6.0 ENVIRONMENTAL SETTING

6.1 PHYSICAL SETTING AND PHYSIOGRAPHY

The proposed mine and the study area occur within the Fraser Plateau (Holland 1976). In general this plateau is characterized as a rolling, drumlinized till plain dissected by deep valleys and containing many upland surfaces with maximum elevations between about 1,200 and 1,500 metres. Within the study area the plateau has moderately low relief, with Mount Polley extending approximately 300 metres above the surrounding terrain.

Generally volcanic origin rocks underlie this part of the plateau with inclusions of some intrusive rocks. Most of the area is covered by a morainal blanket of unconsolidated till which contains fluvial, lacustrine, and colluvial deposits. Also within the study area are patches of organic soils deposited in poorly drained depressions, including bogs.

The study area is in the biogeoclimatic zone designated as the Interior Cedar Hemlock Zone and more particularly in the Cedar Subzone (Lord 1984).

6.2 CLIMATE

6.2.1 General Climate

Climate in the area is strongly influenced by proximity to the Quesnel Highlands, which borders the Fraser Plateau to the east. The general trends of climate within the region are governed primarily by elevation, latitude and the position in relation to the mountains.

Although still in the rain shadow of the Coast Mountains the region surrounding Mount Polley receives significantly more precipitation than areas between Williams Lake and the Coast Mountains. A rapid increase in precipitation is very apparent as one progresses northeast from Williams Lake (Williams Lake Airport 413mm, Horsefly Lake 739mm and Barkerville 1,044mm per year). Most of the increases can be explained by the increase in elevation and proximity to the mountains of the Quesnel Highlands. (B.C. Ministry of Forests, 1979.) This is reflected by both rainfall and snowfall.

The semi-arid conditions notable in Williams Lake are not characteristic of the Mount Polley area. Temperatures tend to be cooler, growing periods shorter and precipitation heavier along this northeast trend. Forest cover and agricultural practices reflect these changes (Lord, 1984).

6.2.2 Mount Polley Climate

During the 1989 summer exploration season Imperial Metals Corporation installed a weather station at Mount Polley in the general vicinity of where the mill and the central pit will be located. This weather station records precipitation, minimum and maximum temperature, and relative humidity.

There are no long term records of any of these parameters from the site or from any nearby site with similar elevation and surrounding terrain. The Atmospheric Environment Service (AES 1981) provides a compilation of data from weather stations that meet a set of minimum standards. Long term data from a series of these regional weather stations was used to extrapolate certain climatic parameters and provide estimates of what could be expected at the location of the Mount Polley weather station (Appendix 1).

Figure 6-1 illustrates the location of these AES stations in the vicinity. Four of these locations were particularly useful in extrapolating to the Mount Polley location. They were Barkerville, Horsefly (an average of Horsefly B.C.F.S and Horsefly Lake), Likely and Ochiltree. Appendix II contains a report on the synthesis from these regional data to the Mount Polley location.

Figure 6-2 illustrates the predicted mean monthly temperature at the Mount Polley weather station based on these regional data.

In Figure 6-3 the predicted distribution of precipitation by months is displayed. Total precipitation is represented by the solid bar,

