4.0 CLIMATIC AND HYDROLOGIC CHARACTERIZATION OF THE ATHABASCA OIL SANDS AREA IN 2005

The following general description of the 2005 climate and hydrology of the Athabasca oil sands area and comparison with long-term normals provides a context for the results of the 2005 RAMP monitoring program. The comparison is based primarily on federal and provincial hydrologic monitoring stations because of the long history available at those stations.

Total precipitation in the region was slightly below normal in 2005, despite a relatively wet summer. Precipitation measured at the Fort McMurray Airport during the water year (November 1, 2004 to October 31, 2005) was 406 mm. That total compares to a long-term average, since 1944, of 442 mm (Figure 4.1-1). Figure 4.1-2 compares monthly precipitation to average and extreme historical monthly values. Precipitation was near average for most months of the year, except in May when it was somewhat below average, and July when it was well above average and close to the historical maximum. A detailed view of the distribution of precipitation throughout the year is shown on the graph of cumulative precipitation occurring in Figure 4.1-3. The largest one-day rainfall event of the year was 57.5 mm on July 23, accounting for almost half of the precipitation recorded in July. A 25 mm rainfall occurred on June 14, with smaller events in May and August.

There was much greater rainfall south of Fort McMurray relative to Fort McMurray or north of Fort McMurray[1]. Precipitation at the Aurora climate station was also significantly higher than at Fort McMurray (Figure 4.1-3). This spatial variation of precipitation may account for the fact that regional streamflows were above normal in 2005 despite the fact that precipitation at Fort McMurray was below normal.

The spring snowpack was larger than has been observed for several years and it melted fairly abruptly, causing high spring runoff in most regional streams.

The annual runoff and maximum and minimum daily discharges observed at four selected regional Water Survey of Canada (WSC) streamflow stations are compared with historical values in Table 4.1-1. The stations are selected to represent four main areas of interest: the Muskeg River to represent watersheds east of the Athabasca River, the MacKay River to represent watersheds west of the Athabasca River, the Athabasca River itself, and the Christina River to reflect conditions south of Fort McMurray.

Flows in the Athabasca River measured at WSC station 07DA001 (Athabasca River below McMurray) were slightly above normal, with a total annual volume of 107% of the long-term average (Figure 4.1-4). Only two years in the past decade—1996 and 1997—have been above the long-term average.

Spring breakup on the Athabasca River was earlier than usual and included an ice jam at Crooked Rapids, upstream of Fort McMurray, that caused some flooding in Fort McMurray when it released.

[1] As shown on AENV precipitation maps located at: http://www3.gov.ab.ca/env/water/WS/data/precipmaps/archives/summacc.pdf; and http://www3.gov.ab.ca/env/water/WS/WaterSupply/aug2005/precfig1.pdf

Winter discharges were very close to historical mean values, and during the open-water season fluctuated between slightly below and well above the long-term average (Figure 4.1-5). Following spring runoff that resulted in above-normal flows in late April, several peaks in the hydrograph occurred at almost regular intervals. The maximum daily discharge of 2,420 m^3/s on July 3 was very close to the mean annual flood (the mean of the series of annual maximum daily discharges) of 2,490 m^3/s. The minimum daily discharge of 155 m^3/s was slightly greater than the historical average minimum value of 138 m^3/s.

In the Muskeg River basin, total runoff in 2005 was well above normal, and was the third highest recorded since 1974 at almost 166% of the long-term average (Figure 4.1-6). Discharges were well above normal in spring and peaked on April 27 apparently due to rapid snowmelt. Discharge peaks in July, August and September were also observed in response to rainfall, and then subsided to near average levels at the end of October (Figure 4.1-7). Mid-April and early August discharges were close to record values for those dates. The annual maximum daily discharge of 33.8 m^3/s was 30% greater than the mean annual flood of 26 m^3/s, and the minimum winter discharge of 0.19 m^3/s was almost exactly equal to the historical average minimum flow.

The MacKay River basin also experienced above normal runoff, although it was less extreme than the Muskeg River basin. Runoff volume in the MacKay River basin was 133% of normal (Figure 4.1-8). Except for 1996, 1997 and 2005, annual runoff has been below average in the MacKay River basin every year since 1991. The MacKay River discharge hydrograph (Figure 4.1-9) was very similar to the Muskeg River hydrograph except that the spring runoff peaked almost two weeks earlier, on April 14. The maximum daily discharge of 122 m^3/s was almost exactly equal to the mean annual flood of 126 m^3/s. The flows fluctuated from somewhat below to well above normal for most of the year and subsided to below average after mid-September. The Ells River hydrograph (not shown) was very similar to the MacKay River hydrograph in April, May and September, but the discharges held quite steady and near normal values during June and July.

