Information Request 18

Responses to Information Request 18

IR 18 – Lake Productivity – Climate Change

References:

EIS Guidelines, Section 2.7.2.4
EIS Appendix 2.7.2.4A-A (Lake Level Fluctuation Predictions for Fish Lake)

Related Comments:

CEAR # 277 (Fisheries and Oceans Canada)
CEAR # 302 (Canadian Science Advisory Secretariat)
CEAR # 292 (Environment Canada)

Rationale:

Fisheries and Ocean Canada (DFO) has indicated that the future effects to water availability from climate change on the nutrient status, thermal regimes, and productivity of Fish Lake has not been adequately assessed in the climate change assessment. According to DFO, the climate change assessment has negated any impacts of climate change on the Fish Lake watershed in the past century by referencing temperature and precipitation time series from the meteorological records at Barkerville, British Columbia. DFO has questioned the representativeness of the Barkerville station data for characterizing the climatic conditions at Fish Lake, as it is located approximately 230 km northeast of Fish Lake and is within the Sub-Boreal Ecoprovince, a biogeoclimatically-distinct region from the Central Interior Ecoprovince, where Fish Lake is situated.

DFO also noted that the Proponent did not consider changes in seasonal temperature patterns in its analysis, despite the critical influence of changing seasonality on lake stratification and ice cover, which are key drivers of lake and fisheries productivity in northern-temperate lakes

Information Requested:

To gain a better understanding of the possible effects of climate change, the Panel requests that Taseko:

a) Provide additional information on the current and future impacts of climate change and increased seasonal variability on the hydrology and hydrochemistry of the Fish Lake watershed to fully assess the adequacy of the habitat and fish productivity and water quality and quantity models.

b) Provide a rationale why climate data from a closer meteorological station was not used (e.g. Nemiah Station).

Information Request #18a

Provide additional information on the current and future impacts of climate change and increased seasonal variability on the hydrology and hydrochemistry of the Fish Lake watershed to fully assess the adequacy of the habitat and fish productivity and water quality and quantity models.

Response Summary

A review of historical climate data for the past 100 years would indicate that there is no basis for assuming any material change in temperature or precipitation in the region within the time frame of project development and closure.

Increased climate variability has already been accounted for in the estimates associated with surface water stream flow volumes.

The water management system designed for the project mitigates potential pathways for unexpected climate change that could affect water flow, level, and temperature related to Fish Lake.

No hydrochemistry related changes in water quality from a hypothetical climate change scenario are anticipated.

Discussion

A review of historical climate data for the past 100 years would indicate that there is no basis for assuming any material climate change in the region within the time frame of project development and closure (KP, 2012).

Based on an analysis of regional temperature, precipitation and streamflow data, trends of regional stations indicate that changes in precipitation and temperature will not cause substantial changes to surface water streamflow volumes outside the natural variability of systems in British Columbia. The regional climate change analysis is described in full in Appendix 2.7.2.4A-D.

Climate change could potentially have effects to the surface water stream flow with an increase in variability. However, these potential effects have already been accounted for in the estimates associated with surface water stream flow volumes by including the variability that has been seen over the past several decades. In the event that unexpected climate change does manifest in a way that has a material impact on the hydrology or water temperature of the Fish Creek watershed, the following rationale is applicable:

The project design enhances pre-development flows in the lower reaches of upper Fish Creek, which has been demonstrated to support the quantity and quality of fish habitat required, considering the changes to the overall fish habitat of the watershed. Furthermore, the project design maintains the water level in Fish Lake to within baseline variability, effectively mitigating the effect of potential variability. i.e. if there are changes in precipitation/temperature outside the

historic natural variability, the water management system of the project will allow maintenance of baseline stream flows and lake levels, effectively mitigating the effects of any increased variability.

The two potential pathways for climate change to affect water temperatures are recirculation of the lake water to the inlets, as well as a reduction in forest cover of the upstream catchment that is the source of water for the inlets of Fish Lake. The intake system for the Fish Lake recirculation system has the ability to extract water at different depths of the water column (i.e. warmer water on top; cooler water at depth). Secondly, under baseline conditions, the spring melt brings a flush of cool water into the lake, which then flows into lower Fish Creek. Under the project design, this water is recirculated, which would ultimately see a lengthening of the time period when cool water enters the lake. Eventually, as the ice melts and the summer temperatures warm the lake surface, the recirculated water will warm, which is when the pumping intake system can begin to pump cooler water from depth. The water management system, therefore, mitigates these potential pathways for climate change affecting the water temperatures and related aspects of Fish Lake.