FIGURE 6-2

PREDICTED MEAN MONTHLY TEMPERATURE AT THE MOUNT POLLEY WEATHER STATION

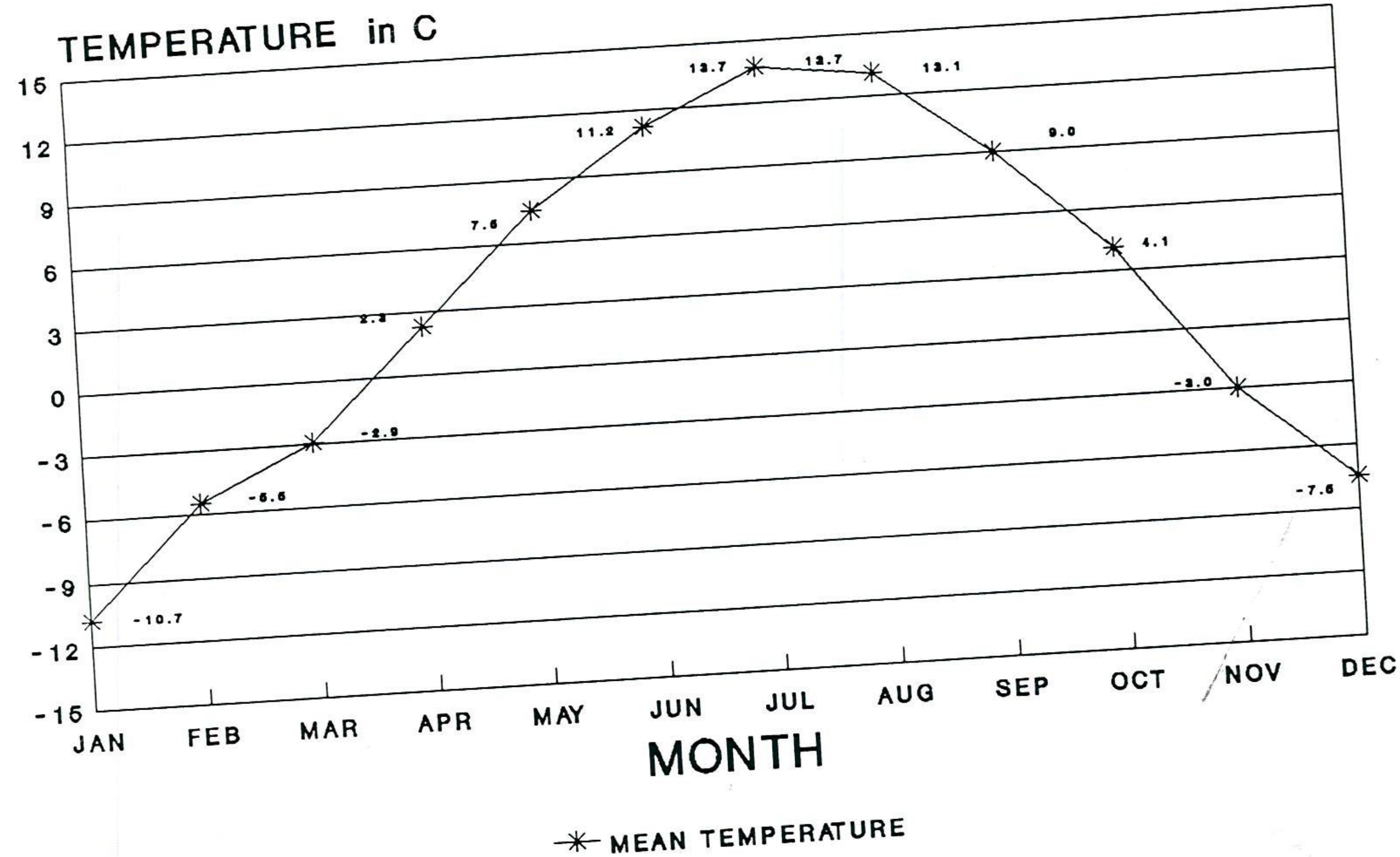
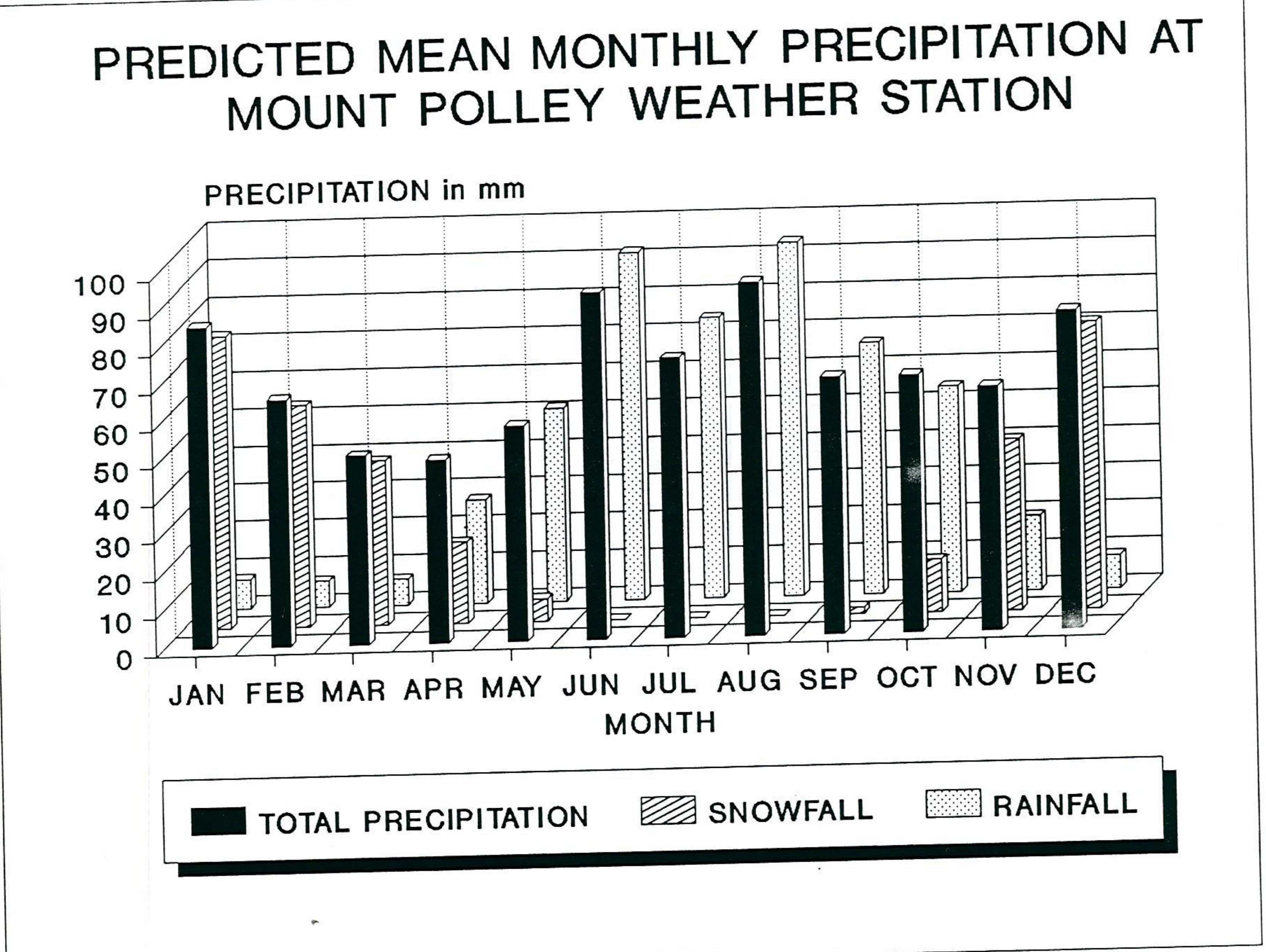