South of Fort McMurray in the Christina River basin, the 2005 annual runoff was almost exactly double the long-term average, and was the third highest recorded since 1982 (Figure 4.1-10). Spring runoff peaked on April 16, but the highest discharge of the year occurred on May 25 in response to rainfall. Mid-April and late May discharges were the largest ever recorded for those times of the year. The maximum daily discharge of 116 m^3/s was 49% higher than the mean annual flood of 77.6 m^3/s (Figure 4.1-11). Discharges ranged from average to approximately triple the average flow during the open-water season, exceeding the mean annual flood three separate times, and subsiding in September to approximately average values.

In summary, 2005 was slightly below average in terms of precipitation at Fort McMurray itself, but well above average in terms of runoff volume in local streams in the Athabasca oil sands area both north and south of Fort McMurray. All river basins experienced above-normal to near-record flows in spring due to snowmelt runoff, and throughout most of the open-water season in response to rainfall. In the Athabasca River, both runoff volume and the annual maximum discharge were very close to historical average values.

Figure 4.1-1 Historical annual precipitation at Fort McMurray (1946 to 2005).

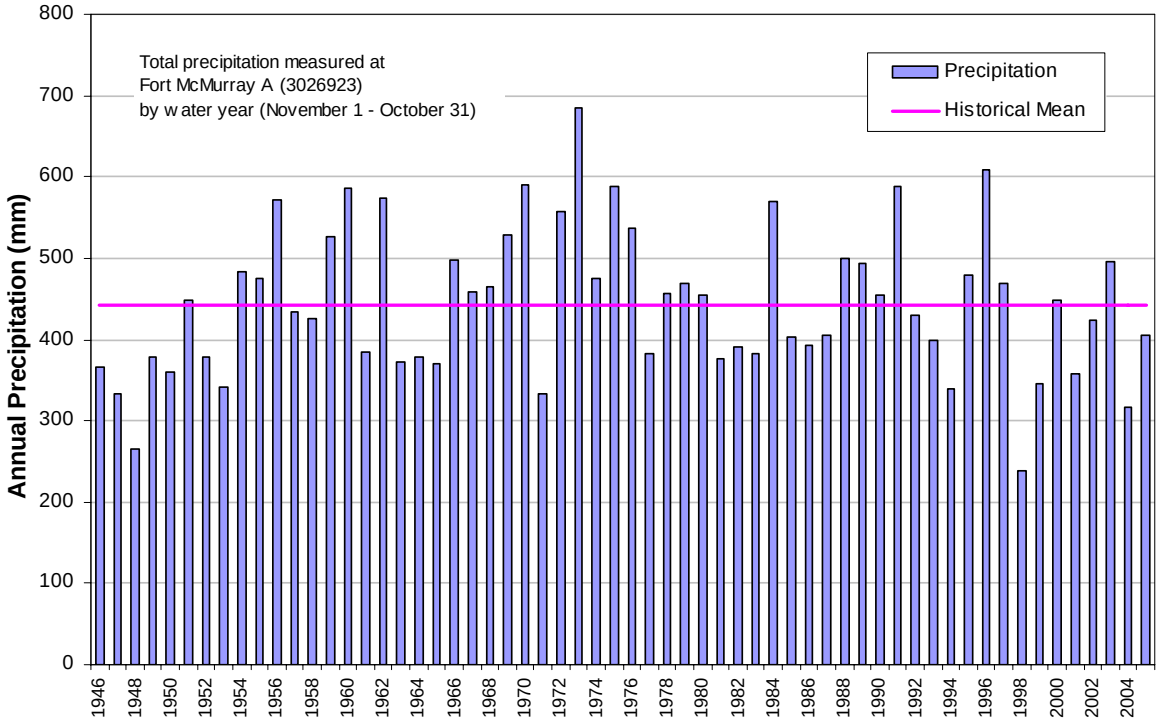

Figure 4.1-2 Monthly precipitation at Fort McMurray in 2005.

