	14.0	30.5	271.4
1975	20.3	4.6	0.3	18.3	13.7	16.5	71.6	29.0	32.3	20.8	15.7	12.2	255.3
1976	30.5	14.0	26.9	10.7	42.9	37.3	46.7	19.3	14.5	15.2	24.1	13.7	295.8
1977	31.1	4.1	16.8	25.0	24.2	44.8	30.3	18.3	14.9	18.1	21.7	11.7	261.0
1978	10.8	3.3	3.4	12.9	17.8	33.4	100.0	46.7	23.8	24.7	23.7	26.9	327.4
1979	23.8	19.5	20.9	4.6	29.5	47.7	54.1	10.2	33.5	4.0	18.9	17.6	284.3
1980	24.3	11.5	2.8	3.2	9.2	24.8	44.4	33.0	53.4	17.6	21.5	1.8	247.5
1981	5.4	27.0	4.3	11.0	13.2	33.3	87.9	43.6	52.9	43.0	41.5	6.0	369.1
1982	11.3	13.1	6.4	13.9	33.7	13.3	62.7	22.4	31.7	25.4	22.0	13.2	269.1
1983	30.1	27.2	3.3	5.8	29.0	50.3	53.8	82.2	26.0	20.6	6.6	11.3	346.2
1984	24.1	23.6	8.2	8.5	33.5	27.0	44.6	48.7	25.0	14.4	14.7	28.9	301.2
1985	27.6	17.0	5.6	8.9	20.5	69.8	88.4	48.8	28.5	23.1	17.2	10.9	366.3
1986	27.7	4.7	16.9	5.8	30.0	47.4	73.0	44.5	8.0	9.0	20.9	14.5	302.4
1987	11.7	25.7	8.3	9.2	22.3	26.6	53.4	34.6	43.1	42.9	32.4	25.2	335.4
1988	12.4	14.8	13.9	4.1	23.8	26.2	68.8	28.6	9.8	26.6	22.0	21.3	272.3
1989	14.0	6.0	5.6	0.2	32.6	49.1	13.1	20.4	23.8	18.6	35.9	12.0	231.3
1990	11.6	21.9	6.8	1.6	48.4	57.0	13.0	41.0	45.0	34.0	23.2	40.0	343.5
1991	16.6	23.8	9.9	4.0	25.1	30.0	47.8	34.7	43.0	23.4	40.1	30.0	328.4
1992	32.0	11.2	16.0	46.6	28.2	32.2	44.3	47.4	56.4	39.2	31.0	19.4	403.9
1993	24.9	6.8	34.4	8.8	18.4	16.8	61.9	40.0	20.8	28.1	34.8	7.0	302.7
1994	24.6	4.8	15.9	7.7	37.8	53.6	36.2	8.6	21.6	27.4	27.4	3.6	269.2
1995	5.8	12.4	4.6	0.2	16.8	31.8	84.4	78.2	10.6	22.9	15.8	22.4	305.9
1996	12.8	16.6	9.9	16.6	3.4	27.9	67.2	58.2	33.6	32.8	6.2	24.4	309.6
1997	7.6	17.0	18.4	12.6	86.0	56.6	80.6	36.0	29.4	24.0	24.7	18.2	411.1
# years	44	44	43	44	43	44	44	44	44	44	44	45	41
Mean	19.5	14.7	11.4	10.6	23.3	35.7	52.7	36.9	26.7	23.5	24.2	21.0	
Max.	48.3	37.3	34.4	46.6	86.0	70.9	117.9	86.1	59.7	54.1	61.0	48.3	411.1
Min.	4.6	3.3	0.3	0.1	3.4	3.3	5.3	8.6	2.8	2.3	6.2	1.8	218.7
Std. Dev	10.76	8.09	7.96	8.76	15.13	16.45	25.37	18.38	14.12	13.00	9.70	11.25	47.14
	Sum of Average Months =												300.2
	Average of Complete Years =												300.4

#REF!

**TABLE I.5 - PELLY RIVER RANCH Total Rainfall (mm)**

													Station 2100880	Lat 62o 49' N
													Elevation 454 m	Long 137o 22' W
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	
1951												0.0		
1952	0.0	0.0	0.0	0.0	6.6									
1954						6.1	40.6	17.8	19.3	2.5	0.0	5.1		
1955	0.0	0.0	0.0	0.0	7.1	43.2	14.0	86.1	10.4	1.5	0.0	0.0	162.3	
1956	0.0	0.0		0.0	40.1	45.0	48.3	40.9	2.5	16.0	0.0	0.0		
1957	0.0	0.0	0.0	7.6	15.2	12.7	34.8	19.6	13.5	0.1	2.5	0.0	106.0	
1958	0.0	0.0	0.0	0.0	14.2	33.5	62.0	67.1	12.7	4.6	0.0	0.0	194.1	
1959	0.0	0.0	0.0	0.1	18.8	46.7	29.0	37.6	25.1	0.0	0.0	0.0	157.3	
1960	0.0	0.0	0.0	2.3	18.5	26.4	117.9	36.6	28.4	7.4	0.3	0.0	237.8	
1961	0.0	0.0	0.0	0.0	23.4	45.0	44.5	25.9	18.3	12.4	0.0	0.0	169.5	
1962	0.0	0.0	0.0	20.8	16.3	55.9	35.6	39.4	13.0	5.1	0.0	0.0	186.1	
1963	0.0	0.0	0.0	5.1		47.5	58.7	18.5	35.1	14.5	0.0	0.0		
1964	0.0	0.0	0.0	0.0	19.8	53.6	88.1	30.7	21.1	4.6	0.0	0.0	217.9	
1965	0.0	0.0	0.0	0.3		30.0	41.9	17.5	40.4	10.4	0.0	0.0		
1966	0.0	0.0	0.0		5.8	28.2	7.1	20.3	16.0	8.6	0.0	0.0		
1967	0.0	0.0	0.0	1.3	16.5	46.2	65.0	56.4	28.4	8.6	1.3	0.0	223.7	
1968	0.0	0.0	2.5	5.1	25.1	21.3	29.7	25.7	50.8	0.0	0.0	0.0	160.2	
1969	0.0	0.0	0.0	0.8	30.5	3.3	81.5	12.2	22.9	1.5	0.0	0.0	152.7	
1970	0.0	0.0	0.0	1.0	47.5	24.4	5.3	42.7	41.7	11.9	2.5	0.0	177.0	
1971	0.0	0.0	0.0	1.0	7.4	11.7	24.1	45.0	22.1	4.1	0.0	0.0	115.4	
1972	0.0	0.0	0.0	0.0	13.0	70.9	47.2	23.1	17.3	2.8	0.0	0.0	174.3	
1973	0.0	0.0	0.0	22.4	5.1	50.8	47.5	54.1	8.6	1.5	0.0	0.0	190.0	
1974	0.0	0.0	0.0	0.8	6.4	14.7	65.8	31.8	8.6	12.7	0.1	0.0	140.9	
1975	0.0	0.0	0.0	7.4	13.7	16.5	71.6	29.0	32.3	3.3	0.0	0.1	173.9	
1976	0.0	0.0	0.0	0.1	42.9	37.3	46.7	19.3	14.5	2.3	2.0	0.0	165.1	
1977	0.0	0.3	0.0	1.8	24.2	44.8	30.3	18.3	14.9	16.8	0.0	0.0	151.4	
1978	0.0	0.0	0.0	4.0	17.8	33.4	100.0	46.7	23.8	0.5	0.0	0.0	226.2	
1979	0.0	0.0	2.5	0.0	29.5	47.7	54.1	10.2	33.5	2.2	10.0	0.0	189.7	
1980	0.0	0.0	0.0	3.2	9.2	24.8	44.4	33.0	49.9	11.2	0.0	0.0	175.7	
1981	0.0	0.0	0.8	7.6	13.2	33.3	87.9	43.6	50.9	31.4	0.0	0.0	268.7	
1982	0.0	0.1	0.0	0.0	33.7	13.3	62.7	22.4	31.7	2.3	0.0	0.0	166.2	
1983	0.0	0.0	0.0	4.8	29.0	50.3	53.8	82.2	23.7	9.8	0.0	0.0	253.6	
1984	0.0	0.0	0.0	3.4	33.5	27.0	44.6	47.7	25.0	8.7	0.0	0.0	189.9	
1985	0.0	0.0	0.0	0.0	20.5	69.8	88.4	48.8	28.5	2.4	0.0	0.1	258.5	
1986	0.0	0.0	0.0	0.1	30.0	47.4	73.0	44.5	8.0	9.0	0.0	0.1	212.1	
1987	0.0	0.0	2.0	2.0	17.9	26.6	53.4	34.6	43.1	33.4	0.0	0.0	213.0	
1988	0.0	0.0	0.0	2.9	23.8	26.2	68.8	28.6	9.6	0.0	0.0	0.0	159.9	
1989	0.0	0.0	0.0	0.2	32.6	49.1	13.1	20.4	21.0	2.8	0.0	0.0	139.2	
1990	0.0	0.0	0.1	0.6	48.4	57.0	13.0	41.0	45.0	12.4	0.0	0.0	217.5	
1991	0.0	0.0	0.0	0.0	25.1	30.0	47.8	34.7	43.0	14.6	0.0	0.0	195.2	
1992	0.0	0.0	0.8	18.0	24.4	32.2	44.3	47.4	34.2	2.6	0.0	0.0	203.9	
1993	0.0	0.0	0.0	7.8	18.4	16.8	61.9	40.0	18.8	14.2	0.0	0.0	177.9	
1994	0.0	0.0	0.1	1.4	37.8	53.6	36.2	8.6	21.6	7.4	0.1	0.0	166.8	
1995	0.0	0.0	0.4	0.2	16.8	31.8	84.4	78.2	10.6	14.6	0.0	0.0	237.0	
1996	0.0	0.0	0.0	7.6	3.4	27.9	67.2	58.2	33.6	0.0	0.0	0.0	197.9	
1997	0.0	0.0	0.0	5.8	86.0	56.6	80.6	36.0	29.4	0.0	0.0	0.0	294.4	
# years	44	44	43	43	42	44	44	44	44	44	44	45	39	
Mean	0.0	0.0	0.2	3.4	23.1	35.7	52.7	36.9	25.1	7.6	0.4	0.1		
Max.	0.0	0.3	2.5	22.4	86.0	70.9	117.9	86.1	50.9	33.4	10.0	5.1	294.4	
Min.	0.0	0.0	0.0	0.0	3.4	3.3	5.3	8.6	2.5	0.0	0.0	0.0	106.0	
Std. Dev	0.00	0.05	0.62	5.38	15.26	16.45	25.37	18.37	12.72	7.58	1.60	0.76	40.69	
Sum of Average Months =													185.1	
Average of Complete Years =													189.7	



