7 Environmental Assessment Findings

7.1 Climate

Climate parameters provide important information concerning the state of the environment and its natural variability. Climate shapes the general ecology of the study region and is the primary input for local environmental processes such as runoff and evaporation. In general, climate affects the project rather than the project affecting climate. Potential effects of climate on the project are discussed in Section 7.15.3: Extreme Weather Events and Section 7.15.5: Climate Change.

This section characterizes climate conditions in the project area to provide background information for assessment of project effects on hydrology and air quality. Potential localized effects of the project on climate parameters such as wind speed, snow drifting, and solar radiation are briefly discussed.

7.1.1 Scope of Assessment

While climate will not be affected to any great degree by the project, it has been identified as a VECC because of its influence in mediating project effects on other VECCs, such as hydrology, and air quality. Climate parameters analyzed in this section were selected based on requirements outlined in the EA Report Guidelines (Yukon Executive Council Office [ECO] 2005), the Biophysical Assessment Workplan 1 (YZC 2005) submitted to the Technical Committee, and data requirements for project design (Section 2.8 Tailings Disposal; Section 2.9: Site Water Management) and impact assessment (Section 7.2: Air Quality; Section 7.4: Surface Water Hydrology). Selected parameters are summarized in Table 7.1-1.

Temporal Boundaries

The temporal boundaries for the climate assessment include the 30-year period of record for climate data used in this assessment and the 14 year period of mine construction, operation and decommissioning from 2006 to 2019. Regional data from climate stations in the Liard Basin span the period from 1975 to the present. Data was collected intermittently at the project site from 1996 to the present and continuously at the minesite airstrip from October 2004 to the present. The 14-year life of the project is when the project may cause localized effects on climate and climate will mediate project effects on hydrology and air quality.

Study Area

Local Study Area

The LSA for the climate assessment is defined as the area where climate will have an effect on project design, operations and impact mitigation and is shown in Figure 7.1-1. This includes the approximately 4 km² area encompassing the underground mine, industrial complex, airstrip and proposed tailings facility and the approximately 120 km² encompassing the headwaters of Go Creek, Hawkowl Creek, Wolverine Creek, the mine access road, and the existing exploration camp on Wolverine Lake. Any localized effects on project climate will be confined within the 4 km² minesite area of the LSA.

Table 7.1-1 Climate Parameters Analyzed, Selection Rationale and Data Sources

Parameter	Rationale for Selection	Linkage to EA Report Guidelines or Other Regulatory Drivers	Baseline Data for EA
Air temperature	• Influences, type of precipitation, evaporation and snowmelt rate • Influences dispersion of air emissions	• Requirement in EA Report Guidelines • Identified in Biophysical Workplan	• Field data • Regional data
Precipitation (snowfall and rainfall: mean daily, monthly, and annual; peak and drought)	• Controlling input to site hydrology and water balance • Required for water management facilities design • Influences surface erosion • Influences natural hazards (landslides, avalanches, floods)	• Requirement in EA Report Guidelines • Identified in Biophysical Workplan	• Field data • Regional data
Snowpack depth and snow water equivalent	• Influences runoff • Can influence operability of mine operations, growing season, wildlife migration, and avalanche risk	• Requirement in EA Report Guidelines • Identified in Biophysical Workplan	• Field data • Regional data
Wind velocity and wind direction	• Can influence evaporation and controls snow drifting • Affects dispersion of dust and air emissions	• Requirement in EA Report Guidelines • Identified in Biophysical Workplan	• Field data • Regional data
Relative humidity	• Affects evaporation and site hydrology	• Requirement in EA Report Guidelines	• Field data
Solar radiation	• Affects evaporation	• Requirement in EA Report Guidelines	• Calculated from latitude of minesite • Field data

Figure 7.1-1 Climate – Local Study Area (Vol. 2)

Regional Study Area

The RSA for climate is defined by the location of the three Environment Canada regional climate stations within the Liard Basin, located at Watson Lake, Tuchitua and Hour Lake (Figure 7.1-2). Additional regional data is available from the Yukon Government's annual snow surveys. The RSA is approximately 20,000 km².

Figure 7.1-2 Climate – Regional Climate and Hydrology Stations (Vol. 2)

7.1.2 Baseline Conditions

7.1.2.1 Methods

Regional Data

Regional climate data is available from three Environment Canada stations located within the Liard Basin. Watson Lake is located 175 km south-southeast of the project, at an elevation of 687 m asl Climate data is available for the period 1938-2005. Tuchitua is located 80 km southeast of the project, at an elevation of 724 m asl Climate data is available for the period 1971-2004. Hour Lake is located 60 km east-southeast of the project at an elevation of 890 m asl Climate data is available for the period 1982-2004.

These three stations are sited in valley bottoms and range from 500 m to 900 m lower in elevation than the project site. They are not fully representative of the climate at the project site, which is located in the upland region of the Pelly Mountains. Therefore, interpretation of regional climatic data to characterize conditions in the project area was tempered by the data collected on site. Wherever possible, regional data was corrected for the effects of location and elevation to generate expected conditions at the project.