FIGURE 6-3



PREDICTED MEAN MONTHLY PRECIPITATION AT MOUNT POLLEY WEATHER STATION
PRECIPITATION in mm
100
90
80
70
60
50
40
30
20
10
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
MONTH
TOTAL PRECIPITATION
SNOWFALL
RAINFALL

snowfall is represented by the cross-hatched bar and rainfall by the stippled bar. This figure is the precipitation predicted for the elevation of the weather station (1,142m). The total annual precipitation at this elevation is predicted to be 856mm with a standard deviation of 119mm. On average, 511.1mm of that is expected as rain and 344.9mm is expected as snow. As an indication of the effect of elevation at this location the estimate for the surface of Bootjack Lake (elev. 986m) would be about 737mm annual precipitation.

Table 6-1 lists precipitation extremes for 10 regional weather stations. This is a rough indication of what Mount Polley might experience in maximum rainfall and snowfall (moisture) in 24 hour periods.

Evaporation measurements are taken only during the frost-free season (AES 1981). The network of evaporation pans in B.C. is quite sparse. Table 6-2 lists the location of regional evaporation stations and shows their averages for evaporation in frost-free months. The values in the table demonstrate that pan evaporation is not particularly sensitive to location or elevation, in this part of B.C., therefore, the average is a reasonable prediction for what could be expected at Mount Polley for these months. The average evaporation for the frost-free period was 423mm which does not include losses by sublimation or evaporation outside the frost-free period.

Figure 6-4 demonstrates the observed maximum and minimum daily temperatures at the Mount Polley weather station for the 1989 period of record. The observed daily extremes of humidity for that same period are expressed in Figure 6-5.

The observed precipitation during the late summer and fall of 1989 at Mount Polley are presented in Figure 6-6. During the latter part of October and November precipitation fell both as snow and rain. The mechanism of the recording device does not segregate these two forms and only records snowfall as it melts. As a result during periods of snow melt (i.e. November 3), daily precipitation is overstated, sometimes grossly.

 AMEC011534

TABLE 6-1

PRECIPITATION EXTREMES IN THE REGION

LOCATION	POSITION	ELEVATION (m A.S.L.)	PRECIPITATION (mm) GREATEST rainfall in 24 hrs	snowfall in 24 hrs	precip. in 24 hrs
BARKERVILLE	53 4' N 121 31' W	1265	69.9	58.46	71.1
BOSS MOUNTAIN	52 6' N 120 53' W	1532	52.3	58.4	58.4
HORSEFLY BCFS	52 20' N 121 25' W	785	32.3	43.2	43.2
HORSEFLY LAKE	52 23' N 121 17' W	788	51.8	34.3	51.8
KERSLEY	52 49' N 122 22' W	671	39.1	30.5	39.1
LIKELY	52 36' N 121 32' W	724	33.0	27.4	38.1
OCHILTREE	52 16' N 121 48' W	1128	36.3	31.8	56.1
150 MILE HOUSE	52 7' N 121 56' W	738	43.9	40.1	43.9
WILLIAMS LAKE AIRPORT	52 11' N 122 4' W	940	37.3	42.7	42.7
WILLIAMS LAKE GLENDALE	52 9' N 122 10' W	588	32.6	30.0	32.6

SOURCE: ATMOSPHERIC ENVIRONMENT SERVICE, 1981. CANADIAN CLIMATE NORMALS.

AMEC011535

TABLE 6-2

AES REGIONAL EVAPORATION STATIONS USED

AES STAION	LOCATION AND ELEVATION	EVAPORATION (mm) MAY	JUNE	JULY	AUG	SEPT	OCT	TOTALS
BLUE RIVER A	52 7' N 119 17' W 683m		100	106	96.9	50.4	34.4	387.7
HIGHLAND VALLEY	50 31' N 121 1' W 1554m		122	112	110	77.5		421.5
HUDSON HOPE BCHPA DAM	56 1' N 122 12' W 678m	102	121	111	98.0	48.4		480.4
MICA DAM	52 3' N 118 35' W 579m		91	83.8	61.6	26.3	15.4	278.7
TOPLEY LANDING	54 49' N 126 10' W 722m	73	93	92.5	74.3	34.2		367.1
VERNON SOUTH	50 14' N 119 17' W 555m	105	143	137	111	63.2	40.4	599.6
AVERAGE								423mm

SOURCE: ATMOSPHERIC ENVIRONMENT SERVICE, 1981.
CANADIAN CLIMATE NORMALS.