**TABLE I.6 - PELLY RIVER RANCH Total Snowfall (mm)** Station 2100880 62o 49' N  
Elevation 454 m 137o 22' W

(Note - Calculation of Total Precipitation (Table I.4) assumes constant 10% density for snowfall)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1951													48.3
1952	48.3	5.1	6.4	2.5	0.0								
1954						0.0	0.0	0.0	4.1	0.0	18.8	27.7	
1955	22.4	5.3	8.1	0.1	0.1	0.0	0.0	0.0	0.3	3.3	26.4	23.6	89.6
1956	12.7	11.7		6.9	0.1	0.0	0.0	0.0	0.3	21.8	33.0	18.0	
1957	14.7	23.9	13.7	0.3	0.1	0.0	0.0	0.0	6.4	2.3	30.7	20.8	112.9
1958	20.8	16.3	1.3	3.0	0.0	0.0	0.0	0.0	4.3	40.6	35.1	12.4	133.8
1959	10.2	21.1	24.4	10.7	0.5	0.0	0.0	0.0	0.0	6.4	20.1	14.5	107.9
1960	11.2	15.2	12.7	2.8	0.0	0.0	0.0	0.0	0.0	1.0	23.9	17.8	84.6
1961	13.5	10.9	11.2	6.6	0.1	0.0	0.0	0.0	0.0	29.5	24.4	29.2	125.4
1962	25.4	17.3	4.1	4.1	0.0	0.0	0.0	0.0	0.0	1.3	15.0	37.8	105.0
1963	47.8	7.4	10.7	5.8		0.0	0.0	0.0	0.0	12.7	14.7	47.5	
1964	24.1	19.1	16.5	16.0	6.4	0.0	0.0	0.0	0.0	15.2	19.1	20.1	136.5
1965	12.2	9.9	5.1	3.3		0.0	0.0	0.0	0.1	32.0	17.8	24.9	
1966	7.6	26.2	6.6		0.0	0.0	0.0	0.0	0.0	26.7	61.0	10.4	
1967	37.6	26.7	31.2	13.0	0.1	0.0	0.0	0.0	0.0	4.3	15.0	18.5	146.4
1968	30.7	12.2	17.3	10.7	0.0	0.0	0.0	0.0	8.9	14.2	27.4	10.7	132.1
1969	11.7	3.6	14.5	11.2	0.0	0.0	0.0	0.0	0.0	6.4	25.7	14.5	87.6
1970	8.4	16.0	2.0	6.6	1.3	0.0	0.0	0.0	8.6	23.4	23.1	35.3	124.7
1971	4.6	6.6	7.9	3.8	0.1	0.0	0.0	0.0	0.1	24.4	28.4	40.4	116.3
1972	23.1	13.7	7.9	12.7	1.8	0.0	0.0	0.0	6.1	51.3	20.1	12.2	148.9
1973	25.1	12.4	17.8	8.1	0.0	0.0	0.0	0.0	0.0	15.7	22.6	34.3	136.0
1974	4.6	37.3	9.7	18.3	1.0	0.0	0.0	0.0	0.0	15.2	14.0	30.5	130.6
1975	20.3	4.6	0.3	10.9	0.0	0.0	0.0	0.0	0.0	17.5	15.7	12.2	81.5
1976	30.5	14.0	26.9	10.7	0.1	0.0	0.0	0.0	0.0	13.0	22.1	13.7	131.0
1977	31.1	3.8	16.8	23.2	0.0	0.0	0.0	0.0	0.0	1.3	21.7	11.7	109.6
1978	10.8	3.3	3.4	8.9	0.0	0.0	0.0	0.0	0.0	24.2	23.7	26.9	101.2
1979	23.8	19.5	18.4	4.6	0.0	0.0	0.0	0.0	0.0	1.8	8.9	17.6	94.6
1980	24.3	11.5	2.8	0.0	0.0	0.0	0.0	0.0	3.5	6.4	21.5	1.8	71.8
1981	5.4	27.0	3.5	3.4	0.1	0.0	0.0	0.0	2.0	11.6	41.5	6.0	100.5
1982	11.3	13.1	6.4	13.9	0.1	0.0	0.0	0.0	0.0	23.1	22.0	13.2	103.1
1983	30.1	27.2	3.3	1.0	0.0	0.0	0.0	0.0	2.3	10.8	6.6	11.3	92.6
1984	24.1	23.6	8.2	5.1	0.0	0.0	0.0	1.0	0.0	5.7	14.7	28.9	111.3
1985	27.6	17.0	5.6	8.9	0.0	0.0	0.0	0.0	0.0	20.7	17.2	10.9	107.9
1986	27.7	4.7	16.9	5.8	0.0	0.0	0.0	0.0	0.1	0.1	20.9	14.5	90.7
1987	11.7	25.7	6.3	7.2	4.4	0.0	0.0	0.0	0.0	9.5	32.4	25.2	122.4
1988	12.4	14.8	13.9	1.2	0.0	0.0	0.0	0.0	0.2	26.6	22.0	21.3	112.4
1989	14.0	6.0	5.6	0.1	0.0	0.0	0.0	0.0	2.8	15.8	35.9	12.0	92.2
1990	11.6	21.9	6.8	1.0	0.0	0.0	0.0	0.0	0.0	21.6	23.2	40.0	126.1
1991	16.6	23.8	9.9	4.0	0.0	0.0	0.0	0.0	0.0	8.8	40.1	30.0	133.2
1992	32.0	11.2	15.2	28.6	3.8	0.0	0.0	0.0	22.2	36.6	31.0	19.4	200.0
1993	24.9	6.8	34.4	1.0	0.0	0.0	0.0	0.0	2.0	13.9	34.8	7.0	124.8
1994	24.6	4.8	15.9	6.3	0.0	0.0	0.0	0.0	0.0	20.0	27.4	3.6	102.6
1995	5.8	12.4	4.2	0.0	0.0	0.0	0.0	0.0	0.0	8.3	15.8	22.4	68.9
1996	12.8	16.6	9.9	9.0	0.0	0.0	0.0	0.0	TR	32.8	6.2	24.4	111.7
1997	7.6	17.0	18.4	6.8	0.0	0.0	0.0	0.0	0.0	24.0	24.7	18.2	116.7
# years	44	44	43	43	42	44	44	44	43	44	44	45	39
Mean	19.5	14.7	11.2	7.2	0.5	0.0	0.0	0.0	1.7	16.0	23.8	20.9	
Max.	48.3	37.3	34.4	28.6	6.4	0.0	0.0	1.0	22.2	51.3	61.0	48.3	200.0
Min.	4.6	3.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	1.8	68.9
Std. Dev	10.76	8.10	7.88	6.25	1.32	0.00	0.00	0.15	3.98	11.91	9.92	11.15	24.36
													Sum of Average Months = 115.5
													Average of Complete Years = 113.5