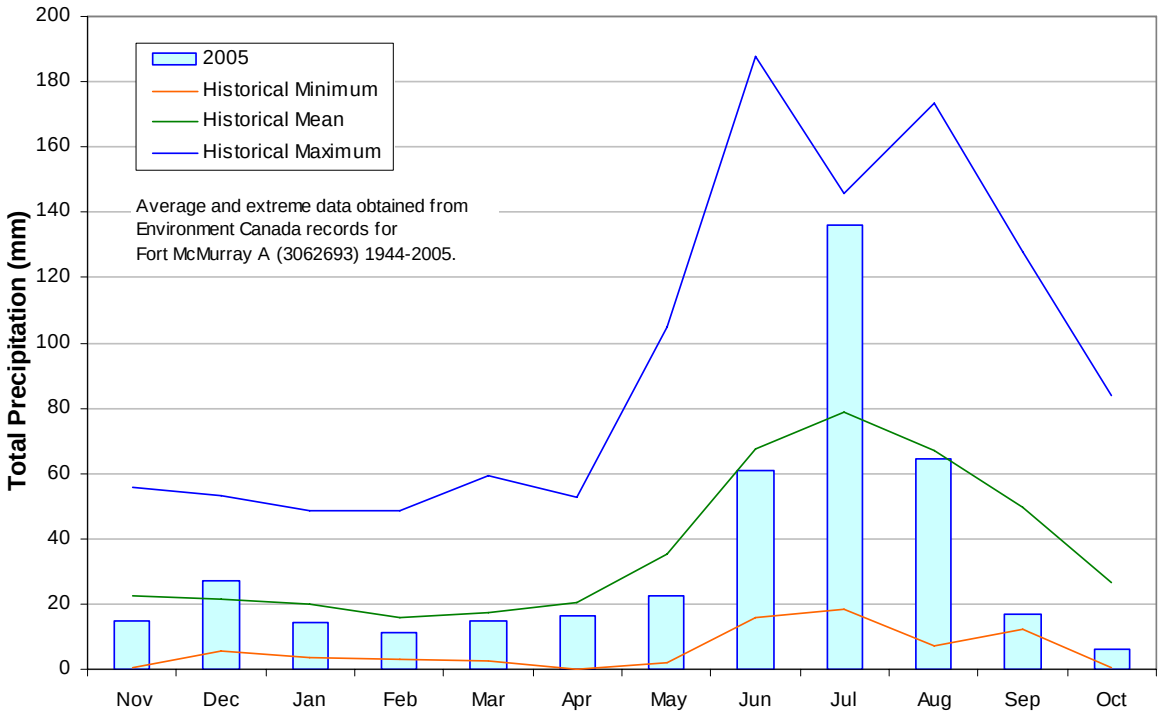

Figure 4.1-3 Cumulative total precipitation at Fort McMurray and at the Aurora Climate Station in 2005.