FIGURE 6 - 4

DAILY TEMPERATURE EXTREMES OVER THE PERIOD OF SEPTEMBER 19TH TO NOVEMBER 17TH AT MOUNT POLLEY WEATHER STATION

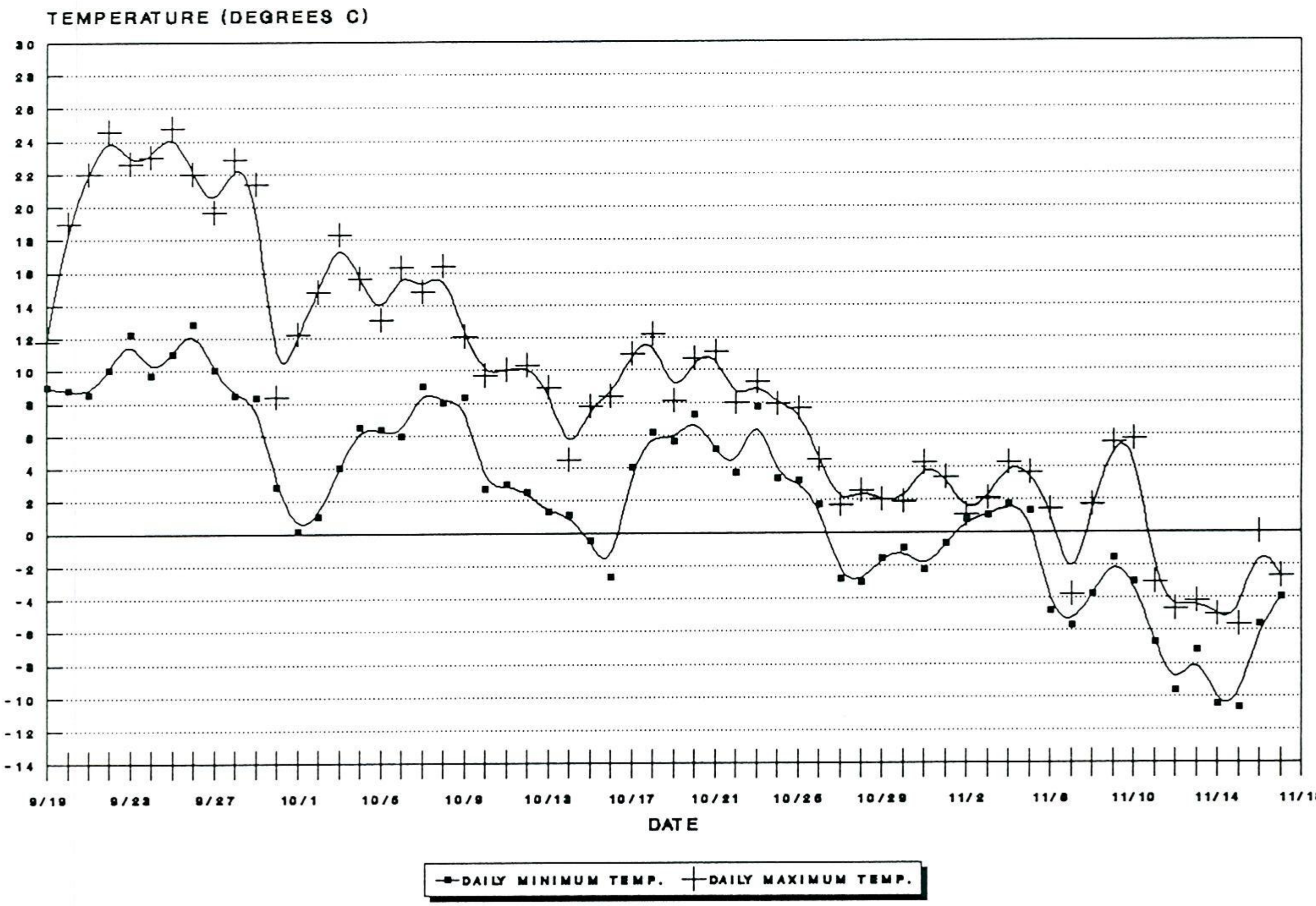


FIGURE 6-5