**TABLE I.7 - Average Monthly Values - Williams Creek Climate Station (1994-1998)**

Date	Net Radiation	Licor Shortwave Incoming	Licor Shortwave Outgoing	REBS Soil Heat Flux	Soil Temp 6cm Depth	HM35CF Upper Temp	HM35C Upper RH	Lower Wind Speed	Upper Wind Speed	Precip. Tip Bucket Totalized
	W/m <sup>2</sup>	W/m <sup>2</sup>	W/m <sup>2</sup>	W/m <sup>2</sup>	°C	°C	%	m/s	m/s	mm
<b>1994</b>										
*Sep-94	-6999	89.03	8.82	0.47	3.11	5.47	62.73	19.43	-7.42	22.2
**Oct-94	8.48	42.59	6.09	-1.64	-0.17	-0.71	76.82	2.98	-0.63	5.10
Nov-94	-10.98	5.05	0.97	-6.10	-7.53	-16.42	76.38	0.83	0.39	0.00
Dec-94	-3.09	13.79	2.57	-7.13	-4.62	-15.92	75.85	0.82	-0.02	0.00
* Average of records from September 13 to September 30, 1997; Average excludes Sept-13 Upper Temperature record										
** Average does not include October 1 to October 4 Net Radiation record										
<b>1995</b>										
Jan-95	-1.17	7.48	2.12	-4.96	-8.46	-15.32	80.22	0.93	0.71	0.00
Feb-95	6.70	38.10	6.13	-3.36	-6.79	-11.93	71.99	0.87	0.32	0.00
Mar-95	53.30	96.72	12.83	-2.81	-7.09	-10.50	58.51	1.03	2.64	3.30
Apr-95	148.41	193.55	21.84	1.33	-0.26	4.09	46.55	1.03	2.21	19.50
May-95	185.37	221.94	22.31	6.89	3.69	10.82	43.71	1.05	2.32	772.3 <sup>s</sup>
Jun-95	210.51	245.25	25.31	6.60	7.62	14.60	43.53	1.08	2.57	546.9 <sup>s</sup>
Jul-95	160.67	175.79	16.81	6.72	10.71	15.07	60.98	0.84	1.90	118.9 <sup>s</sup>
Aug-95	138.42	155.49	14.21	4.61	8.51	11.67	64.36	0.89	2.09	661.4 <sup>s</sup>
Sep-95	79.92	110.45	10.14	2.56	6.34	10.85	58.48	1.08	2.23	25.00
Oct-95	20.85	39.05	4.17	-2.07	0.71	-0.68	84.10	0.80	1.45	8.50
*Nov-95	7.47	13.87	2.74	-9.18	-2.61	-12.35	82.68	0.72	1.35	0.30
* Average of records from November 1 to November 25, 1995										
<b>1996</b>										
*Mar-96	130.92	169.73	20.13	-1.73	-5.71	-8.20	36.99	0.93	2.89	0.00
Apr-96	153.07	184.37	20.38	0.38	-2.52	1.10	44.29	0.99	2.28	5.90
May-96	194.10	219.95	20.73	3.76	1.65	6.90	41.47	0.89	2.44	16.00
Jun-96	222.97	248.91	23.48	7.78	4.45	12.71	40.08	0.99	2.50	12.00
Jul-96	179.32	206.10	19.13	9.46	7.84	14.83	57.95	0.85	2.10	91.00
Aug-96	133.40	155.58	13.96	5.36	7.27	10.54	68.66	0.86	2.16	79.90
Sep-96	73.25	109.36	9.87	0.39	3.21	5.19	63.12	1.03	2.47	10.30
Oct-96	17.96	28.06	7.44	-3.68	-0.72	-7.66	83.91	0.74	1.53	19.10
Nov-96	5.66	10.69	2.88	-13.69	-2.65	-15.25	82.05	0.70	1.04	0.00
Dec-96	-0.26	1.42	1.35	-11.41	-5.49	-17.80	80.64	0.68	1.28	0.00
* Average of records from March 28 to March 31, 1996										
<b>1997</b>										
Jan-97	-0.37	4.00	2.60	-11.93	-9.57	-21.60	76.16	0.69	1.11	0.00
Feb-97	2.58	24.91	5.57	-3.02	-5.99	-7.54	82.42	0.83	1.60	19.00
Mar-97	66.02	100.87	13.28	-4.81	-6.37	-11.48	62.68	0.80	1.96	1.90
Apr-97	139.50	182.76	22.36	3.47	-1.73	1.99	47.84	0.91	2.16	7.30
May-97	190.43	216.61	19.85	2.97	1.69	7.64	51.69	0.97	2.39	57.70
Jun-97	204.59	229.80	21.28	8.83	5.42	13.13	54.68	0.96	2.41	48.50
Jul-97	181.13	201.43	19.02	8.25	9.48	15.51	63.51	0.90	2.09	102.40
Aug-97	145.75	169.56	15.92	4.90	9.32	13.67	62.72	0.90	2.18	14.60
*Sep-97	101.51	122.49	11.33	3.14	7.75	11.70	71.85	0.88	1.80	2.70
**Nov-97	2.83	5.40	1.89	-5.55	-2.53	-9.87	89.05	0.75	1.35	0.00
Dec-97	-11.56	3.55	0.83	-4.58	-3.27	-9.19	82.82	0.91	1.73	8.20
*Average of records from September 1 to September 5, 1997										
**Average of records from November 20 to Nov 30, 1997										
<b>1998</b>										
*Jan-98	0.22	2.33	1.90	-8.76	-9.61	-27.12	73.72	0.68	0.88	0.00
*Average of records from January 1 to January 21, 1998										
<u>Note:</u> Erroneous precipitation values caused by electrical short in wire to tipping gauge. Wire replaced on Aug-30-95.										
Reported 1995 rainfall data not used in this study.										
Precipitation values represent the total sum of values recorded within a given month rather than an average										

**TABLE I.8 - Williams Creek and Concurrent Regional Rainfall Data**

Month & Year	Rainfall (mm)				Total Precipitation (mm)		
	Williams Creek	Carmacks	Pelly River Ranch	Average Carmacks & Pelly)	Carmacks	Pelly River Ranch	Average Carmacks & Pelly)
Sep 13-30, 94 *	22.2	20.3	14.5	17.4	20.3	14.5	17.4
Sept 1 - 30, 94		27.6	21.6	24.6	27.6	21.6	24.6
**Oct-94	5.1	21.1	7.4	14.3	29.0	27.4	28.2
Mar-95	3.3	0	0.4	0.2	8.5	4.6	6.6
Apr-95 *	19.5	4.5	0.2	2.4	4.5	0.2	2.4
Sep-95 *	25.0	26.4	10.6	18.5	26.4	10.6	18.5
Oct-95	8.5	10.6	14.6	12.6	12.1	22.9	17.5
Apr-96	5.9	4.0	7.6	5.8	4.0	16.6	10.3
May-96 *	16.0	11.4	3.4	7.4	11.4	3.4	7.4
Jun-96 *	12.0	10.2	27.9	19.1	10.2	27.9	19.1
Jul-96 *	91.0	87.3	67.2	77.3	87.3	67.2	77.3
Aug-96 *	79.9	55.7	58.2	57.0	55.7	58.2	57.0
Sep-96 *	10.3	14.1	33.6	23.9	14.1	33.6	23.9
Oct-96	19.1	0	0	0.0	41.0	32.8	36.9
Feb-97	19.0	0	0	0.0	13.0	17.0	15.0
Mar-97	1.9	0	0	0.0	11.5	18.4	15.0
Apr-97	7.3	6.0	5.8	5.9	11.8	12.6	12.2
May-97 *	57.7	32.2	86.0	59.1	32.2	86.0	59.1
Jun-97 *	48.5	39.2	56.6	47.9	39.2	56.6	47.9
Jul-97 *	102.4	45.0	80.6	62.8	45.0	80.6	62.8
Aug-97 *	14.6	17.0	36.0	26.5	17.0	36.0	26.5
<b>Total Rainfall</b>							
All Common Data	569.2	405	510.6	457.8	494.2	627.1	560.7
Number	21	21	21	21	21	21	21
<b>Total Rainfall (Note)</b>							
Rainfall Months Only *	499.1	363.3	474.8	419.1	363.3	474.8	419.1
Number	12	12	12	12	12	12	12
<b>Total Rainfall</b>							
1994 (1 mo.)	22.2	20.3	14.5	17.4	20.3	14.5	17.4
1995 (2 mo.)	44.5	30.9	10.8	20.9	30.9	10.8	20.9
1996 (5 mo.)	209.2	178.7	190.3	184.5	178.7	190.3	184.5
1997 (4 mo.)	223.2	133.4	259.2	196.3	133.4	259.2	196.3
Station Elevation (m)	850	525	454	489.5	525	454	489.5

**NOTES**

- 1) Concurrent rainfall data for Carmacks and Pelly River Ranch indicate a decrease in rainfall with increasing elevation.
- 2) Total concurrent rainfall data for 12 months between Williams Creek and Pelly River Ranch indicates an orographic factor for rainfall of 1.3% increase per 100 m increase in elevation.