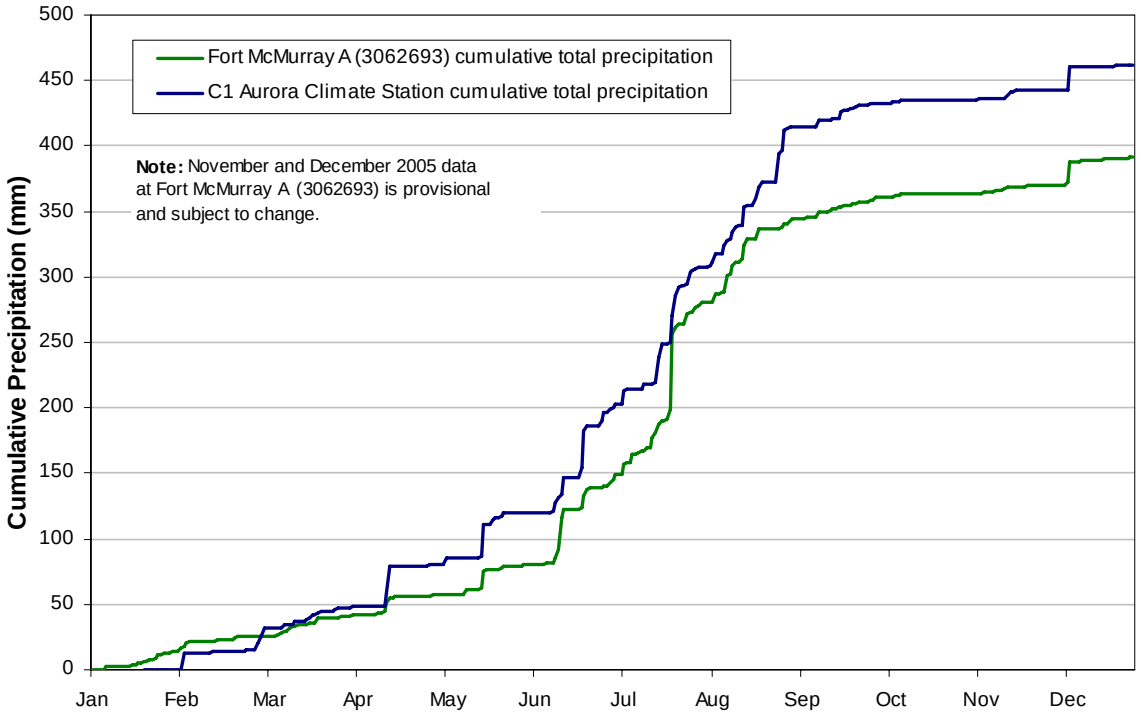

Table 4.1-1 A summary of 2005 streamflow variables compared to historical values measured in the Athabasca oil sands area.

	Athabasca River below McMurray (07DA001)	Muskeg River near Fort McKay (07DA008)	Christina River near Chard (07CE002)	MacKay River near Fort McKay (07DB001)
Effective Drainage Area (km^2)	131,000	1,460	4,851	5,570
Period of Record	1957 - 2005	1974 - 2005	1982 - 2005	1972 - 2005
Annual Runoff Depth				
Historical mean (mm)	152	82.8[1]	82.7[1]	77.4[1]
2005 (mm)	163	138[1]	165[1]	103[1]
Annual Maximum Daily Discharge				
Historical mean (m^3/s)	2,490	26.0	77.6	126
2005 (m^3/s)	2,420	33.8	116	122
Annual Minimum Daily Discharge[2]				
Historical mean (m^3/s)	138	0.20	2.05	0.295
2005 (m^3/s)	155	0.19	2.59	0.314

[1] Based on March 1 – October 31 volumes.

[2] Based on November 1 – October 31 water year.

Figure 4.1-4 Historical annual runoff in the Athabasca River basin (1974 to 2005).

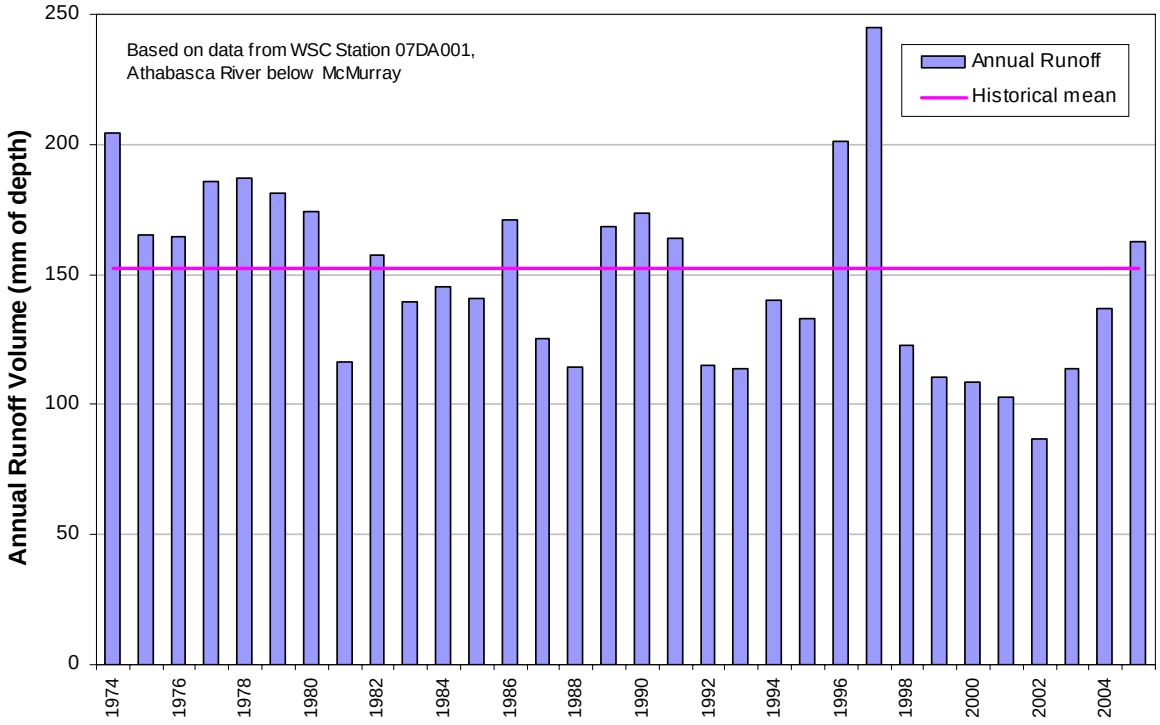

Figure 4.1-5 The 2005 hydrograph at the WSC Station 07DA001 (Athabasca River below McMurray) compared to historical values.