On-site Data Collection

Baseline data collection began at the project site in 1996 and has continued intermittently to the present. In 1996 and 1997, and again for portions of 2000 and 2001, some automated data was collected at a location near the exploration camp site on Wolverine Lake.

Beginning in October 2004, continuous data has been collected by an automated weather station located adjacent to the project site airstrip (Figure 7.1-1; Figure 7.1-3). The weather station is located approximately 500 m northwest of the western corner of the airstrip and 2 km southeast of the underground mine portal at an elevation of 1325 m. The automated station consists of several instruments and a data logger. The station measures rainfall, air pressure, solar radiation, wind speed and wind direction, air temperature, and relative humidity. Data from the instruments is recorded by the data logger and is manually downloaded to a computer several times per year.

Figure 7.1-3 Automated Weather Station Located Near Airstrip

This weather station will remain in continuous operation during mine construction, operation and decommissioning. Following mine decommissioning, the automated station will be removed.

7.1.2.2 Results

Overview

The project is at latitude 61º25’ N, longitude 130º07’ W in the Campbell Range of the Pelly Mountains, 280 km east-northeast of Whitehorse. The underground mine is located in a southeast-northwest oriented pass between two valley systems at an elevation of 1350 m asl, near treeline.

To the west of the underground mine, Wolverine Creek flows to Little Wolverine Lake, dropping 200 m elevation in 3 km. The Wolverine-Little Wolverine lake system is oriented roughly southwest-northeast and approximately 10 km long. Nougha Creek drains Wolverine Lake north to join Finlayson River. To the southeast of the underground mine, the headwaters of Go Creek flow southeastwards to join Money Creek. To the north of the mine, steep valley slopes climb to open alpine ridges with a summit elevation of 1750 m. To the south and southwest of the mine, across the Wolverine-Go pass, there is a low alpine ridge with a summit elevation of 1530 m; the far side of this ridge drops away to Little Jimmy Lake, at an elevation of 1150 m.

The project area has a south to southwestern aspect. The pass in which the mine is located is a subsidiary saddle on the valley wall; the main pass between the drainages is located between Little Jimmy Lake and Wolverine Lake. The position of the project site in relation to the major valleys, the site elevation and the south-facing aspect, largely determine the prevailing winds, temperature and solar radiation.

The climate at the project site is typical of its location and position. In general, summers are characterized by unstable air, thunderstorms, and frequent rainfall. Winters are cold and dry. Winter conditions begin in October and last through April. Late April and May are the driest months of the year and constitute spring. Summer lasts from June to August and is the wettest season of the year. The shortfall period consists of late August through September.

Temperature

Temperatures at the project site were characterized from the field data recorded in 1996-1997, 2000-2001, and 2004-2005. The data collected in 1996-1997 and 2000-2001 at the exploration camp site (elevation 1150 m asl) was corrected for elevation using an environmental lapse rate (Kushnir 2000) of 1ºC/100 m for winter conditions and 0.6ºC/100 m for summer conditions. The mean annual temperature at project site is –3.5ºC and there is a strong seasonal temperature variation. Mean monthly temperatures are below freezing between October and April, and above freezing from May through September (Figure 7.1-4). The minimum recorded winter temperature is -36ºC and the maximum recorded summer temperature is 31ºC. There are anecdotal reports from workers overwintering at the site of temperatures as low as -70ºC.