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**TABLE I.9 - Regional & Site Snow Survey Data****Regional Snow Survey Stations**

Number	Name	Elevation (m)	Location	Years
No. 1	Williams Creek	739	at site	1992
No. 3	Williams Creek	755	at site	1992
No. 2	Williams Creek	876	at site	1992
09AH-SC04	Williams Creek	914	at site	1995 - 1997
09CD-SC03	Pelly Farm	472	70 km NNW	1986 - 1997
09CA-SC01	Mt. Nansen	1021	50 km SW	1976 - 1997
09AH-SC01	Mt. Berdoe	1035	50 km SE	1975 - 1997
09CA-SC02	MacIntosh	1160	80 km SW	1976 - 1997
09AH-SC03	Satasha Lake	1106	90 km S	1987 - 1997
09CD-SC01	Casino Creek	1065	120 km WNW	1977 - 1997

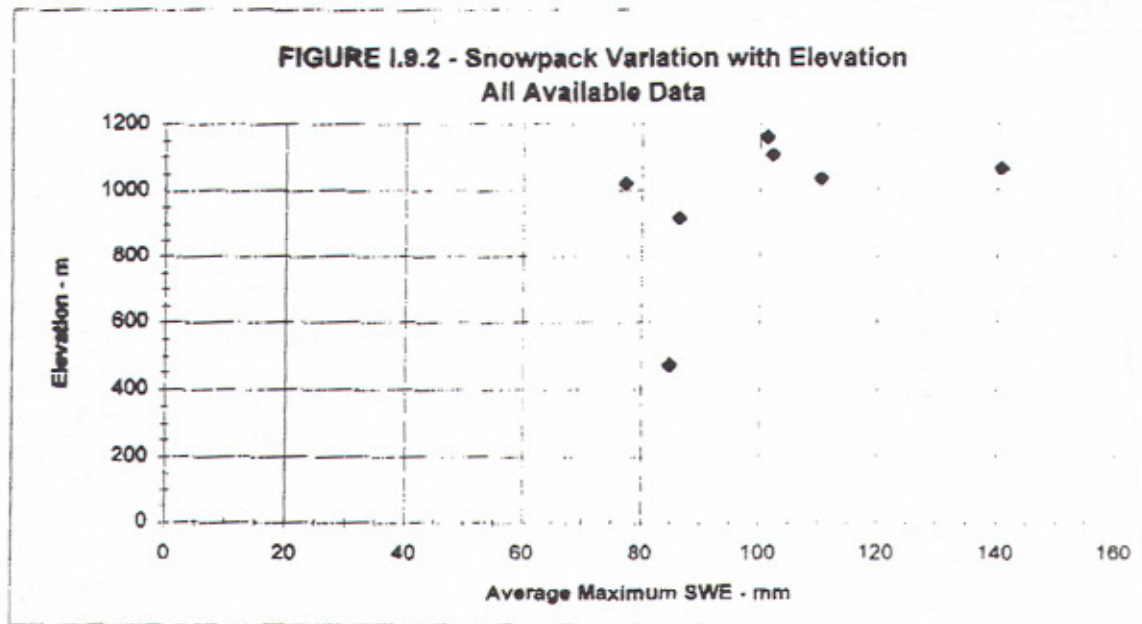
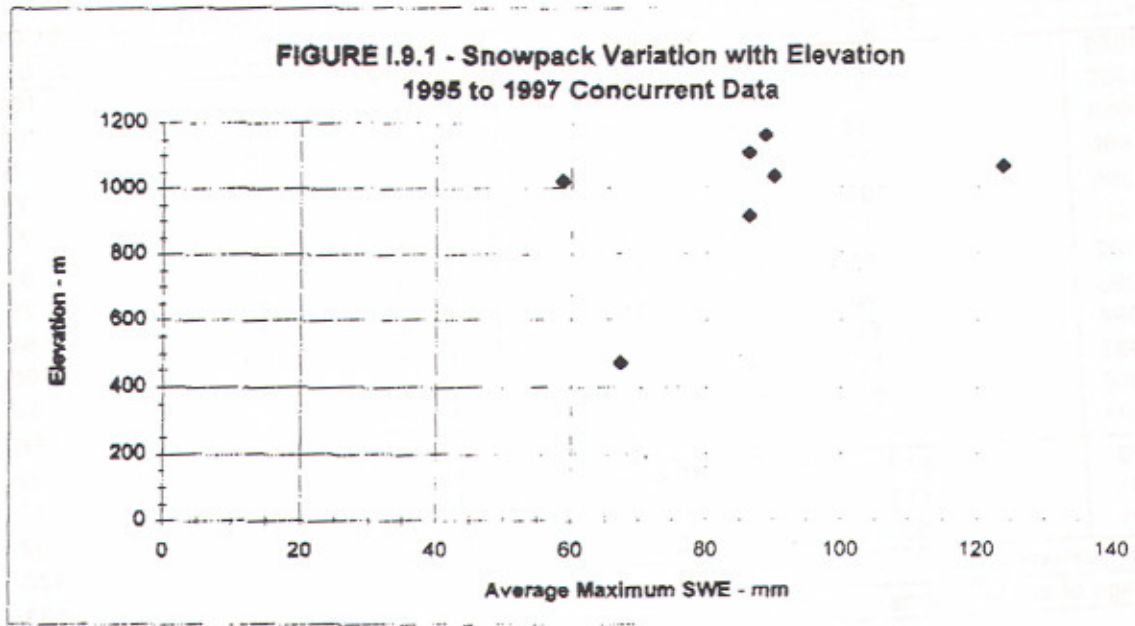
**Average Maximum Annual Snowpack SWE (mm water)**

Period	Station	Avg. Max SWE	Elevation (m)	Max. Max.	Min. Max.
1992 only	Pelly Farm	97	472		
	Williams Creek	141	790		
	Mt. Nansen	102	1021		
	Mt. Berdoe	170	1035		
	MacIntosh	140	1160		
	Satasha Lake	167	1106		
	Casino Creek	207	1065		
1995 - 1997	Pelly Farm	67.3	472	77	52
	Williams Creek	86.3	914	93	78
	Mt. Nansen	59	1021	64	50
	Mt. Berdoe	90	1035	106	74
	MacIntosh	89	1160	103	78
	Satasha Lake	86	1106	106	67
	Casino Creek	124	1065	149	104
1986 - 1997	Pelly Farm	84.8	472	116	52
	Mt. Nansen	81	1021	106	50
	Mt. Berdoe	123	1035	175	74
	MacIntosh	109	1160	162	59
	Satasha Lake	102	1106	167	50
	Casino Creek	147	1065	225	99
	1977 - 1997	Mt. Nansen	79	1021	106
Mt. Berdoe		111	1035	175	74
MacIntosh		102	1160	162	45
Casino Creek		141	1065	225	88
All Data	Pelly Farm	85	472	116	52
	Williams Creek	86	914	93	78
	Mt. Nansen	77	1021	106	50
	Mt. Berdoe	110	1035	175	74
	MacIntosh	101	1160	162	45
	Satasha Lake	102	1106	167	50
	Casino Creek	141	1065	225	88

(SWE = snow water equivalent in mm water)



**TABLE I.9 - Regional & Site Snow Survey Data (continued)**



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**TABLE 1.9 (continued) - Snowpack SWE (Snow Water Equivalents) as mm water**

**PELLE FARM (09CD-SC03)**

Year	Feb-01	Mar-01	Apr-01	May-01	May-15
1986		74	84	70	0
1987		73	56	0	0
1988		88	89	0	0
1989		76	77	0	0
1990		105	89	0	0
1991		113	116	0	0
1992		95	97	31	0
1993		95	113	15	0
1994		62	60	0	0
1995		52	52	0	0
1996		50	73	0	0
1997			77	9	
Avg.		80.3	81.9	10.4	0.0
Max.		113	116	70	0
Min.		50	52	0	0
No. of Maximums		3	9	0	0
Average of all Maximums		84.8			

**MT. NANSEN (09CA-SC01)**

Year	Feb-01	Mar-01	Apr-01	May-01	May-15
1976	48	66	66	20	0
1977	44	48	63	0	0
1978	53	64	51	0	0
1979	36	56	87		0
1980	45	76	60	0	0
1981	44	52	56	0	0
1982	60	69	85	0	0
1983	69	70	80	0	0
1984	49	65	60	0	0
1985	74	95	104	101	0
1986		59	82	78	0
1987		28	51	0	0
1988		77	92	0	0
1989		79	99	0	0
1990		63	92	0	0
1991		102	106	0	0
1992		92	102	68	0
1993		67	96	0	0
1994		73	73	0	0
1995		50	49	0	0
1996		50	62	0	0
1997		64	63	0	
Avg.	52.2	66.6	75.4	12.7	0.0
Max.	74	102	106	101	0
Min.	36	28	49	0	0
No. of Maximums		6	16		
Average of all Maximums		77.2			