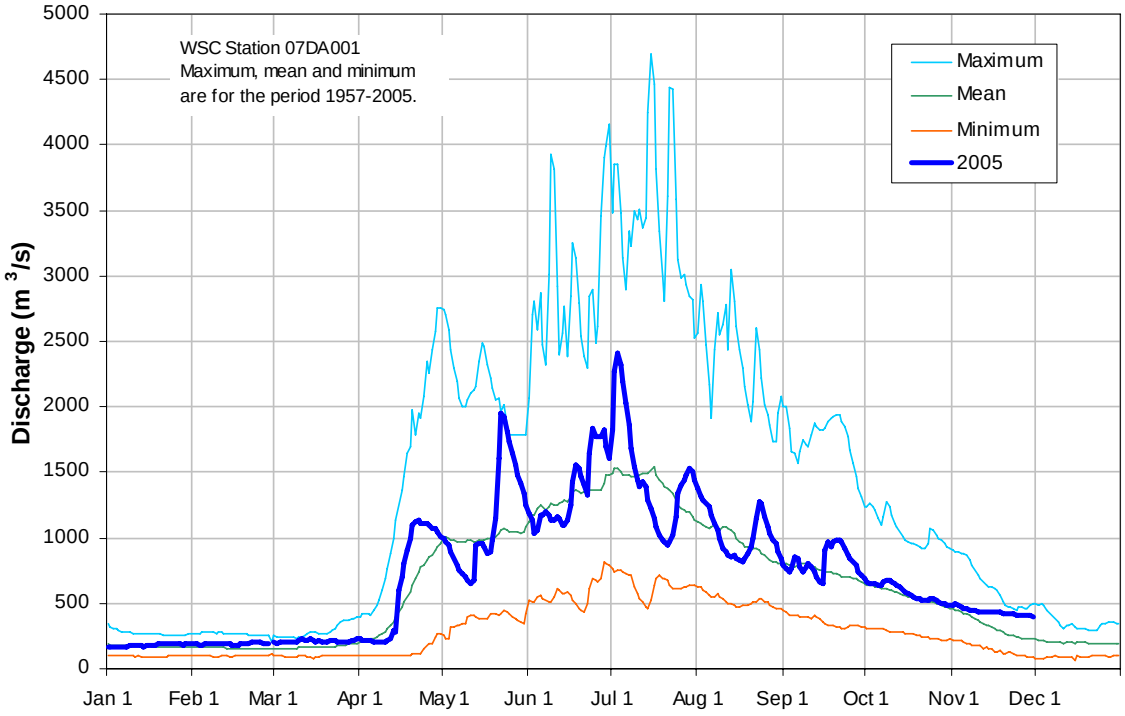

Figure 4.1-6 Historical annual runoff in the Muskeg River basin (1974 to 2005).