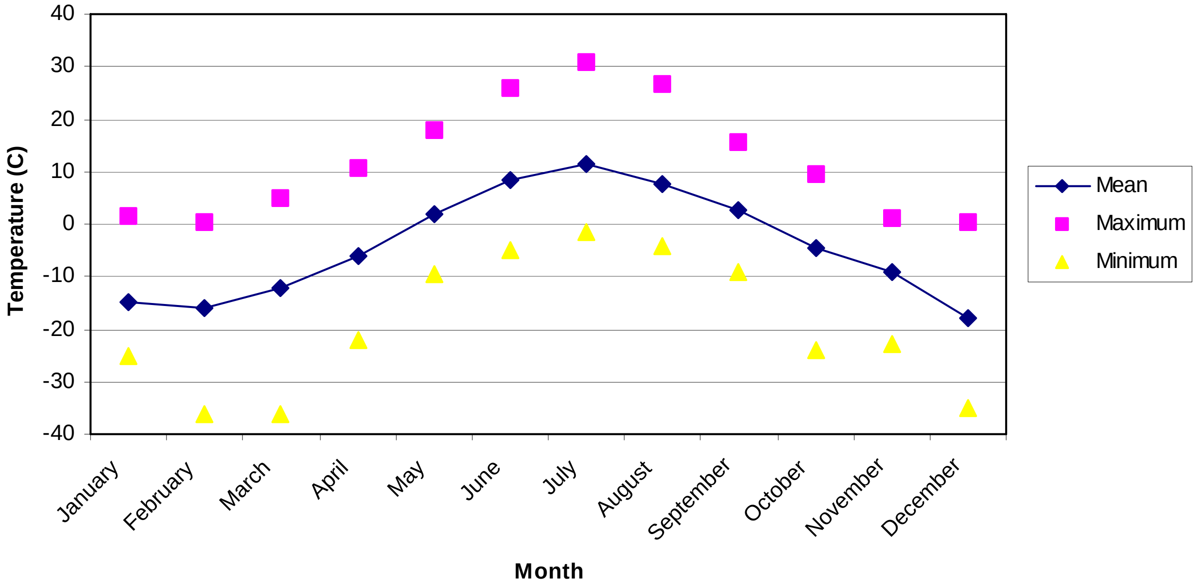

Figure 7.1-4 Mean, Maximum and Minimum Temperatures (°C) by Month – Wolverine Project

Generally, the temperatures recorded at the project site are comparable to the temperatures recorded at the regional stations, if the regional stations are corrected for the elevation difference. The extreme minimum temperature recorded at Watson Lake is –59ºC, in January 1947; corrected for elevation, this would be -77ºC at the project site, suggesting that the anecdotal accounts of temperature may be valid.

Precipitation

Mean Annual Precipitation

The three regional climate stations have mean annual precipitation totals ranging from 418 mm at Watson Lake, to 514 mm at Hour Lake. Mean annual precipitation increases with elevation (the orographic effect); therefore, the mean annual precipitation at the project site should be higher than at any of the three regional stations.

Precipitation data collected at the project site is available for only the summer of 2005, and portions of the summer of 1996 and 1997. Although this is insufficient to directly determine the mean annual precipitation at the project site, it is possible to compare the recorded precipitation at the site for the periods of record, to the recorded precipitation at the regional stations for the same periods. Such a comparison indicates that monthly precipitation recorded at the site varies from 52% to 165% of precipitation recorded at regional stations. There is a weakly positive trend (higher precipitation at the project site than at regional stations) as might be expected because of the orographic effect; however, the data are too limited to provide definitive conclusions.

The *Rainfall Atlas of Canada* (Bruce 1968) and an Oregon State University reference for Yukon and Alaska[2] both indicate that mean annual precipitation at the project site is expected to be in the range of 500-600 mm. Mean annual precipitation at the project site has therefore been estimated at approximately 550 mm. As noted below, this estimated value is consistent with other observations.

Mean Monthly Precipitation

There are several scenarios whereby the precipitation at the project site could be higher than at the regional stations. Precipitation could be higher evenly throughout the year, higher in winter but not in summer, higher in summer but not in winter, or higher at some times but not others in a manner that is more complex than a simple seasonal variation. Regional data indicate that the trend in increased precipitation with elevation is most pronounced in summer and is weak or nonexistent in winter. This supports the third scenario; that is, precipitation at the project site is higher than at the regional stations in summer, but similar to the regional stations during the winter.

When the regional data for summer precipitation is adjusted to account for increase elevation at the project site, the projected net summer precipitation at the site is roughly 25% higher than the regional summer mean, while the net winter precipitation remains similar to the regional winter mean. The results of this seasonal scaling are presented in Table 7.1-2. Additionally, the mean annual precipitation found by summing the mean monthly precipitation totals is 548 mm, essentially identical to the 550 mm estimate determined from regional precipitation mapping.

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[2] http://www.ocs.oregonstate.edu/pub/maps/Precipitation/Total/States/AK/ak_ppt.gif (accessed August 15, 2005)

Seasonal Precipitation Trends

As is shown in Table 7.1-2, mean monthly precipitation is greatest in July and lowest in April. Approximately 320 mm, or 58% of annual precipitation falls during the May-September period as rain or non-accumulating snow. Precipitation which falls between October and April forms the winter snow pack. When examining Table 7.1-2, note that a conversion factor of 10:1 (1 cm of snow = 1 mm of precipitation), as used by Atmospheric Environment Service (AES), can be applied to estimate the snowfall in centimeters. For instance, the mean monthly precipitation at the project site for March is 21 mm. This is equivalent to 21 cm of snowfall

The high summer precipitation and low winter precipitation characterize the continental climate of the southeastern Yukon. High pressure cells and cold temperatures dominate the winter months, leading to extended periods of low precipitation. In summer, thermal instabilities resulting from seasonal heating result in frequent convective storms (thunderstorms).

Annual and Monthly Precipitation

Gartner Lee Ltd. (2004) conducted a frequency analysis of the regional climate data in order to determine the variability of mean monthly and mean annual precipitation for a range of return periods. This frequency analysis determined the ratio of annual precipitation to mean annual precipitation that occurs for a given return period. For instance, precipitation in a 1-in-10 year wet year is approximately 25% greater than in a normal year. These ratios have been applied to the mean annual and monthly precipitation figures in Table 7.1-2 to provide estimates of monthly and annual precipitation for return periods ranging from a 1-in-100 dry year to a 1-in-10,000 year wet year.