**MT. BERDOE (09AH-SC01)**

Year	Feb-01	Mar-01	Apr-01	May-01	May-15
1975		91	109		
1976		104	107	89	0
1977	51	60	79	0	0
1978	59	72	75	41	0
1979	44	63	79	12	0
1980	60	80	92	32	0
1981	61	71	75	34	0
1982	61	81	94	89	0
1983	91	95	100	43	0
1984	56	82	94	62	0
1985	94	111	156	160	118
1986		117	167	169	102
1987		89	72	40	0
1988		81	82	31	0
1989		110	130	23	18
1990		91	133	0	0
1991		155	175	107	0
1992		165	170	126	115
1993		134	147	35	0
1994		97	110	51	0
1995		54	74	18	
1996		81	90	15	
1997		106	106	49	
Avg.	64.1	95.2	109.4	55.7	18.6
Max.	94	165	175	169	118
Min.	44	54	72	0	0
No. of Maximums		1	20	2	
Average of all Maximums		110.4			

**SATASHA LAKE (09AH-SC03)**

Year	Feb-01	Mar-01	Apr-01	May-01	May-15
1987		31	50	0	0
1988		87	86	25	0
1989		80	107	12	25
1990		91	96	0	0
1991		130	139	55	0
1992		162	167	108	39
1993		109	118	24	0
1994		78	101	25	0
1995		51	67	0	
1996		78	86	14	
1997		74	106	17	
Avg.		88.3	102.1	25.5	8.0
Max.		162	167	108	39
Min.		31	50	0	0
No. of Maximums		1	10		
Average of all Maximums		102.182			



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**TABLE I.9 (continued) - Snowpack SWE (Snow Water Equivalents) as mm water****MACINTOSH (09CA-SC02)**

Year	Feb-01	Mar-01	Apr-01	May-01	May-15
1976	48	76	90	61	0
1977	34	42	59	0	0
1978	60	68	88	70	0
1979	50	65	94	0	0
1980	53	70	119	92	0
1981	35	45	55	34	0
1982	92	114	140	160	0
1983	72	78	87	0	0
1984	38	45	35	0	0
1985	95	115	122	130	105
1986		99	134	126	69
1987		41	59	0	0
1988		91	115	51	0
1989		68	101	65	25
1990		127	120	0	0
1991		120	162	104	0
1992		138	140	121	92
1993		87	110	0	0
1994		87	88	23	0
1995		56	78	13	
1996		69	85	0	
1997		70	103		
Avg.	57.7	80.5	99.3	50.0	15.3
Max.	95	138	162	160	105
Min.	34	41	35	0	0
No. of Maximums	2	18	2		
Average of all Maximums	101.3				

**CASINO CREEK (09CD-SC01)**

Year	Feb-01	Mar-01	Apr-01	May-01	May-15
1977	53	68	80	125	
1978	80	90	98	86	
1979	97	113	170	145	
1980	40	68	81	95	0
1981	45	70	78	88	0
1982	94	110	118	165	173
1983	43	118	120	80	0
1984	86	105	110	139	72
1985	116	130	143	180	166
1986		108	127	168	150
1987		63	92	101	117
1988		98	99	54	
1989			136	80	0
1990		119	144	100	0
1991		179	225	167	79
1992		124	135	207	207
1993		148	184	190	0
1994		83	110	56	0
1995		75		104	
1996		89	118	110	
1997		110	149	94	
Avg.	72.7	103.4	125.9	120.7	68.9
Max.	116	179	225	207	207
Min.	40	63	78	54	0
No. of Maximums			10	9	2
Average of all Maximums	140.7				

**WILLIAMS CREEK**

Year	Feb-01	Mar-01	Apr-01	May-01	May-15
<b>1992 only</b>					
No. 1	128	104	120	84	0 Elev. 739 m
No. 2	164	110	130	129	38 Elev. 876 m
No. 3	130	150	132	103	36 Elev. 755 m
Averages at approx. Elev. 790 m					
	140.7	121.3	127.3	105.3	24.7

**WILLIAMS CREEK #09AH-SC04**

Year	Feb-01	Mar-01	Apr-01	May-01	May-15
1995		55	78	20	
1996		79	88	17	
1997		84	93	59	
Avg.		72.7	86.3	32.0	
Max.		84	93	59	
Min.		55	78	17	
No. of Maximums		3			
Average of all Maximums		86.3			

**TABLE I.10 - Pelly Farm Snow Survey & Concurrent Snowfall Data - 1986-1997**

Pelly Farm Snow Survey Station # 09CD-SC03 at Elevation 472 m

Pelly River Ranch Precipitation Station # 2100880 at Elevation 454 m

Year	March 1 SWE	Oct - Feb Total Snowfall	Apparent Sublimation Losses	OR, Apparent Snowfall Density	April 1 SWE	Oct - Mar Total Snowfall	Apparent Sublimation Losses	OR, Apparent Snowfall Density	May 1 SWE	Oct - Apr Total Snowfall	Apparent Sublimation Losses	OR, Apparent Snowfall Density
1986	74	81.2	7.2	9.1%	<b>84</b>	<b>98.1</b>	<b>14.1</b>	<b>8.6%</b>	70	103.9	33.9	6.7%
1987	<b>73</b>	<b>72.9</b>	<b>-0.1</b>	<b>10.0%</b>	56	79.2	23.2	7.1%	0	86.4	86.4	0.0%
1988	88	94.3	6.3	9.3%	<b>89</b>	<b>108.2</b>	<b>19.2</b>	<b>8.2%</b>	0	109.4	109.4	0.0%
1989	76	89.9	13.9	8.5%	<b>77</b>	<b>95.5</b>	<b>18.5</b>	<b>8.1%</b>	0	95.6	95.6	0.0%
1990	<b>105</b>	<b>100.0</b>	<b>-5.0</b>	<b>10.5%</b>	89	<b>106.8</b>	17.8	8.3%	0	<b>107.8</b>	107.8	0.0%
1991	113	125.2	12.2	9.0%	<b>116</b>	<b>135.1</b>	<b>19.1</b>	<b>8.6%</b>	0	139.1	139.1	0.0%
1992	<b>95</b>	122.1	27.1	7.8%	<b>97</b>	<b>137.3</b>	<b>40.3</b>	<b>7.1%</b>	31	165.9	134.9	1.9%
1993	95	<b>140.9</b>	45.9	6.7%	<b>113</b>	<b>175.3</b>	<b>62.3</b>	<b>6.4%</b>	15	<b>176.3</b>	161.3	0.9%
1994	<b>62</b>	<b>85.1</b>	<b>23.1</b>	<b>7.3%</b>	60	101.0	41.0	5.9%	0	107.3	107.3	0.0%
1995	<b>52</b>	69.2	17.2	7.5%	<b>52</b>	<b>73.4</b>	<b>21.4</b>	<b>7.1%</b>	0	73.4	73.4	0.0%
1996	50	75.9	25.9	6.6%	<b>73</b>	<b>85.8</b>	<b>12.8</b>	<b>8.5%</b>	0	94.8	94.8	0.0%
1997	M				<b>77</b>	<b>106.4</b>	<b>29.4</b>	<b>7.2%</b>	9	113.2		
Averages	80.3	96.1	15.8	8.4%	81.9	108.5	26.6	7.6%	10.5	114.5	104.0	0.9%
Maximum	113.0	140.9	45.9	10.5%	116.0	175.3	62.3	8.6%	70.0	176.3	161.3	6.7%
Minimum	50.0	69.2	-5.0	6.6%	52.0	73.4	12.8	5.9%	0.0	73.4	33.9	0.0%

**Maximum Reported Snowpack each year**

Average Maximum Snowpack SWE	84.8	mm water (9 of 12 maximums occurred on April 1)
Average Total Snowfall to time of Maximum Snowpack	106.1	mm water
Average Apparent Sublimation Loss	21.3	mm water
OR, Average Apparent Snowfall Density	8.1%	(assuming zero sublimation)

**NOTES**

- "SWE" = Snow Water Equivalent of the snowpack in millimetres
- Total Snowfall = Cumulative recorded snowfall from October of previous year up to start of indicated month  
All reported snowfall (as mm precipitation) for Pelly assumes a constant 10% density for new snowfall measured in centimetres depth.  
(NOTE - September 1989 & 1992 snowfall depths included in 1990 & 1993 (respectively) total snowfalls above)
- September 1992 Total Precipitation was the second highest on record since 1954
- "Apparent Sublimation Losses" = (Reported Total Snowfall mm) minus (Snow Water Equivalent mm) for indicated date.
- "Apparent Snowfall Density" = Snowfall Density required such that the total snowfall (as mm water) would equal the SWE (as mm water) assuming zero sublimation losses over the indicated period.