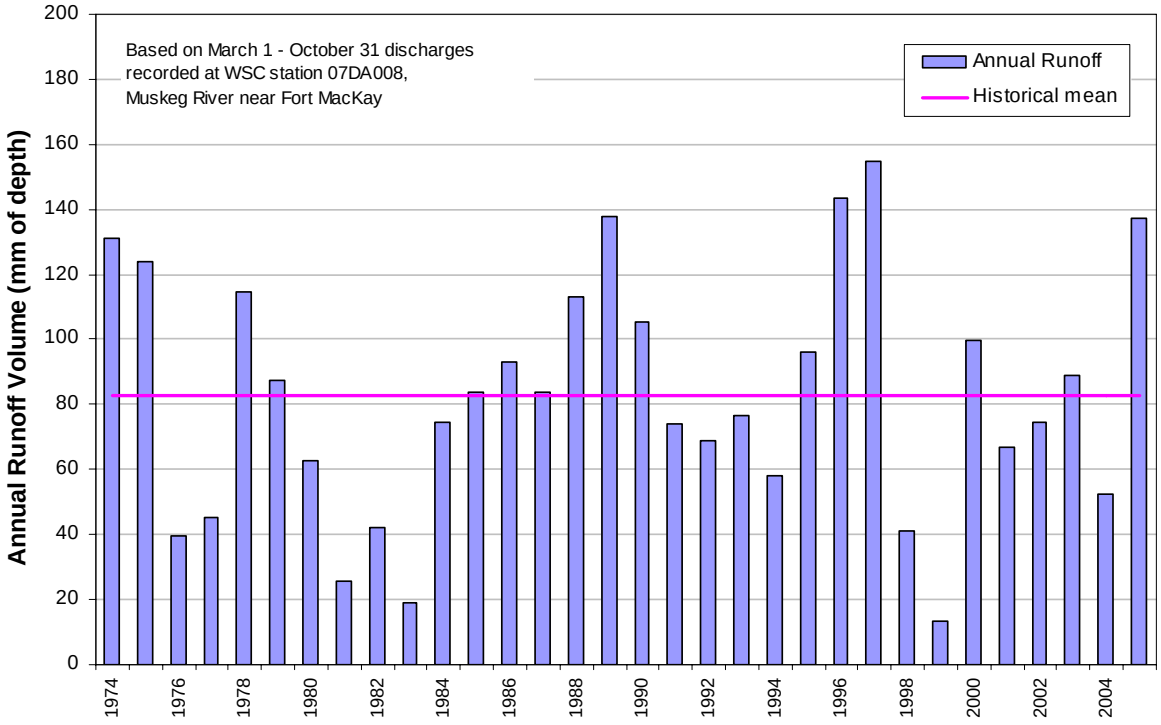

Figure 4.1-7 The 2005 hydrograph at Station S7 – Muskeg River near Fort McKay (07DA008) compared to historical values.

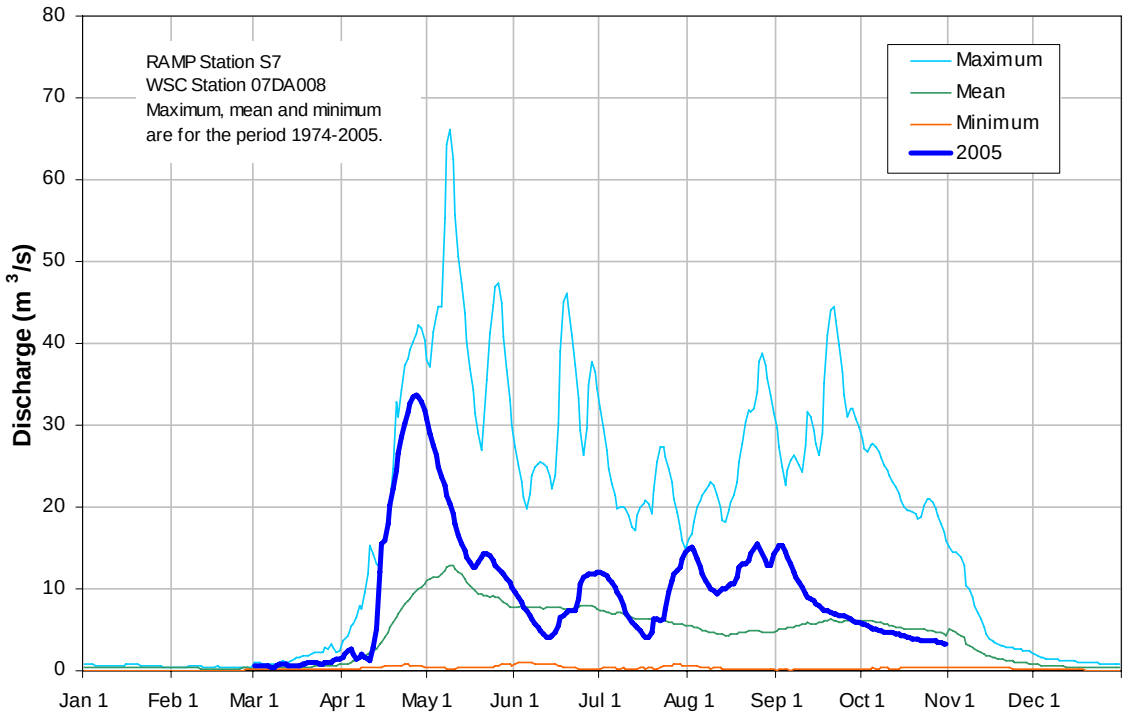

Figure 4.1-8 Historical annual runoff in the MacKay River basin (1974 to 2005).