With respect to hydrochemistry the only potential adverse effect that could be attributed to climate change would be under a scenario of reduced precipitation resulting in reduced inflows of both non-contact and contact water to Fish Lake. As the majority of contact water reporting to Fish Lake in the long-term (i.e. in Post-closure) is surface water discharge from the TSF, any relative decrease in both contact and non-contact water reporting to Fish Lake can be considered constant. Therefore, no change in water quality under this climate change effect scenario is likely.

References

Taseko Mines Limited (2012). *New Prosperity Gold-Copper Mine Project Environmental Impact Statement*.

Knight Piésold (2012). *New Prosperity Project – Climate Change Assessment*. Ref no. VA12-01495, August 12, 2012.

Information Request #18b

Provide a rationale why climate data from a closer meteorological station was not used (e.g. Nemiah Station).

Response Summary

The assessment of the effects of potential climate change considers long-term regional climatic trends, outside the natural local climate variability and cyclical climate patterns. As a result it is necessary to look at long climate records to discern climate change patterns because short records are more susceptible to influence from regional climate cycles.

The Nemiah climate station is located approximately 15km from Fish Lake. However, this station does not collect winter precipitation data and only has historical climate information dating back to 1982. The short period of record and lack of winter data preclude its usefulness for assessing long-term regional climatic trends for the project.

The climate station at Williams Lake was identified as the nearest long-term climate station in the Central Interior Ecoprovince. It is located approximately 135 km northeast of the project but has only 52 years of complete precipitation and temperature record, from 1961 to 2012.

Data from the regional climate station at Barkerville were used to assess climatic trends because this station has the longest historical climate record available for the general project region, with over 100 years of complete record (1885 – 2006).

The data from the Barkerville station was compared to the Williams Lake station for the period concurrent with the available Williams Lake data (1961 to 2006). The strong similarity between the sets of data trendlines, for both precipitation and temperature, supports the conclusion that the historical Barkerville data are more appropriate for assessing long term climate trends near Williams Lake, and subsequently for the Prosperity Project area.

Discussion

<u>Climate Trends</u>

Data from the regional climate station operated by Environment Canada (EC) at Barkerville (station ID 1090660) were used to assess climatic trends (KP, 2012) because this station has the longest historical climate record available for the general project region, with over 100 years of complete record (1885 – 2006). It is necessary to look at long climate records to discern climate change patterns because short records are more susceptible to influence from regional climate cycles. However, as identified by DFO, Barkerville is located within a different Ecoprovince than the Central Interior Ecoprovince where the project (and Fish Lake) is located, and accordingly, patterns detected there may not be directly applicable to Fish Lake. It should be noted that Barkerville is actually situated within the Southern Interior Mountains Ecoprovince,

not the Sub-Boreal Ecoprovince, as stated by DFO. Regardless, in light of DFO's comments and given the definition of an Ecoprovince as an area with consistent climatic processes, a climate station within the Central Interior Ecoprovince has been selected and used to provide a supplementary climatic trend characterization of the Fish Lake area.

The Nemiah climate station, as suggested by DFO, is located in close proximity to Fish Lake (~15 km). However, this station, which is operated by the British Columbia Forest Service (BCFS), does not collect winter precipitation data and only has historical climate information dating back to 1982. The short period of record and lack of winter data preclude its usefulness for assessing long-term regional climatic trends for the project. As an alternative, the climate station operated by EC at Williams Lake (station ID 1098940 and 1098941) was identified as the nearest long-term climate station in the Central Interior Ecoprovince, and accordingly its data were selected as the basis of a supplementary climatic trend analysis.