**TABLE I.11 - Wet & Dry Year Precipitation, Rainfall and Snowfall - Williams Creek Site**

Return Period (years)	Annual Percent Probability	Pelly Ranch Total Precipitation (Elev. 454 m)	Williams Creek Total Precipitation (Elev. 850 m)	Williams Creek Rainfall	Williams Creek Snowfall
		Note 1	Note 2	Note 3	Note 3
20 (Dry)	95.0%	224	252	146	106
5 (Dry)	80.0%	257	290	168	122
2 (Average)	50.0%	300	338	195	143
5 (Wet)	20.0%	342	385	223	162
10 (Wet)	10.0%	369	416	241	175
20 (Wet)	5.0%	392	442	256	185
50 (Wet)	2.0%	418	471	273	198
100 (Wet)	1.0%	436	491	285	206
200 (Wet)	0.5%	452	509	295	214
500 (Wet)	0.2%	471	531	308	223

**NOTES**

- 1) Frequency analysis results from GEV distribution for Pelly Ranch 1955 to 1997 Total Precipitation data.  
Mean Annual Total Precipitation = 300 mm (62% Rainfall, 38% Snowfall)  
Standard Deviation = 47.14 mm  
Coefficient of Variation = 0.157
- 2) Williams Creek total precipitation estimated assuming 3.2% increase per 100 m elevation difference between Pelly River Ranch and Williams Creek, equal to a factor of 1.1267 times the precipitation at Pelly River Ranch.
- 3) Rainfall and Snowfall for extreme years above estimated assuming Rainfall = 58% of Total Precipitation and Snowfall = 42% of Annual Total Precipitation.

**TABLE I.12 - CARMACKS Wet Period Precipitation**

(May through September = Rainfall, Winter October through April = Snowfall)

Year	Maximum One Month						Maximum Two Month Periods					Maximum Three Months				Winter Precip.	
	May	June	July	Aug	Sept	MAX	M/J	J/J	J/A	A/S	MAX	M/J/J	J/J/A	J/A/S	MAX	6-mo. O - M	7-mo. O - A
1963					40.4	40.4											
1964	29.7	56.1	39.6	41.4	14.2	56.1	85.8	95.7	81.0	55.6	95.7	125.4	137.1	95.2	137.1	73.9	74.4
1965	16.8	23.6	32.8	15.0	23.4	32.8	40.4	56.4	47.8	38.4	56.4	73.2	71.4	71.2	73.2	52.0	53.8
1966	11.4	35.1	42.4	43.7	18.3	43.7	46.5	77.5	86.1	62.0	86.1	88.9	121.2	104.4	121.2	61.1	69.7
1967	42.4	45.0	54.1	25.4	12.2	54.1	87.4	99.1	79.5	37.6	99.1	141.5	124.5	91.7	141.5	170.3	177.9
1968	21.8	20.1	59.2	33.8	50.0	59.2	41.9	79.3	93.0	83.8	93.0	101.1	113.1	143.0	143.0	100.9	116.9
1969	11.7	5.8	55.4	32.0	27.9	55.4	17.5	61.2	87.4	59.9	87.4	72.9	93.2	115.3	115.3	61.5	65.8
1970	29.0	11.2	25.1	18.5	51.6	51.6	40.2	36.3	43.6	70.1	70.1	65.3	54.8	95.2	95.2	68.7	80.1
1971	0.1	9.4	37.1	39.6	23.1	39.6	9.5	46.5	76.7	62.7	76.7	46.6	86.1	99.8	99.8	104.9	106.4
1972	15.5	65.3	34.0	25.9	43.2	65.3	80.8	99.3	59.9	69.1	99.3	114.8	125.2	103.1	125.2	90.3	104.8
1973	5.8	35.3	28.7	63.5	9.1	63.5	41.1	64.0	92.2	72.6	92.2	69.8	127.5	101.3	127.5	77.7	85.1
1974	6.4	36.3	52.6	68.6	19.6	68.6	42.7	88.9	121.2	88.2	121.2	95.3	157.5	140.8	157.5	135.2	137.2
1975	5.6	13.2	60.2	57.4	38.4	60.2	18.8	73.4	117.6	95.8	117.6	79.0	130.8	156.0	156.0	98.7	116.7
1976		30.5		6.6	0.3	30.5				6.9						104.4	106.7
1977	24.7	49.5	57.1	52.5	63.7	63.7	74.2	106.6	109.6	116.2	116.2	131.3	159.1	173.3	173.3	63.8	71.9
1978	15.0	46.6	56.8	39.6	13.8	56.8	61.6	103.4	96.4	53.4	103.4	118.4	143.0	110.2	143.0		
1979	23.2	47.6	104.4	23.6	23.4	104.4	70.8	152.0	128.0	47.0	152.0	175.2	175.6	151.4	175.6		
1980	20.6	24.8	72.8	53.6	55.2	72.8	45.4	97.6	126.4	108.8	126.4	118.2	151.2	181.6	181.6	100.0	105.6
1981	8.8	27.1	105.2	27.8	37.3	105.2	35.9	132.3	133.0	65.1	133.0	141.1	160.1	170.3	170.3	92.8	100.6
1982	33.0	11.4	86.9	46.1	26.7	86.9	44.4	98.3	133.0	72.8	133.0	131.3	144.4	159.7	159.7	90.2	92.2
1983	35.5	53.0	71.6	69.2	37.6	71.6	88.5	124.6	140.8	106.8	140.8	160.1	193.8	178.4	193.8	102.2	108.0
1984	27.8	37.8	42.8	32.4	12.3	42.8	65.6	80.6	75.2	44.7	80.6	108.4	113.0	87.5	113.0	72.9	74.9
1985	4.6	30.1	79.0	48.6	24.6	79.0	34.7	109.1	127.6	73.2	127.6	113.7	157.7	152.2	157.7	111.0	116.0
1986	24.4	27.9	47.4	31.3	37.0	47.4	52.3	75.3	78.7	68.3	78.7	99.7	106.6	115.7	115.7	116.4	132.8
1987	40.0	30.8	26.0	36.0	34.2	40.0	70.8	56.8	62.0	70.2	70.8	96.8	92.8	96.2	96.8	79.0	79.8
1988	27.0	37.4	88.8	33.6	17.8	88.8	64.4	126.2	122.4	51.4	126.2	153.2	159.8	140.2	159.8	94.3	96.3
1989	32.7	41.9	31.6	17.6	19.9	41.9	74.6	73.5	49.2	37.5	74.6	106.2	91.1	69.1	106.2		
1990	37.2	78.6	40.2	50.1	61.2	78.6	115.8	118.8	90.3	111.3	118.8	156.0	168.9	151.5	168.9	126.1	132.1
1991	11.7	53.2	62.7	37.2	44.0	62.7	64.9	115.9	99.9	81.2	115.9	127.6	153.1	143.9	153.1	121.3	123.3
1992	36.3	18.0	68.7	27.9	48.5	68.7	54.3	86.7	96.6	76.4	96.6	123.0	114.6	145.1	145.1	143.8	163.8
1993	52.0	29.4	35.0	56.3	38.8	56.3	81.4	64.4	91.3	95.1	95.1	116.4	120.7	130.1	130.1	96.4	96.4
1994	16.3	27.4	25.4	21.9	27.6	27.6	43.7	52.8	47.3	49.5	52.8	69.1	74.7	74.9	74.9	138.3	141.3
1995	11.2	6.6	60.2	56.9	26.4	60.2	17.8	66.8	117.1	83.3	117.1	78.0	123.7	143.5	143.5	80.7	85.2
1996	11.4	10.2	87.3	55.7	14.1	87.3	21.6	97.5	143.0	69.8	143.0	108.9	153.2	157.1	157.1	84.9	88.9
1997	32.2	39.2	45.0	17.0	15.6	45.0	71.4	84.2	62.0	32.6	84.2	116.4	101.2	77.6	116.4	98.1	109.9
# years	33	34	33	34	35	35	33	33	33	34	33	33	33	33	33	31	31
Average	21.9	32.8	55.0	38.4	30.0	60.2	54.7	87.9	94.4	68.2	102.5	109.8	127.3	125.0	137.2	97.2	103.7
Max.	52.0	78.6	105.2	69.2	63.7	105.2	115.8	152.0	143.0	116.2	152.0	175.2	193.8	181.6	193.8	170.3	177.9
Min.	0.1	5.8	25.1	6.6	0.3	27.6	9.5	36.3	43.6	6.9	52.8	46.6	54.8	69.1	73.2	52.0	53.8
Std. Dev	12.77	17.39	22.42	16.19	15.69	19.42	24.66	26.79	29.24	24.57	25.58	30.44	34.18	34.17	31.08	26.83	27.96
# Max.	1	5	20	5	4	35	2	12	16	3	33	5	13	15	33		