DAILY EXTREMES OF HUMIDITY OVER THE PERIOD OF SEPTEMBER 19 TO NOVEMBER 17, 1989 AT MOUNT POLLEY WEATHER STATION

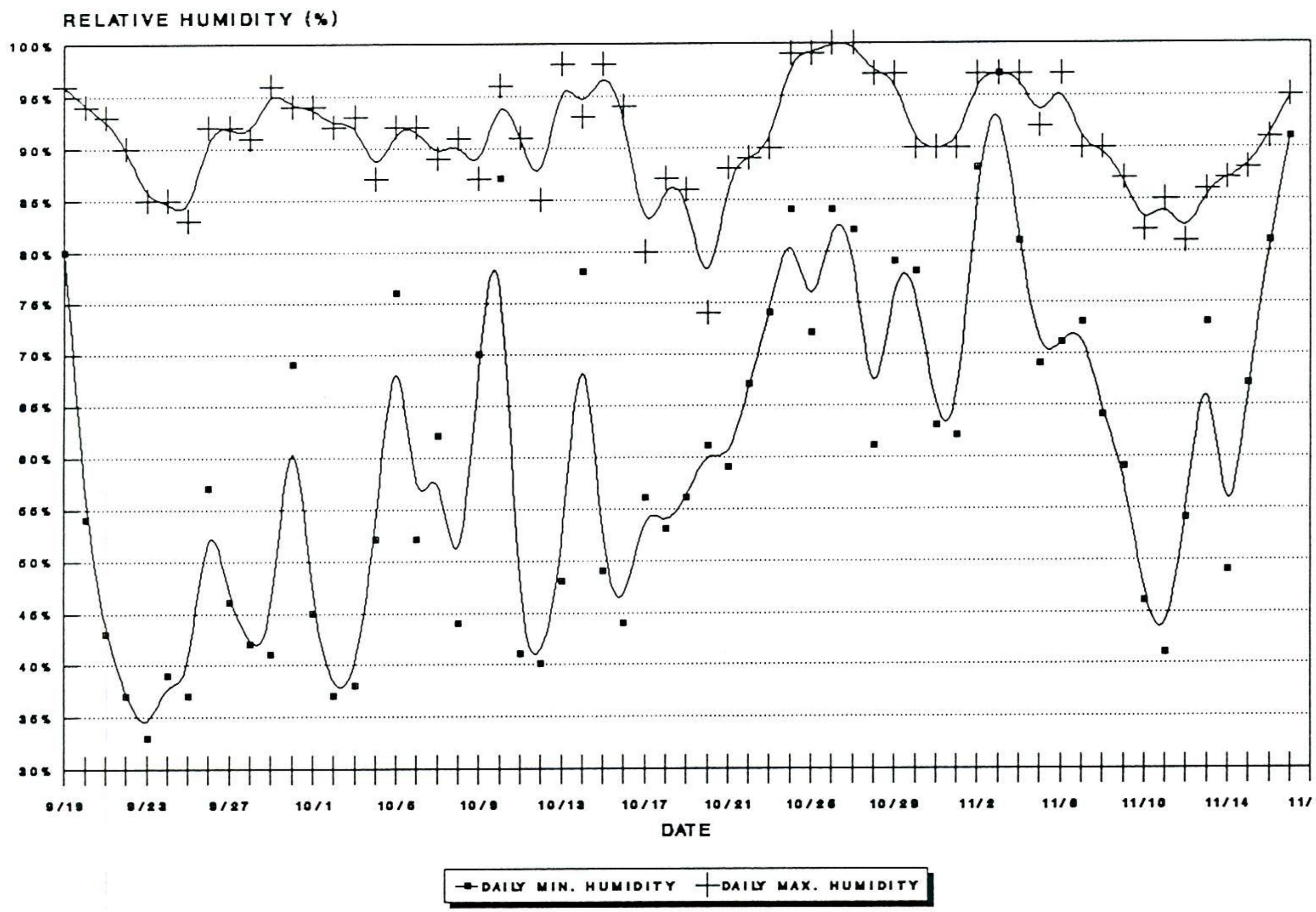
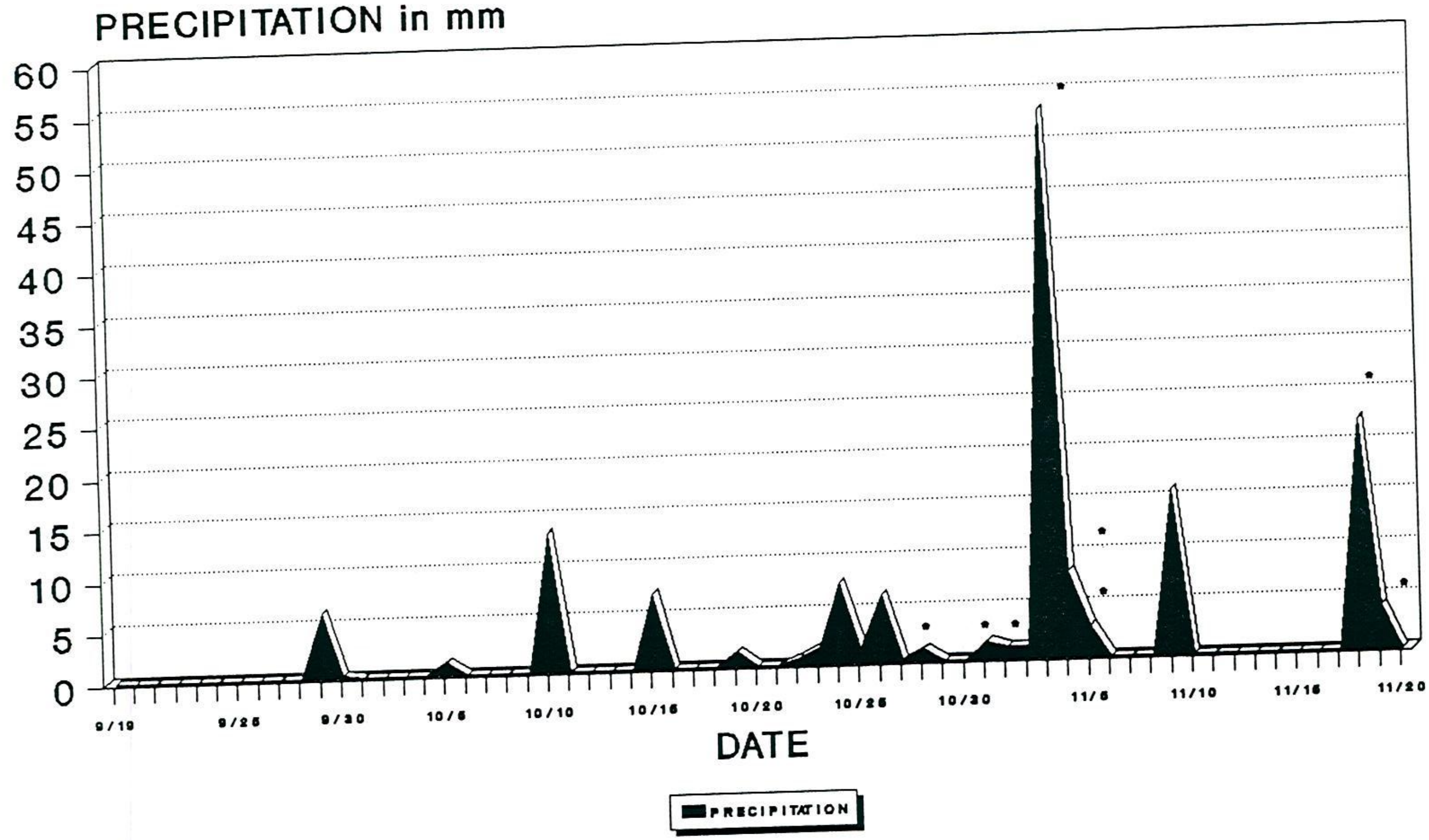