Hourly and Daily Rainfall

Daily rainfall values over the period of record are available from the Watson Lake and Tuchitua regional stations. At Tuchitua, some periods of data are missing, but not enough to significantly affect the analysis. The Environment Canada program Consolidated Frequency Analysis (CFA) was used to conduct a frequency analysis by fitting the data to several statistical distributions. The daily rainfall records were determined by the program to be strongly bimodal[3]; therefore, the Wakeby and nonparametric distributions were chosen to fit to the data as they provide better fits to bimodal distributions than do distributions such as Generalized Extreme Value or triple-lognormal. Both Wakeby and nonparametric distributions gave similar goodness of fits for the two stations. The results from the two were therefore averaged to estimate maximum daily (24-hour) rainfall intensities for various return periods.

Regional one-hour rainfall intensities for a range of return periods were calculated using data from the maps in the Rainfall Atlas of Canada (Bruce 1968) and the equations given in Alila (2000).

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[3] The cause of the bimodality in the data was not determined and is not directly relevant in any case. It could result from El Nino vs. non-El Nino years, from a difference in precipitation between cyclonic storms and convective storms, or from other reasons.

Table 7.1-2 Frequency Analysis of Monthly and Annual Precipitation at the Wolverine Project Site – Dry and Wet Years

Return Period (years)	1 in 100 Year Dry	1 in 25 Year Dry	1 in 10 Year Dry	Average Year	1 in 10 Year Wet	1 in 25 Year Wet	1 in 100 Year Wet	1 in 1000 Year Wet	1 in 10,000 Year Wet
Ratio of annual precipitation to mean annual[4]	0.509	0.639	0.74	1.00	1.255	1.344	1.451	1.595	1.75
Month									
Jan	18.3	23.0	26.6	36	45.2	48.4	52.2	57.4	63
Feb	14.3	17.9	20.7	28	35.1	37.6	40.6	44.6	49
Mar	10.7	13.4	15.5	21	26.4	28.2	30.5	33.5	36.8
April	10.2	12.8	14.8	20	25.1	26.9	29	31.9	35
May	24.4	30.7	35.5	48	60.2	64.5	69.6	76.6	84
Jun	35.1	44.1	51.1	69	86.6	92.7	100.1	110.0	120.8
July	41.7	52.4	60.7	82	102.9	110.2	119	130.8	143.5
Aug	31.6	39.6	45.9	62	77.8	83.3	90	98.9	108.5
Sept	29.0	36.4	42.2	57	71.5	76.6	82.7	90.9	99.8
Oct	22.9	28.8	33.3	45	56.5	60.5	65.3	71.8	78.8
Nov	20.4	25.6	29.6	40	50.2	53.8	58	63.8	70
Dec	20.4	25.6	29.6	40	50.2	53.8	58	63.8	70
Annual	278.9	350.1	405.5	548	687.7	736.5	795.1	874.1	959

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[4] From Gartner Lee Ltd. (2004)

As neither one-hour nor 24-hour rainfall intensity vary significantly with elevation over the regional scale, these calculations should be representative of the expected maximum rainfall for the given durations and return periods at the project site and do not need to be corrected for the location of the project site relative to regional climate stations. Expected one-hour and 24-hour rainfall values are presented in Figure 7.1-5.