**TABLE I.13 - PELLY RIVER RANCH Wet Period Precipitation**

(May through September = Rainfall, Winter October through April = Snowfall)

Year	Maximum One Months						Maximum Two Month Periods					Maximum Three Months				Winter Precip.	
	May	June	July	Aug	Sept	MAX	M/J	J/J	J/A	A/S	MAX	M/J/J	J/J/A	J/A/S	MAX	6-mo. O - M	7-mo. O - A
1951																	
1952	6.6																
1954		6.1	40.6	17.8	23.4	40.6		46.7	58.4	41.2	58.4		64.5	81.8	81.8		
1955	7.1	43.2	14.0	86.1	10.7	86.1	50.3	57.2	100.1	96.8	100.1	64.3	143.3	110.8	143.3	89.9	90.0
1956	40.1	45.0	48.3	40.9	2.8	48.3	85.1	93.3	89.2	43.7	93.3	133.4	134.2	92.0	134.2		
1957	15.2	12.7	34.8	19.6	19.8	34.8	27.9	47.5	54.4	39.4	54.4	62.7	67.1	74.2	74.2	140.4	148.3
1958	14.2	33.5	62.0	67.1	17.0	67.1	47.7	95.5	129.1	84.1	129.1	109.7	162.6	146.1	162.6	94.8	97.8
1959	19.3	46.7	29.0	37.6	25.1	46.7	66.0	75.7	66.6	62.7	75.7	95.0	113.3	91.7	113.3	148.4	159.1
1960	18.5	26.4	117.9	36.6	28.4	117.9	44.9	144.3	154.5	65.0	154.5	162.8	180.9	182.9	182.9	80.1	85.2
1961	23.4	45.0	44.5	25.9	18.3	45.0	68.4	89.5	70.4	44.2	89.5	112.9	115.4	88.7	115.4	85.9	92.5
1962	16.3	55.9	35.6	39.4	13.0	55.9	72.2	91.5	75.0	52.4	91.5	107.8	130.9	88.0	130.9	142.3	167.2
1963		47.5	58.7	18.5	35.1	58.7		106.2	77.2	53.6	106.2		124.7	112.3	124.7	125.1	136.0
1964	26.2	53.6	88.1	30.7	21.1	88.1	79.8	141.7	118.8	51.8	141.7	167.9	172.4	139.9	172.4	149.1	165.1
1965	14.0	30.0	41.9	17.5	40.4	41.9	44.0	71.9	59.4	57.9	71.9	85.9	89.4	99.8	99.8	86.2	89.8
1966	5.8	28.2	7.1	20.3	16.0	28.2	34.0	35.3	27.4	36.3	36.3	41.1	55.6	43.4	55.6	125.5	135.7
1967	16.5	46.2	65.0	56.4	28.4	65.0	62.7	111.2	121.4	84.8	121.4	127.7	167.6	149.8	167.6	202.2	216.4
1968	25.1	21.3	29.7	25.7	59.7	59.7	46.4	51.0	55.4	85.4	85.4	76.1	76.7	115.1	115.1	110.5	126.2
1969	30.5	3.3	81.5	12.2	22.9	81.5	33.8	84.8	93.7	35.1	93.7	115.3	97.0	116.6	116.6	82.1	94.0
1970	48.8	24.4	5.3	42.7	50.3	50.3	73.2	29.7	48.0	93.0	93.0	78.5	72.4	98.3	98.3	74.5	82.1
1971	7.4	11.7	24.1	45.0	22.1	45.0	19.1	35.8	69.1	67.1	69.1	43.2	80.8	91.2	91.2	115.4	120.2
1972	14.7	70.9	47.2	23.1	23.4	70.9	85.6	118.1	70.3	46.5	118.1	132.8	141.2	93.7	141.2	141.9	154.6
1973	5.1	50.8	47.5	54.1	8.6	54.1	55.9	98.3	101.6	62.7	101.6	103.4	152.4	110.2	152.4	141.7	172.2
1974	7.4	14.7	65.8	31.8	8.6	65.8	22.1	80.5	97.6	40.4	97.6	87.9	112.3	106.2	112.3	125.8	144.9
1975	13.7	16.5	71.6	29.0	32.3	71.6	30.2	88.1	100.6	61.3	100.6	101.8	117.1	132.9	132.9	97.6	115.9
1976	42.9	37.3	46.7	19.3	14.5	46.7	80.2	84.0	66.0	33.8	84.0	126.9	103.3	80.5	126.9	120.1	130.8
1977	24.2	44.8	30.3	18.3	14.9	44.8	69.0	75.1	48.6	33.2	75.1	99.3	93.4	63.5	99.3	105.0	130.0
1978	17.8	33.4	100.0	46.7	23.8	100.0	51.2	133.4	146.7	70.5	146.7	151.2	180.1	170.5	180.1	69.0	81.9
1979	29.5	47.7	54.1	10.2	33.5	54.1	77.2	101.8	64.3	43.7	101.8	131.3	112.0	97.8	131.3	139.5	144.1
1980	9.2	24.8	44.4	33.0	53.4	53.4	34.0	69.2	77.4	86.4	86.4	78.4	102.2	130.8	130.8	79.1	82.3
1981	13.2	33.3	87.9	43.6	52.9	87.9	46.5	121.2	131.5	96.5	131.5	134.4	164.8	184.4	184.4	77.6	88.6
1982	33.7	13.3	62.7	22.4	31.7	62.7	47.0	76.0	85.1	54.1	85.1	109.7	98.4	116.8	116.8	121.3	135.2
1983	29.0	50.3	53.8	82.2	26.0	82.2	79.3	104.1	136.0	108.2	136.0	133.1	186.3	162.0	186.3	121.2	127.0
1984	33.5	27.0	44.6	48.7	25.0	48.7	60.5	71.6	93.3	73.7	93.3	105.1	120.3	118.3	120.3	94.4	102.9
1985	20.5	69.8	88.4	48.8	28.5	88.4	90.3	158.2	137.2	77.3	158.2	178.7	207.0	165.7	207.0	108.2	117.1
1986	30.0	47.4	73.0	44.5	8.0	73.0	77.4	120.4	117.5	52.5	120.4	150.4	164.9	125.5	164.9	100.5	106.3
1987	22.3	26.6	53.4	34.6	43.1	53.4	48.9	80.0	88.0	77.7	88.0	102.3	114.6	131.1	131.1	90.1	99.3
1988	23.8	26.2	68.8	28.6	9.8	68.8	50.0	95.0	97.4	38.4	97.4	118.8	123.6	107.2	123.6	141.6	145.7
1989	32.6	49.1	13.1	20.4	23.8	49.1	81.7	62.2	33.5	44.2	81.7	94.8	82.6	57.3	94.8	95.5	95.7
1990	48.4	57.0	13.0	41.0	45.0	57.0	105.4	70.0	54.0	86.0	105.4	118.4	111.0	99.0	118.4	106.8	108.4
1991	25.1	30.0	47.8	34.7	43.0	47.8	55.1	77.8	82.5	77.7	82.5	102.9	112.5	125.5	125.5	147.5	151.5
1992	28.2	32.2	44.3	47.4	56.4	56.4	60.4	76.5	91.7	103.8	103.8	104.7	123.9	148.1	148.1	152.7	199.3
1993	18.4	16.8	61.9	40.0	20.8	61.9	35.2	78.7	101.9	60.8	101.9	97.1	118.7	122.7	122.7	155.7	164.5
1994	37.8	53.6	36.2	8.6	21.6	53.6	91.4	89.8	44.8	30.2	91.4	127.6	98.4	66.4	127.6	115.2	122.9
1995	16.8	31.8	84.4	78.2	10.6	84.4	48.6	116.2	162.6	88.8	162.6	133.0	194.4	173.2	194.4	81.2	81.4
1996	3.4	27.9	67.2	58.2	33.6	67.2	31.3	95.1	125.4	91.8	125.4	98.5	153.3	159.0	159.0	100.4	117.0
1997	86.0	56.6	80.6	36.0	29.4	86.0	142.6	137.2	116.6	65.4	142.6	223.2	173.2	146.0	223.2	106.4	119.0
# years	43	44	44	44	44	44	42	44	44	44	44	42	44	44	44	42	42
Average	23.3	35.7	52.7	36.9	26.7	62.5	59.8	88.3	89.6	63.6	101.9	112.6	125.2	116.3	134.9	114.0	124.9
Max.	86.0	70.9	117.9	86.1	59.7	117.9	142.6	158.2	162.6	108.2	162.6	223.2	207.0	184.4	223.2	202.2	216.4
Min.	3.4	3.3	5.3	8.6	2.8	28.2	19.1	29.7	27.4	30.2	36.3	41.1	55.6	43.4	55.6	69.0	81.4
Std. Dev	15.13	16.45	25.37	18.38	14.12	18.60	24.73	29.85	33.18	21.79	28.06	34.88	37.97	34.34	35.76	28.63	32.90
# Max.	1	9	24	6	4	44	4	13	22	5	44	7	20	17	44		