FIGURE 6-6

PRECIPITATION MEASURED AT THE MOUNT POLLEY WEATHER STATION



MEASUREMENT PERIOD FROM SEPTEMBER 19
TO NOVEMBER 19, 1989.
* INCLUDES MELTING SNOW

The precipitation observed during this short period is slightly above the predicted long term average. Tabulation of the Mount Polley weather station data is included in Appendix 1.

6.2.3 Air Quality

The Mount Polley area is quite remote from any sources of substantial industrial air emissions, and is also remote from any significant concentration of vehicular or residential sources of atmospheric emissions. Seasonal pollen and fugitive dust are expected to be the main airborne material.

The slightly undulating terrain around Mount Polley suggests unobstructed atmospheric exchanges and the absence of prolonged inversions. Major storm tracks are from the west off of the Pacific Ocean.

No air quality monitoring station exists in the vicinity of Mount Polley but there is no reason to expect anything other than excellent air quality to prevail at all locations around the minesite.

6.3 AQUATIC RESOURCES

6.3.1 Surface Water Hydrology

The general trend of drainage in this part of the Fraser Plateau is north and east, ultimately discharging from the Quesnel River into the Fraser River. The start of the Quesnel River is designated at Likely where water discharges from Quesnel Lake.

The Mount Polley Project is located near the divide of two small watersheds within this system (Figure 6-7). The western watershed which includes discharges from Bootjack Lake, Trio Lake and Morehead Lake, discharges to the Quesnel River by Morehead Creek about 20 kilometres downstream of Likely. The eastern watershed including Polley Lake is discharged to the southeast by Hazeltine Creek which joins Edney Creek before entering Quesnel Lake. Bootjack Creek is a small tributary of Hazeltine Creek.

Historical Water Diversions

Historically these small watersheds were somewhat different. Their present configuration is intimately tied to the history of placer gold mining in this region of the Cariboo. Understanding present hydrological regimes requires recognition of the function of previous drainages. Until early in the present century Bootjack Lake was drained by Bootjack Creek into Hazeltine Creek below Polley Lake. In approximately 1913, Bootjack Creek was dammed near Bootjack Lake by a small earth dam which still remains. At the north end of Bootjack Lake a new exit was dug through the glacial till permitting water to create a new stream channel that connected with the outfall from Trio Lake and other small drainages north of Mount Polley (Elaine Bennett, personal communication). This new stream course is what is now known as the upper reaches of Morehead Creek.

At about the same time Morehead Creek was dammed at the Likely Road crossing to create Morehead Lake. The present road to Likely runs along the top of that dam which has been subsequently reinforced and improved. A ditch was dug from the northwest shore of Morehead Lake to carry this stored water to placer gold operations in the vicinity of the community of Hydraulic and ultimately on to the Bullion Pit near Likely.

A control structure was also constructed on Polley Lake at the origin of Hazeltine Creek. Hazeltine Creek was diverted through a ditch on the side of the ridge above the north arm of Quesnel Lake. That ditch carried the flow of Hazeltine Creek and discharged it into the Bullion Pit for placer gold mining operations. That ditch has since been converted to a forest service road which is locally referred to as the Ditch Road. (Elaine Bennett, personal communication).

These water diversions of both Hazeltine and Morehead Creek operated until abandonment during World War II. The flow from Bootjack Lake remains in its diverted course to Morehead Lake and any surface connection to Bootjack Creek is prevented by the earthen dam that remains.