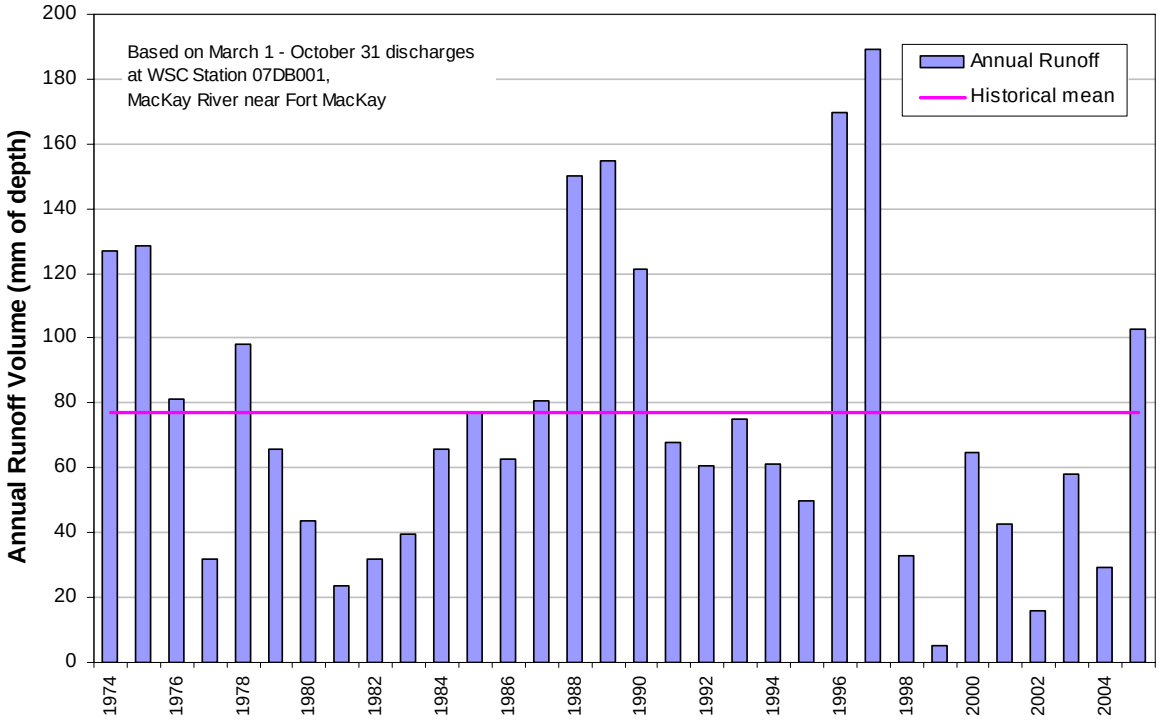

Figure 4.1-9 The 2005 hydrograph at the WSC Station 07DB001 (MacKay River near Fort McKay) compared to historical values.