**TABLE I.14 - One, Two and Three Month Duration Wet Period Rainfall - Common Data**

	One Month Duration		Two Month Duration		Three Month Duration	
	Pelly	Williams	Pelly	Williams	Pelly	Williams
Maximum Recorded Rainfall Amounts (mm)						
1996	67.2	91.0	125.4	170.9	159.0	182.9
1997	86.0	102.4	142.6	150.9	223.2	208.6
Average	76.6	96.7	134.0	160.9	191.1	195.8
Ratio (Williams / Pelly) for 1996/97 Averages % per 100 m	1.262 6.6%		1.201 5.1%		1.024 0.6%	
Long Term Pelly Average (mm, 1955 - 1997)	62.5		101.9		134.9	
Ratio Pelly (Long Term / 1996/97 Average)	0.816		0.760		0.706	
Estimated Williams Creek Average (mm)		78.9		122.4		138.2

	1-Month	2-Month	3-Month
Orographic Factors	1.262	1.201	1.024

**NOTE**

Historic data for Pelly River Ranch shown on Table I.13

**TABLE I.15 - Wet Period Precipitation - One to Seven Month Duration****Table I.15A - Pelly River Ranch**

Return Period (years)	Annual Percent Probability	1 -Month Rainfall	2 -Month Rainfall	3 -Month Rainfall	6 -Month Precipitation	7 -Month Precipitation
20 (Dry)	95.0%	36.7	64.3	85.8	70.9	76.8
5 (Dry)	80.0%	46.5	79.2	105	88.6	95.8
2 (Average)	50.0%	62.5	101.9	135	114	125
5 (Wet)	20.0%	76.6	124	163	138	151
10 (Wet)	10.0%	88.0	140	183	154	171
20 (Wet)	5.0%	98.9	155	203	169	189
50 (Wet)	2.0%	113	174	226	186	212
100 (Wet)	1.0%	123	188	244	198	228
200 (Wet)	0.5%	134	202	260	210	244
500 (Wet)	0.2%	148	219	281	224	264

**NOTE** - Six and seven month precipitation assumed to be all snowfall accumulating from October to March (6 months) and October to April (7 months) respectively.

**Table I.15B - Williams Creek Site**

Return Period (years)	Annual Percent Probability	1 -Month Rainfall	2 -Month Rainfall	3 -Month Rainfall	6 -Month Precipitation	7 -Month Precipitation
Factor (times Pelly)		1.262	1.201	1.024	1.242	1.242
20 (Dry)	95.0%	46.3	77.2	87.9	88.1	95.4
5 (Dry)	80.0%	58.7	95.1	108	110	119
2 (Average)	50.0%	78.9	122	138	142	155
5 (Wet)	20.0%	96.7	149	167	171	188
10 (Wet)	10.0%	111	168	187	191	212
20 (Wet)	5.0%	125	186	208	210	235
50 (Wet)	2.0%	143	209	231	231	263
100 (Wet)	1.0%	155	226	250	246	283
200 (Wet)	0.5%	169	243	266	261	303
500 (Wet)	0.2%	187	263	288	278	328

**NOTES**

- 1) Orographic Factors for One-, Two-, and Three-Month Rainfall from Table I.14
- 2) Orographic Factors for Six- and Seven-Month precipitation based on the factor for annual total snowfall as described in Section 3.2 of this report.
- 3) For extreme winter snowfall years, the total snowfall will represent a greater proportion of the annual total precipitation than the 42% estimated for average conditions.
- 4) The Seven Month cumulative precipitation includes April precipitation, all assumed conservatively to be snowfall.

**TABLE I.16 - Average Monthly Precipitation Conditions - Williams Creek Site**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
<b>Pelly River Ranch at Elevation 454 m</b>													
<u>Average Conditions - Monthly Depths - mm</u>													
Average Rainfall	0.0	0.0	0.2	3.4	23.1	35.7	52.7	36.9	25.1	7.6	0.3	0.0	185.0
Average Snowfall	19.5	14.7	11.2	7.2	0.0	0.0	0.0	0.0	1.7	16.0	23.8	20.9	115.0
Average Precipitation	19.5	14.7	11.4	10.6	23.1	35.7	52.7	36.9	26.8	23.6	24.1	20.9	300.0
<u>Percent per month of Total Annual Precipitation</u>													
Rainfall	0.0%	0.0%	0.1%	1.1%	7.7%	11.9%	17.6%	12.3%	8.4%	2.5%	0.1%	0.0%	61.7%
Snowfall	6.5%	4.9%	3.7%	2.4%	0.0%	0.0%	0.0%	0.0%	0.6%	5.3%	7.9%	7.0%	38.3%
Total Precipitation	6.5%	4.9%	3.8%	3.5%	7.7%	11.9%	17.6%	12.3%	8.9%	7.9%	8.0%	7.0%	100.0%
<b>Williams Creek Site at Elevation 850 m</b>													
<u>Percent per month of Total Annual Precipitation</u>													
Rainfall	0.0%	0.0%	0.0%	1.2%	7.2%	11.1%	16.5%	11.6%	8.0%	2.4%	0.0%	0.0%	58.0%
Snowfall	7.2%	5.4%	4.1%	2.3%	0.0%	0.0%	0.0%	0.0%	0.0%	6.5%	8.7%	7.7%	42.0%
Total Precipitation	7.2%	5.4%	4.1%	3.5%	7.2%	11.1%	16.5%	11.6%	8.0%	9.0%	8.7%	7.7%	100.0%
<u>Average Conditions - Monthly Depths - mm</u>													
Rainfall	0.0	0.0	0.0	4.1	24.3	37.6	55.4	38.6	26.9	8.2	0.0	0.0	195.0
Snowfall	24.3	18.7	13.8	7.8	0.0	0.0	0.0	0.0	0.0	22.0	29.8	26.2	143.0
Total Precipitation	24.1	18.7	13.7	12.7	24.5	37.8	55.4	38.6	26.7	30.1	29.8	25.9	338.0

**NOTES**

- 1) Williams Creek % per month for rainfall, snowfall and total precipitation calculated assuming annual rainfall = 58% and annual snowfall = 42% of total annual precipitation.

**TABLE I.17 - Lake Evaporation Data and Estimates**

Station or Method	Elevation	March	April	May	June	July	Aug	Sept	Total	
Pelly Ranch	454			104.7	121.2	111.2	80.2	36.4	453.7	Note 1
Whitehorse	703			106.4	126.3	113.2	95.7	50.9	492.5	Note 2
Average	579			105.6	123.8	112.2	88.0	43.7	473.1	
Williams Ck (estimated)	850			97.4	114.2	103.5	81.1	40.3	436.4	Note 3
Williams Ck (estimated)	850			92.9	107.5	98.6	71.1	32.3	402.4	Note 4
Williams Ck (estimated)	850			101.9	121.0	108.4	91.7	48.8	471.8	Note 5
Calculation for Carmacks/Pelly Ranch region										Note 6
Lake Evaporation	850	4.2	42.9	98.3	129.4	131.1	89.1	25.9	520.9	Note 7
Evapotranspiration	850		27.0	70.4	95.1	96.3	62.5	14.0	365.3	

**NOTES**

- 1) Reported by AES, 1974 to 1990 period
- 2) Reported by AES, 1964 to 1990 period
- 3) Estimated using 10% decrease per 350 m increase in elevation above elevation 579 m
- 4) Estimated using 10% decrease per 350 m increase in elevation above elevation 454 m (Pelly)
- 5) Estimated using 10% decrease per 350 m increase in elevation above elevation 703 m (Whitehorse)  
(as recommended in manual of Operational Hydrology in BC)
- 6) Calculated by DIAND Water Resources using Morton's Method & shown in Table 3.2.6 of Volume 1 of the IEE "Biophysical Assessment of the Williams Creek Minesite" (January 1994)
- 7) Total lake evaporation calculated by Morton but excluding March & April = 473.8 mm which is the same as the average of the historical data reported for Pelly Ranch and for Whitehorse for the May through September period.
- 8) For application purposes a "conservative" laker evaporation should be used depending on the application:
  - for solution storage determination, use minimum lake evaporation = 402.4 mm per year.
  - for make-up water demand, use maximum lake evaporation = 520.9 mm per year.
  - for average conditions, use average value of 460 mm/year based on average of AES data