The flow from Morehead Lake down the ditch seriously eroded the steep hillside and threatened to undercut the Likely Road. The Provincial Highways Department intervened, reinforced the dam, installed the spillway, blocked the ditch and restored flow to the original channel below Morehead Lake (Ron Williams, personal communication).

Presently, approximately 60% of the drainage in the Mount Polley area discharges into the Morehead Lake watershed, the remainder enters the Hazeltine Creek watershed. The diversion for placer mining has resulted in the capture of approximately 14 square kilometres of drainage area into the Morehead Creek system.

Hydrological Program and Analysis

A comprehensive program of stream monitoring by Imperial Metals Corporation commenced in the spring of 1989 in the Mount Polley Area. The objectives were to provide reliable estimates of volume runoff, low flows and flood peak flows for streams in the project area. This program was designed and initiated in conjunction with suggestions from Water Management staff of the Ministry of Environment in Williams Lake (Hubert Bunce, personal communication).

There are no long term stream flow or precipitation records for locations within the project drainage system. Therefore, assessments included regional analysis of data from outside the basin combined with data collected within the basin to meet these objectives. An additional approach was utilized to provide backup estimates of peak flows and their return periods. This utilized channel geometry and known flow characteristics. The combination of the three approaches yielded estimates on stream flow characteristics that are reported in Table 6-3.

Figure 6-7 illustrates the boundaries of the various component areas of the small headwater drainage systems that were gauged as part of this analysis program. The area in square kilometres of each of the drainage areas is shown at the top of Table 6-3. These small flow areas illustrate the significance of the location of the minesite in the headwaters of small tributary streams.

TABLE 6-3

SURFACE WATER REGIME ESTIMATES

BASIN FLOWS	Month	Morehead Creek at Weir	Morehead Creek at Bridge	Morehead Creek at Outlet	Bootjack Creek at Weir	Hazeltine Creek at Weir	Edney Tributary	6k Creek	4k Creek
Drainage Area, sq km		12.39	14.00	65.87	3.77	33.26	5.28	8.20	4.50
Mean monthly flows (cms)	JAN	0.014	0.015	0.073	0.0042	0.037	0.0058	0.0091	0.0050
	FEB	0.013	0.014	0.068	0.0039	0.034	0.0054	0.0084	0.0046
	MAR	0.032	0.036	0.170	0.010	0.086	0.014	0.021	0.012
	APR	0.164	0.186	0.874	0.050	0.441	0.070	0.109	0.060
	MAY	0.298	0.337	1.587	0.091	0.801	0.127	0.198	0.108
	JUN	0.135	0.152	0.716	0.041	0.361	0.057	0.089	0.049
	JUL	0.056	0.063	0.298	0.017	0.150	0.024	0.037	0.020
	AUG	0.038	0.043	0.200	0.011	0.101	0.016	0.025	0.014
	SEP	0.031	0.035	0.166	0.009	0.084	0.013	0.021	0.011
	OCT	0.045	0.051	0.240	0.014	0.121	0.019	0.030	0.016
	NOV	0.044	0.049	0.232	0.013	0.117	0.019	0.029	0.016
	DEC	0.023	0.026	0.120	0.0069	0.061	0.010	0.015	0.0082
MEAN ANNUAL RUNOFF		0.074	0.084	0.395	0.023	0.200	0.032	0.049	0.027
200 yr Mean Annual Runoff (cms)		0.15	0.17	0.79	0.045	0.40	0.063	0.10	0.054
200 yr Peak (cms)		16.70	17.40	32.00	10.20	24.30	11.90	13.90	11.52

200 YEAR PEAK

For design of:	Drainage Area sq km	Discharge cms
Diversions		
Ditches		
Spillways	0.5	2.6
for small	5	1.2
subbasins.		

LOW FLOWS

	Discharge per unit Area 1/s/sq km	Bootjack Creek at Weir 1/s	Hazeltine Creek at Weir 1/s
Annual 7 day Minimum			
Mean	.690	2.60	22.3
10 year	.250	.943	8.07
Annual Daily Minimum			
Mean	.493	1.86	15.9
10 year	.122	.460	3.94

TABL

In addition to mean annual runoff and mean monthly flows for each drainage area, this table also shows the predicted two hundred year peak flood flow for design of diversion ditches and spillways. Low flow estimates are expressed as discharge per unit surface area as well as separately for the two streams, Bootjack and Hazeltine Creeks.

The hydrological monitoring program is expected to be an ongoing program that would be tailored in its specifics to the needs of this project after the Stage I review. Special recognition is appropriate to Mr. Ron Williams, holder of downstream water rights on Morehead Creek, for the use of his data that spans over two years from his weir at the outlet of Morehead Lake.

Table 6-4 lists the existing water Licences and applications filed by early January 1990 for Bootjack Lake and Morehead Creek. At that time no application, except by Imperial Metals Corporation had been filed for Polley Lake or Hazeltine Creek.