The Williams Lake station, located approximately 135 km northeast of the project, has 52 years of complete precipitation and temperature record, from 1961 to 2012. Trend plots of annual precipitation in Williams Lake over the period of record are shown on Figure 18B-1. Total annual precipitation, annual rainfall, and minimum monthly precipitation show increasing trends, while annual snowfall and maximum monthly precipitation show decreasing trends. Only the annual rainfall trend, however, is statistically significant at the 10% level (i.e. there is a 90% probability that this trend reflects a temporal change in the mean of the annual values, as opposed to a random pattern in the variable data). The other trends have lower significance levels. The annual rainfall trend shows an increase of 16 mm per decade, while annual precipitation only increases 10 mm per decade, given the decreasing trend of 6 mm per decade of annual snowfall (water equivalent). This pattern of increasing annual rainfall and decreasing annual snowfall is consistent with increasing winter temperatures, as noted throughout BC (Pike, *et al*., 2008a).

Trend plots of annual temperature in Williams Lake over the period of record are shown on Figure 18B-2. All of the temperature parameters demonstrate increasing trends, with both the annual mean temperature and the maximum monthly mean temperature statistically significant at the 10% level. The annual mean temperature generally increased at an average rate of +0.2°C per decade and the maximum monthly average temperature increased at a rate of +0.3°C per decade. Assuming the same rates of change, over the proposed 20 year mine life of the project, one might expect an increase in annual mean temperature of 0.4 °C, and over the proposed full mine life of 47 years, an increase of 0.9 °C. These values are relatively minor, particularly considering that the period used for the trend determination extends from a cold phase of the PDO to a warm phase, as discussed below, which would necessarily result in a positive trend.

Climate Cycles

As stated in the Barkerville climate analysis (KP, 2012), climatic trends in the project area are more likely related to the cyclical climate patterns observed throughout the Pacific-Northwest, as opposed to unidirectional climate change effects. The Pacific Decadal Oscillation (PDO) is thought to have the strongest signature on winter temperatures and precipitation in BC (Pike, *et al*., 2008a). The Williams Lake (1961-2012) climate record spans two PDO cycles: the 1961-1976 period is during a cool phase, and the 1977 to present period is during a generally warm phase, as shown on Figure 18B-3. Figure 18B-4 presents the average monthly precipitation data for Williams Lake, for the two PDO phases. The blue columns representing the 1961 to 1976 monthly data illustrate higher winter precipitation (December to March) than the red columns representing the 1977 to present data, which is consistent with cool versus warm PDO conditions (Pike *et al*., 2008a). The warm PDO phase (1977 – present), shown on Figure 18B-4, illustrates the increased precipitation (mostly rainfall) in the spring and summer months (May – August) and into the fall (September – October), consistent with a warm PDO phase. The increased precipitation is likely associated with increased convective storm activity, which is tied to increased atmospheric energy (temperature). These trends appear to be linked more to the multi-decadal PDO than to a unidirectional change in climate.

The Williams lake climate record started in a cool phase of the PDO and extended through a warm phase. Had the record started in the preceding warm phase and ended in a cool phase, then the temperature trends, at the very least, would likely have been reversed. The Barkerville climate record spans more than one PDO cycle, thereby reducing the likelihood of generating spurious results associated with climate cycles.

Williams Lake vs. Barkerville

To address the question of whether or not trends in the historical Barkerville data are applicable to the Prosperity Project area, trendline analyses were completed using Barkerville data for the period concurrent with the available Williams Lake data (1961 to 2006). The trends for precipitation and temperature are shown on Figures 18B-5 and 18B-6, respectively. The respective trends at the two sites are generally very similar, with the only notable exception being the annual precipitation trend, which is shown to be increasing for Williams Lake and decreasing for Barkerville, but neither trend is statistically significant at a 10% level. The strong similarity between the sets of trendlines, for both precipitation and temperature, supports the conclusion that the historical Barkerville data are appropriate for assessing climate trends near Williams Lake, and subsequently for the Prosperity Project area. Accordingly, the assessment previously presented in Appendix 2.7.2.4A-D of the 2012 New Prosperity EIS, which concluded that there has been little change in temperatures and slight increases in precipitation in the Project region over the past 100 years, is considered valid.

Conclusion

Data from the regional climate station at Barkerville were used to assess climatic trends because this station has the longest historical climate record available for the general project region, with over 100 years of complete record (1885 – 2006). It is necessary to look at long climate records to discern climate change patterns because short records are more susceptible to influence from regional climate cycles.