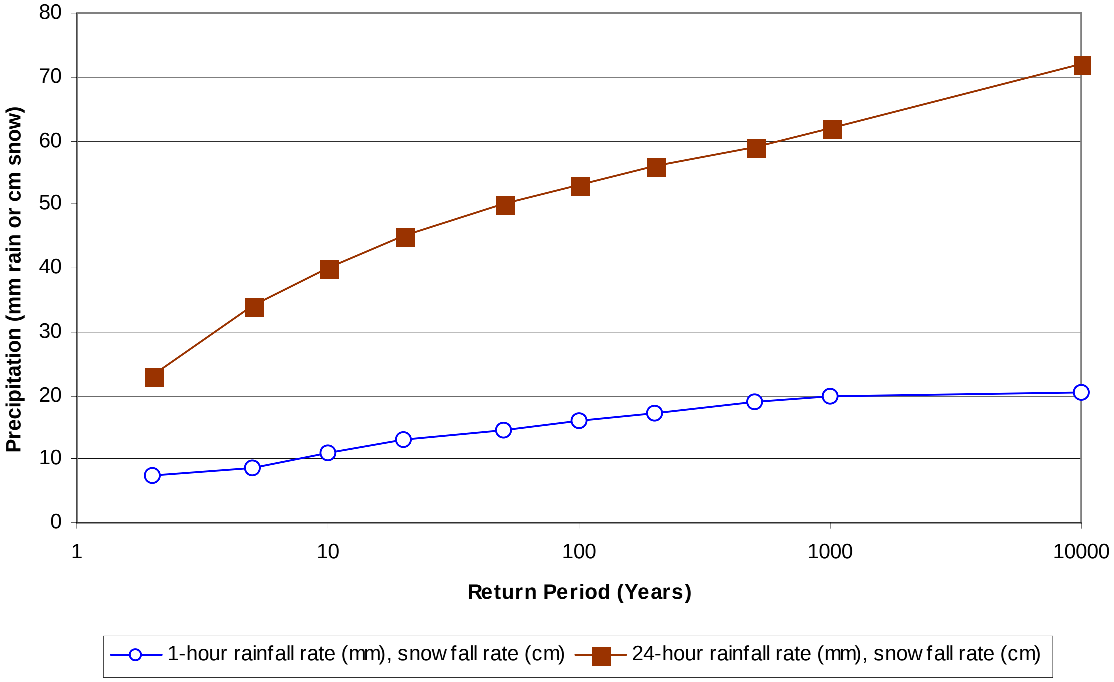

Figure 7.1-5 Hourly and Daily Extreme Precipitation - Wolverine Project Site

Hourly and Daily Snowfall

Because there are gaps in the daily data for winter precipitation at the regional stations, the 24-hour snowfall cannot be accurately determined using the frequency analysis method used for rainfall. No on-site data has been collected for daily or hourly snowfall values at the project site. Because net summer precipitation (rainfall) is greater than net winter precipitation, conversion of the 24-hour and daily rainfall values will provide a conservative estimate (overestimate) of extreme snowfall events. However, in the absence of other data, the values given for millimeters of rainfall in Figure 7.1-5 can be converted to centimeters to provide a conservative estimate of daily and hourly snowfall for various return periods.

Snowpack

Snowpack Depth and Snow Water Equivalent

Snowpack accumulates from October through March at the project site. Snow may fall in other months of the year but mean temperatures are high enough to ensure that snowfall will melt rather than accumulate.

Fresh snow in cold climates is dry and light. If melted, one centimeter of fresh snow produces only one millimeter of water – a 10:1 snow water equivalent. Snow on the ground undergoes changes as it ages. It is compacted by wind and by further snowfall on top of it. Warming and cooling cycles promote changes in snow crystal form, changing the snow from flakes to granules that pack more tightly. The snow water equivalent of old snow is approximately 5:1 (McClung and Schaerer 1993).

Few measurements of snow water equivalent have been made at the project site. Anecdotal reports from workers overwintering at the site report a maximum snow depth of approximately 1 m at undrifted locations. One on-site measurement, in early March 1997, found a snow water equivalent of 128 mm but did not record an associated snowpack depth. The peak snowpack in the average year will occur in late March or early April, immediately before spring warming begins.

Yukon Government snow surveys for the Liard Basin[5] indicate that mean annual snowpack in the Liard Basin is in the range of 150-175 mm snow water equivalent. Using the 5:1 conversion factor for old snow, this would be equivalent to a snowpack depth of 0.75-0.88 m. However, because little total precipitation occurs in late March and April, the snowpack may continue to age and consolidate through this period with few inputs. In this case, the peak snowpack depth would not necessarily occur at the same time as the peak snow water equivalent, but rather earlier in the winter, when the snow water equivalent would have a value between the 10:1 value for new snow and the 5:1 value for old snow. This suggests that the mean annual peak snowpack depth at the project site is probably 1.0 m or greater.

Some snow on the ground melts as a result of heating from below, even in cold climates. Additionally, some snow in the upper snowpack sublimates (evaporates) and returns to the atmosphere as water vapour. For these reasons, the net snow water equivalent of the snowpack throughout the season is lower than the sum of the snowfalls that have occurred. Mean winter precipitation (October-April) from Table 7.1-2 totals 230 mm. This indicates that approximately two-thirds to three-quarters of the winter precipitation accumulates, while approximately one-third to one-quarter is lost to melt or sublimation during the winter.

Frequency Analysis of Annual Snowpack

To estimate the expected snow water equivalent under conditions from a 1-in-1000 year dry year to a 1-in-10,000 year wet year, the regional frequency analysis of annual precipitation (Gartner Lee Ltd. 2004; Table 7.1-2) was applied to snowpack depth and snow water equivalent. The results are given in Table 7.1-3. It should be noted that the maximum snow water equivalent would occur later in the year in the case of a wet year, and earlier in the year in the case of a dry year. Cold temperatures and heavy snowfall both contribute to increased snowpack and snow water equivalent. Therefore, it should be expected that the extreme dry year snowpacks are a result of both light precipitation and warm temperatures. In dry years, the snowpack will reach maximum snow water equivalent early in the year (e.g., early March) and could melt away as soon as early May. Extreme wet year snowpacks are the result of heavy winter precipitation and cold spring temperatures which delay melt. These deep snowpacks could peak in late May and continue to melt through July and even into August.