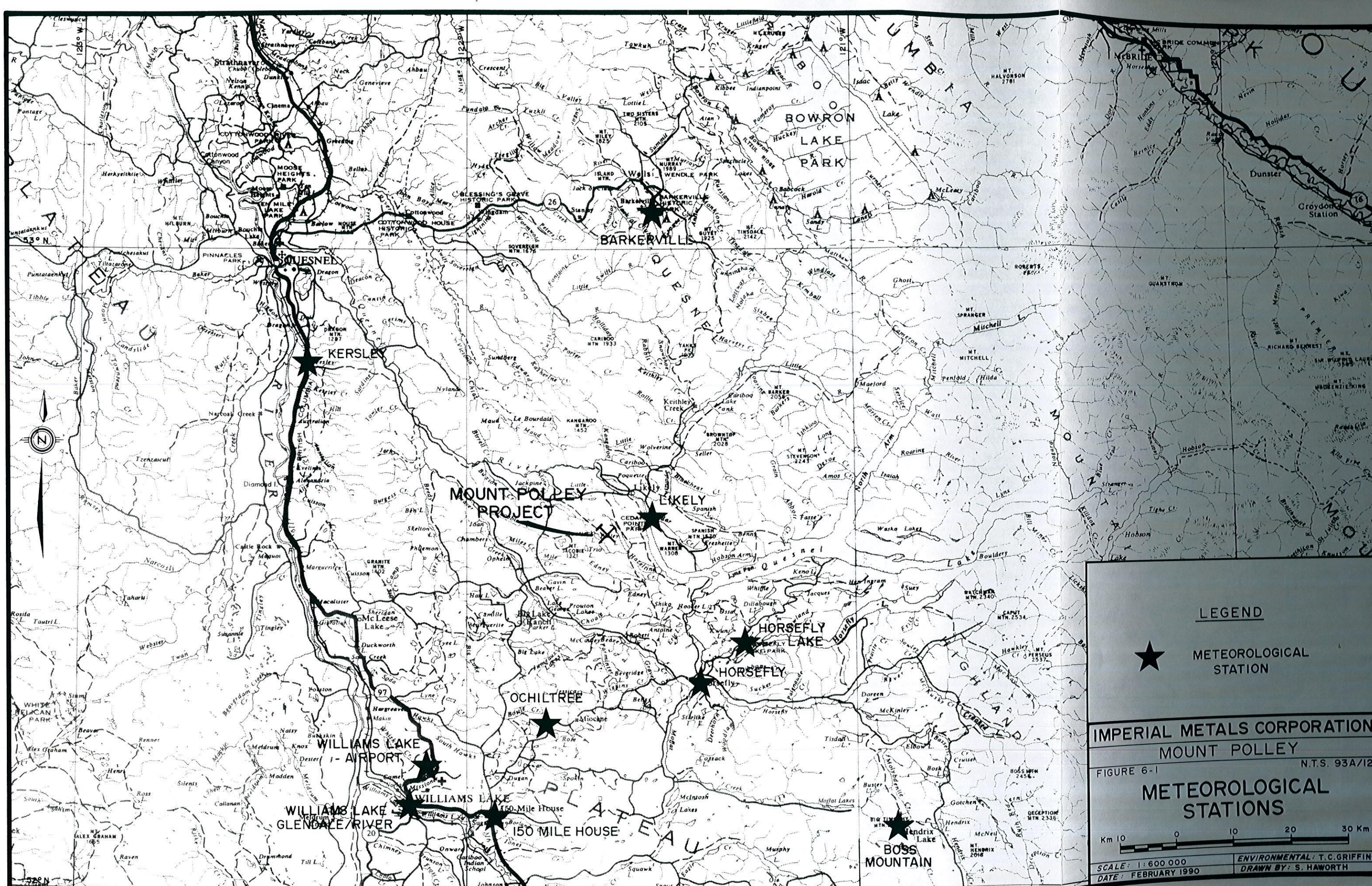
Appendix 2 contains a complete description of the analytical approach used in arriving at these hydrological estimates. This report by PMS Engineering Ltd. includes information on the sources of long term data used in the correlation with on-site gauging results.

6.3.2 Limnology of Lakes

Four lakes have figured prominently in the considerations relating to the Mount Polley Project development. These are Bootjack Lake, Polley Lake, Morehead Lake, and Kay Lake (also known locally as Fry Pan). Morehead Lake is a man-made and relatively shallow reservoir. The other three are all natural lakes that have had varying degrees of public access and manipulation for the purpose of water storage and/or diversion.

Bathymetric Features

The Fish and Wildlife Branch of the Department of Environment surveyed Bootjack Lake in July of 1970, their Bathymetric Map is reproduced as Figure 6-8. The lake is essentially a long and narrow basin with two depressions whose depths


LEGEND
METEOROLOGICAL STATION
IMPERIAL METALS CORPORATION
MOUNT POLLEY
FIGURE 6-1
N.T.S. 93A/12
METEOROLOGICAL STATIONS
Km 10 0 10 20 30 Km
SCALE: 1:600 000
DATE: FEBRUARY 1990
ENVIRONMENTAL: T.C.GRIFFING
DRAWN BY: S. HAWORTH
MOUNT POLLEY PROJECT
BARKERVILLE
QUESNEL
KERSLEY
LIKELY
HORSEFLY LAKE
HORSEFLY
OCHILTREE
WILLIAMS LAKE AIRPORT
WILLIAMS LAKE
WILLIAMS LAKE GLENDALE/RIVER
150 MILE HOUSE
BOSS MOUNTAIN
BOWRON LAKE PARK
PLATEAU
Dunster
McBride