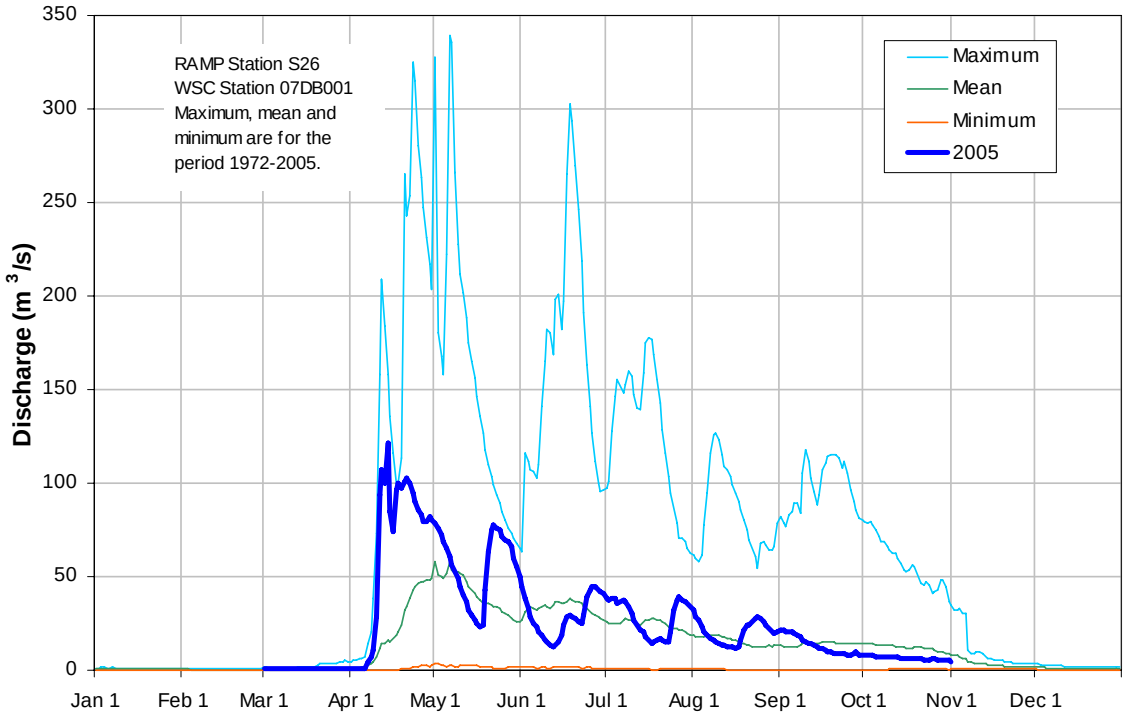

Figure 4.1-10 Historical annual runoff in the Christina River basin (1983 to 2005).

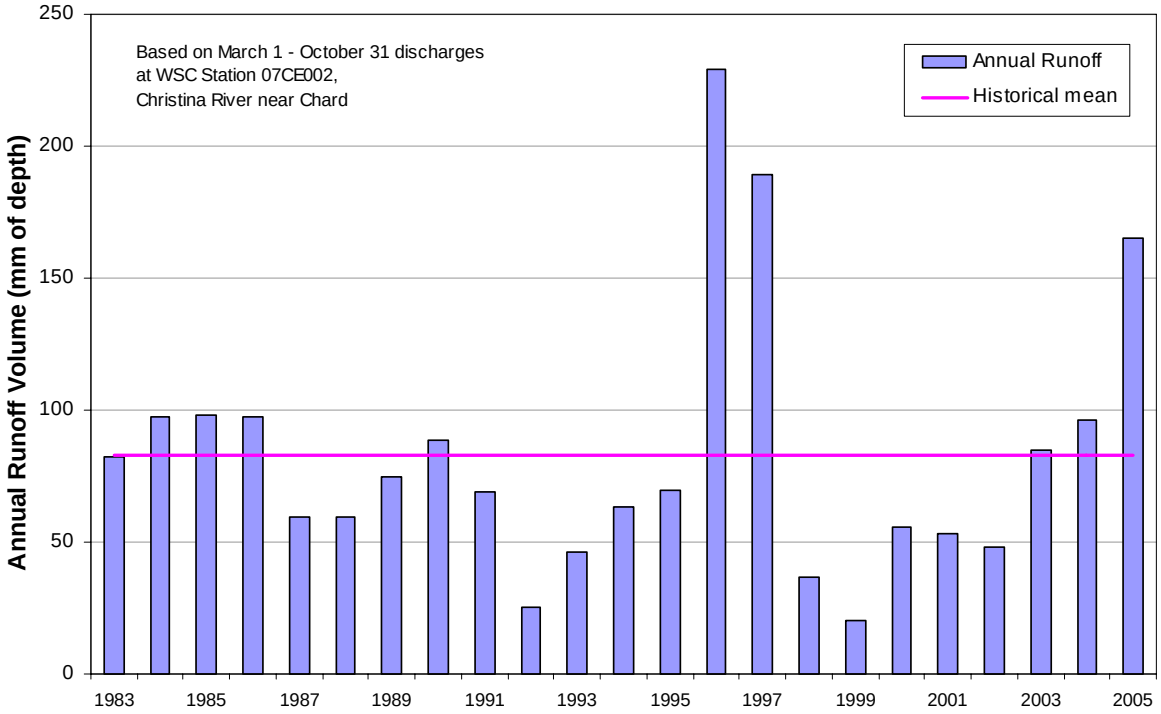

Figure 4.1-11 The 2005 hydrograph at the WSC Station 07CE002 (Christina River near Chard) compared to historical values.