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[5] http://www.environmentyukon.gov.yk.ca/pdf/water_forcast(1).pdf (accessed August 25, 2005)

Table 7.1-3 Frequency Analysis of Winter Snowpack

Return Period (year)	Mean Precipitation Ratio[6]	Maximum Snowpack Water Equivalent (low) (mm)	Maximum Snowpack Water Equivalent (high) (mm)
1000 year dry	0.327	49.1	57.2
100 year dry	0.509	76.4	89.1
25 year dry	0.639	95.9	111.8
10 year dry	0.74	111	129.5
Average year	1.00	150	175
10 year wet	1.255	188.3	219.6
25 year wet	1.344	201.6	235.2
100 year wet	1.451	217.7	253.9
1000 year wet	1.595	239.3	279.1
10,000 year wet	1.75	262.5	306.3

Wind Velocity and Direction

Winds observed at the project site blow primarily from the north, northeast and east (Figure 7.1-7), and can be explained by local topography. The climate station is located east of the Wolverine Creek-Go Creek pass (a northwest-southeast oriented valley) at the northwest corner of the airstrip, near the mouth of the Go Creek headwater drainage, a tributary valley oriented northeast-southwest. The combination of valley winds across the pass and from the tributary valley explains the observed wind directions. In general, sustained windspeeds are less than 30 km/h (16 knots/hr), with occasional gusts not exceeding 45 km/h (24 knots/hr) (Figures 7.1-6 and 7.1-7). At the exploration camp site, the primary wind direction is from the northwest, along the lake (Gartner Lee Ltd. 2004).

It is likely that the wind speed and direction collected at the automated airstrip station do not accurately represent the conditions at the underground mine portal. As mentioned, the climate station is located at the junction of upper Go Creek and the main Wolverine-Go Creek valleys. Northeast outflow winds from the upper Go Creek valley dominate the recorded winds but are unlikely to occur near the mine portal. Northwest and southeast winds blowing across the pass are the most likely to occur at the portal site. Likewise, it appears that the wind speeds recorded at the airstrip are significantly lower than wind speeds recorded at the exploration camp (Gartner Lee Ltd. 2004); the climate station at the airstrip may be sheltered from winds blowing across the pass.

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[6] Gartner Lee Ltd. (2004)