The Nemiah climate station is located in close proximity to Fish Lake but this station does not collect winter precipitation data and only has historical climate information dating back to 1982. The short period of record and lack of winter data preclude its usefulness for assessing long-term regional climatic trends for the project.

The climate station at Williams Lake is the nearest long-term climate station in the Central Interior Ecoprovince, located approximately 135 km northeast of the project. It has only 52 years of complete precipitation and temperature record, from 1961 to 2012. The data from the Barkerville station was compared to the Williams Lake station for the period concurrent with the available Williams Lake data (1961 to 2006).

Relatively minor trends of increasing annual rainfall, annual temperature, and maximum monthly temperature were identified in the Williams Lake climate record, but these appear to be linked more to the multi-decadal PDO than to a unidirectional change in climate.

The strong similarity between the sets of data trendlines, for both precipitation and temperature, indicate that long-term climate trends and cycles are regional in spatial scale and supports the conclusion that the historical Barkerville data are most appropriate for assessing long term climate trends near Williams Lake, and subsequently for the Prosperity Project area.

References

Pike, R.G., D.L. Spittlehouse, K.E. Bennett, V.N. Egginton, P.J. Tschaplinski, T.Q. Murdock, and A.T. Werner (2008a). *Climate Change and Watershed Hydrology: Part I – Recent and Projected Changes in British Columbia.* Streamline: Watershed Management Bulletin, Volume 11, Number 2, Spring 2008.

Pike, R.G., D.L. Spittlehouse, K.E. Bennett, V.N. Egginton, P.J. Tschaplinski, T.Q. Murdock, and A.T. Werner (2008b). *Climate Change and Watershed Hydrology: Part II – Hydrologic Implication for British Columbia.* Streamline: Watershed Management Bulletin, Volume 11, Number 2, Spring 2008.

Knight Piésold (2012). *New Prosperity Project – Climate Change Assessment*. Ref no. VA12-01495, August 12, 2012.

Information Request #18c

Consider changes in seasonal temperature patterns given the critical influence of changing seasonality on lake stratification and ice cover, key drivers of lake and fisheries productivity in northern-temperate lakes. Regional climate models should be incorporated into the estimations of water quantity and quality, and projected beyond the life of the mine.

Response Summary

The effects of any climate change on lake temperature and ice cover in respect of the project as proposed are no greater than, and likely less, than those that would be experienced in the absence of the project given the active water management that has been proposed.

The variability of the regional record over the last several decades has been incorporated into water flow and quality estimates for the project, and the water balance and water quality models have been run with this variability for a 100 year period.

Discussion

A review of historical climate data for the past 100 years would indicate that there is no basis for assuming any material effects of climate change in the region within the time frame of project development and closure (KP, 2012).