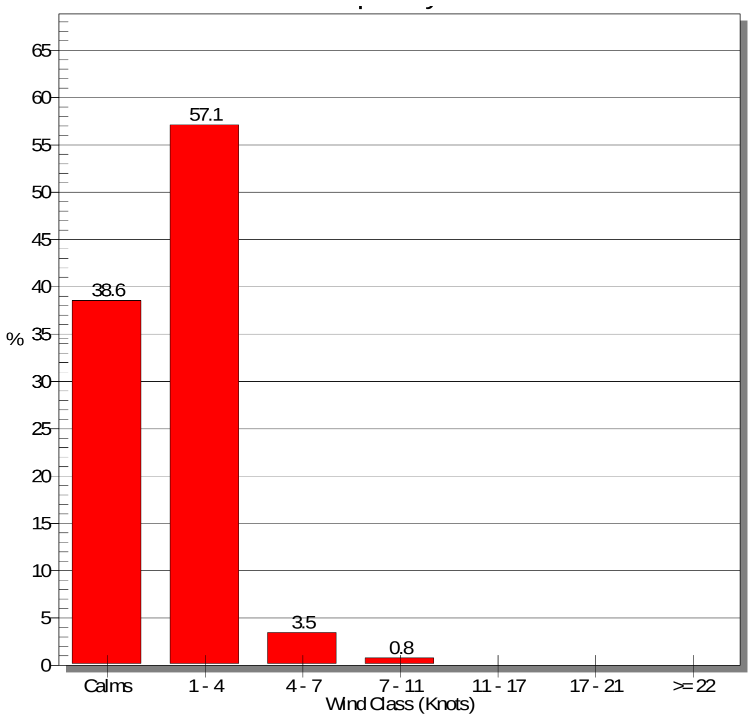

Figure 7.1-6 Wind Class Frequency Distribution

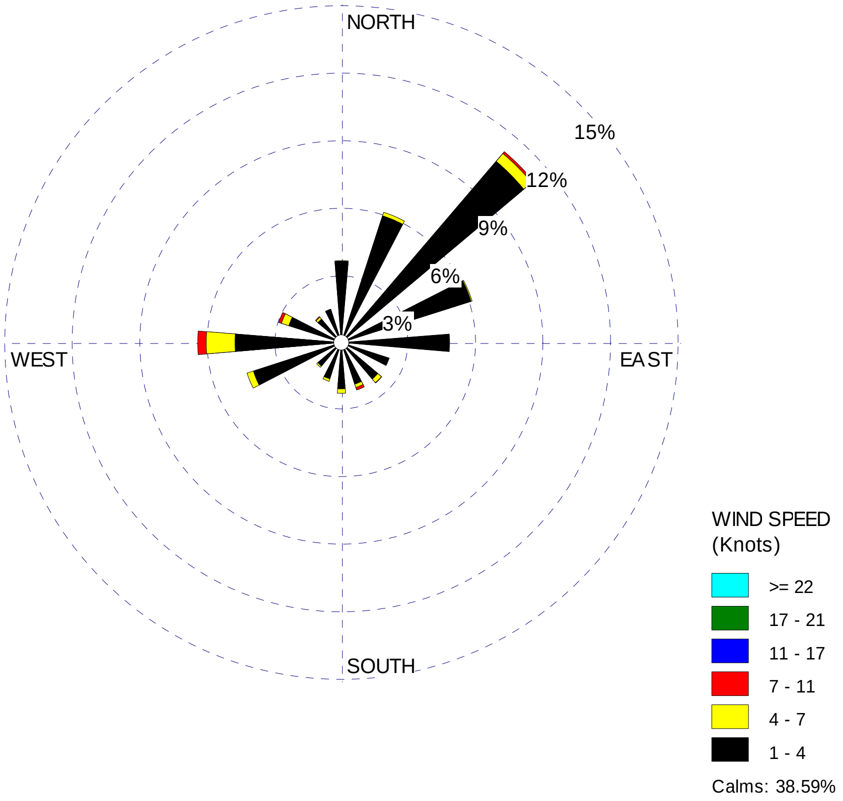

Figure 7.1-7 Wind Speed and Direction at the Project Site

Relative Humidity

Relative humidity data is available from the automated weather station and Gartner Lee Ltd. (2004) summarized earlier relative humidity data collected at the exploration campsite.

In general, the diurnal variation in relative humidity is much greater than the weekly or even monthly variation. The highest relative humidity typically occurs during the cool period before dawn; the lowest relative humidity occurs close to or shortly after noon, when daytime solar heating is at maximum.

Relative humidity records vary between a low of 12% and a high of 100%. The mean relative humidity recorded at the automated airstrip station is 66%; the mean relative humidity recorded at the exploration camp during 1996-1997 was 74%. This higher mean relative humidity at the exploration camp is possibly due to the camp's location close to Wolverine Lake.

Solar Radiation and Insolation

Net solar radiation was recorded at the automated weather station. The maximum value recorded was 1065 watts/m^2 on June 23, 2005. At night, infrared radiation from nearby trees provides a minimum of 0.6 w/m^2. Because of the site's southern aspect and position part way up a south facing slope, there are few obstacles to shade the climate station, so the amount of solar radiation received is in general similar to what would be predicted[7] given the site's latitude.

7.1.3 Effects Assessment Methodology

As noted in Section 7.1.1, any project effects on climate will be at a micro-climatic scale. In accordance with Section 6, those effects that will occur have been characterized according to the effects attributes definitions in Table 7.1-4.

Determination of Effects Significance

The significance of any residual project and cumulative effects will be determined based on the defined effects attributes, as follows:

A residual effect will be considered significant if it is:

- a moderate magnitude adverse effect that is far future in duration
- a high magnitude adverse effect unless it is local in geographic extent
- a high magnitude adverse effect that is local in geographic extent and far future in duration

Otherwise, effects will be rated as not significant.

In addition, as required by the EA Report Guidelines, the likelihood of occurrence of any significant adverse residual effects will be stated with a supporting rationale

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[7] http://solardat.uoregon.edu/SolarPositionCalculator.html (accessed September 19, 2005)

Table 7.1-4 Effect Attributes for Climate

Attribute	Definition
Direction	
Positive	Condition of VECC is improving
Adverse	Condition of VECC is worsening or is not acceptable
Neutral	Condition of VECC is not changing in comparison to baseline conditions and trends
Magnitude	
Low	Effect occurs that might or might not be detectable but is within the range of natural variability and does not compromise ecological, economic or social/cultural values
Moderate	Clearly an effect but unlikely to pose a serious risk to the VECC or represent a management challenge from an ecological, economic or social/cultural standpoint
High	Effect is likely to pose a serious risk to the VECC and represents a management challenge from an ecological, economic or social/cultural standpoint
Geographic Extent	
Site-specific	Effect on VECC confined to a single small area within the Local Study Area
Local	Effect on VECC within Local Study Area
Regional	Effect on VECC within Regional Study Area
Duration	
Short term	Effect on VECC is limited to the <1 year
Medium term	Effect on VECC occurs between 1 and 4 years
Long term	Effect on VECC lasts longer than 4 years, but does not extend more than 10 years after decommissioning and final reclamation
Far future	Effect on VECC extends >10 years after decommissioning and abandonment
Frequency (Short term duration effects that occur more than once)	
Low	Effect on VECC occurs infrequently (< 1 day per month)
Moderate	Effect on VECC occurs periodically (seasonal or several days per month)
High	Effect on VECC occurs frequently throughout the year (weekly)
Reversibility	
Reversible	Effect on VECC will cease to exist during or after the project is complete
Irreversible	Effect on VECC will persist during and/or after the project is complete
Likelihood of Occurrence	
Unknown	Effect on VECC is not well understood and based on potential risk to the VECC, effects will be monitored and adaptive management measures taken, as appropriate
High	Effect on VECC is well understood and there is a high likelihood of effect on the VECC as predicted

7.1.4 Project Effects

Effects of the project on climate will be limited to the effects of vegetation clearing and project-related structures on localized wind exposure, speed and direction; deposition of precipitation; solar radiation; etc., and effects of project site and access road snow plowing and compaction on snowpack, melt rate and water content. These effects will commence early in the construction phase and continue with the same intensity to the end of decommissioning. At closure, effects associated with project site structures will cease; however, localized effects due to site clearing will persist until vegetation re-establishes on reclaimed areas.

The project will have very little effect on air temperature, precipitation, wind direction and velocity, solar radiation and relative humidity because the controlling forces on these parameters are regional to global in scale. Any effects would be neutral, low magnitude, site-specific, short term and of moderate frequency (seasonal). Most effects are reversible, though some (e.g., associated with access road clearing and operation) are functionally irreversible. The likelihood of effects occurring as predicted is high.

The project will have localized effects on snowpack depth, snow water equivalent and snowmelt rate. Road plowing, compaction of snow by mine machinery, and the deposition of windblown dust will result in localized increases and decreases in accumulation or melt rate. These effects can be characterized as both positive and adverse in terms of linkages to other VECCs. Compacted snow will have a lower snowpack depth, but a higher snow water equivalent than uncompacted snow. Changes in snowmelt rate are discussed in Section 7.4: Surface Water Hydrology.

In summary, the effects of the project on snowpack depth, snow water equivalent and snowmelt rate will be positive to adverse, of low magnitude (while measurable on a site-specific scale it will not affect average snowpack depth, snow water equivalent or melt rate in affected stream basins), site-specific, short term, and of moderate frequency (seasonal). Most effects are reversible, though some (e.g., associated with access road operation) are functionally irreversible. The likelihood of effects occurring as predicted is high.

Residual Project Effects and Significance

As noted above any effects of the project on climate parameters will be very localized and well within the range of natural variability for these occurrences. Based on the criteria defined in Section 7.1.3, predicted effects of the project on climate parameters are considered to be not significant.

7.1.5 Cumulative Effects

Residual project effects are very localized and there are no additional activities in the foreseeable future which would contribute to cumulative effects on climate on a local or regional scale. Therefore, there will be no significant adverse cumulative or residual cumulative effects in the project area. The likelihood of occurrence of effects as predicted is high.

7.1.6 Mitigation Measures

There will be no significant effects of the project on climate parameters; therefore, no mitigation measures are proposed.

7.1.7 Monitoring and Follow-up

Data collection at the climate station will continue during the construction, operation, and decommissioning of the mine. It is recommended that the climate station be moved to a suitable site, to obtain wind speeds and directions that are more generally representative of the project site. Possible new locations are at the mine portal and processing area, or at the tailings facility. The accuracy and quality of field climate data will improve as the period of record increases in duration.

A dedicated snow course monitoring program will be installed, with monthly or weekly measurement of snowpack depth and snow water equivalent, to improve site specific data on winter precipitation and to refine site water balances. Follow-up and monitoring programs are summarized in Table 7.1-5.

Table 7.1-5 Monitoring Programs for Climate

Program	Program Objectives	General Methods	Reporting	Implementation
Follow-up and Monitoring Programs				
Climate station data collection	• Confirm the accuracy of the climate characterization • Detect climatic trends and continue data baseline	• Automated data collection with periodic downloads as required	• Internal • Data could be shared with Yukon Territorial Government, AES, or other interested parties if desired	Proponent
Snow course installation	• Measure snowpack depth and snow water equivalent at project site • Refine estimates of winter precipitation and snowpack contributions to site hydrology (Section 7.4)	• Manual data collection on monthly or periodic basis for snowpack depth and snow water equivalent	• Internal • Annual to Yukon Snow Survey (if desired)	Proponent

7.1.8 Summary of Effects

Effects of project and cumulative effects on climate are summarized in Table 7.1-6.

Table 7.1-6 Summary of Effects on Climate

Potential Effect	Level of Effect[1]						Effect Rating[2]	
	Direction	Magnitude	Extent	Duration/ Frequency	Reversi-bility	Likelihood	Project Effect	Cumulative Effect
Construction, Operations and Decommissioning								
Localized increases in snowpack depth, water content and melt rate	Positive to adverse	Low	Site-specific	Short term, seasonal	Reversible to irreversible (ongoing access road use)	High	Not significant	Not significant
Localized changes in wind speed and direction, precipitation deposition, and solar radiation due to site clearing and project structures	Neutral	Low	Site-specific	Short term, seasonal	Reversible to irreversible (ongoing access road use)	High	Not significant	Not significant
Closure								
Ongoing localized effects of clearing and snow plowing on wind, solar radiation and snowpack	Positive to adverse	Moderate	Site-specific	Short term, seasonal	Irreversible	High	Not significant	Not significant

Notes:
1 Based on criteria in Table 7.1-4
2 Based on criteria in Section 7.1.3