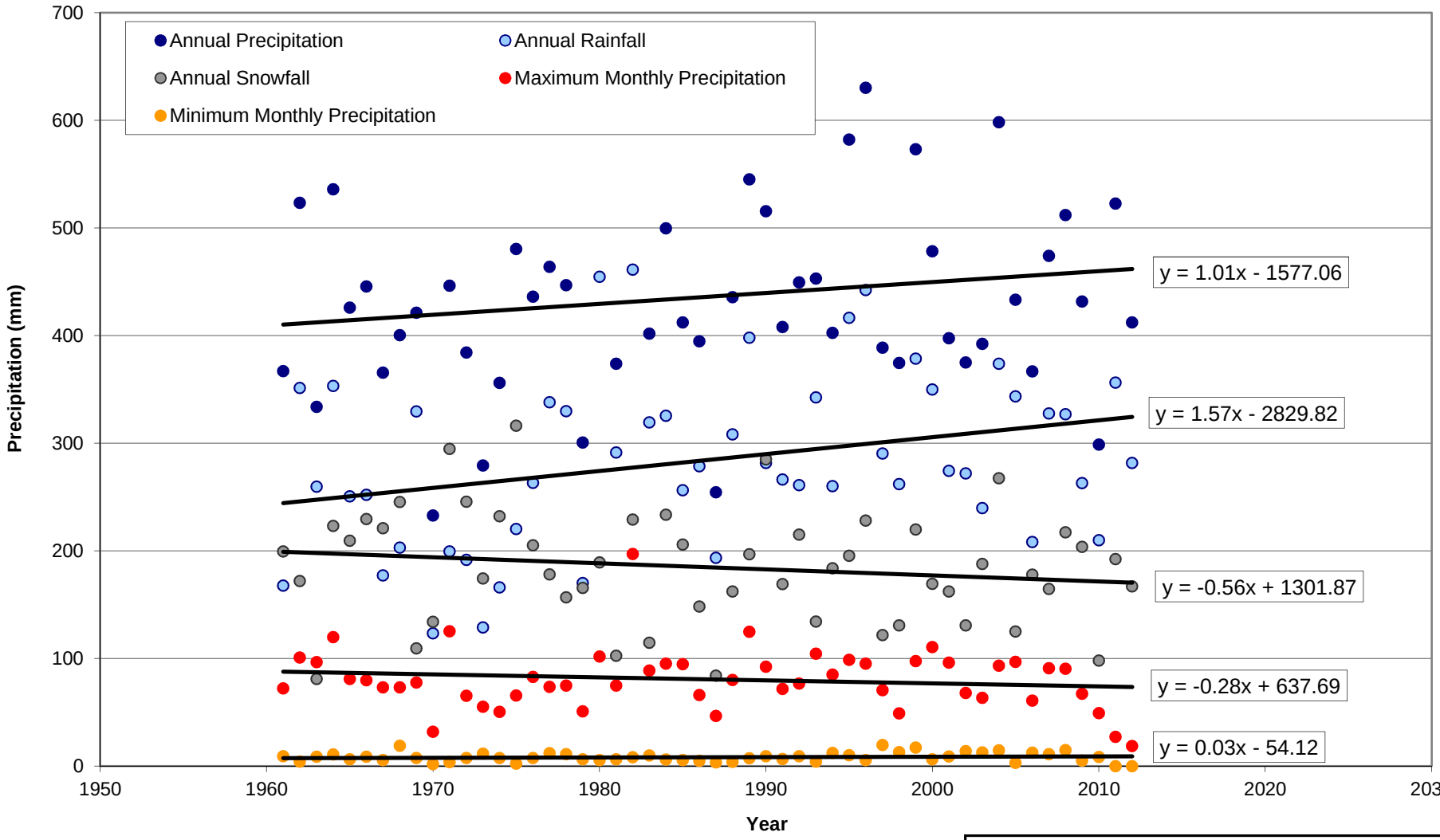
The project design enhances pre-development flows in the lower reaches of upper Fish Creek and maintains the water level in Fish Lake to within baseline variability, effectively mitigating the effect of potential variability. i.e. if there are natural changes in temperature outside the natural historic variability, the effect on lake stratification and ice cover are not due to the project. Those effects would be experienced under a non-development scenario, and perhaps with greater significance in the absence of the mitigating effects of water management system that is a component of the project. The enhancement of baseline flows and maintenance of baseline lake levels by the project provide a level of mitigation for the effects of any changes in seasonal variability.

The variability of the regional record over the last several decades has been incorporated into flow (i.e. water quantity) estimates for the project. This variability is assumed to continue for the foreseeable future, and is therefore the reason it has been included within the water flow estimates. The water quality modelling estimates are driven by chemistry and flows. As the flows through time are varied based on the regional values, potential changes in water chemistry based on regional variability have been accounted for by utilizing this variability and running the water balance and water quality models for a 100 year period (Section 2.7.2.4B of the 2012 EIS).

References

Taseko Mines Limited (2012). *New Prosperity Gold-Copper Mine Project Environmental Impact Statement*.

Knight Piésold (2012). *New Prosperity Project – Climate Change Assessment*. Ref no. VA12-01495, August 12, 2012.



NOTES:

1. THE ANNUAL RAINFALL TREND IS STATISTICALLY SIGNIFICANT AT THE 0.10 SIGNIFICANCE LEVEL.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	14JAN'13	ISSUED WITH MEMO	ER	CN	JGC

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NEW PROSPERITY PROJECT

WILLIAMS LAKE
ANNUAL PRECIPITATION TRENDS

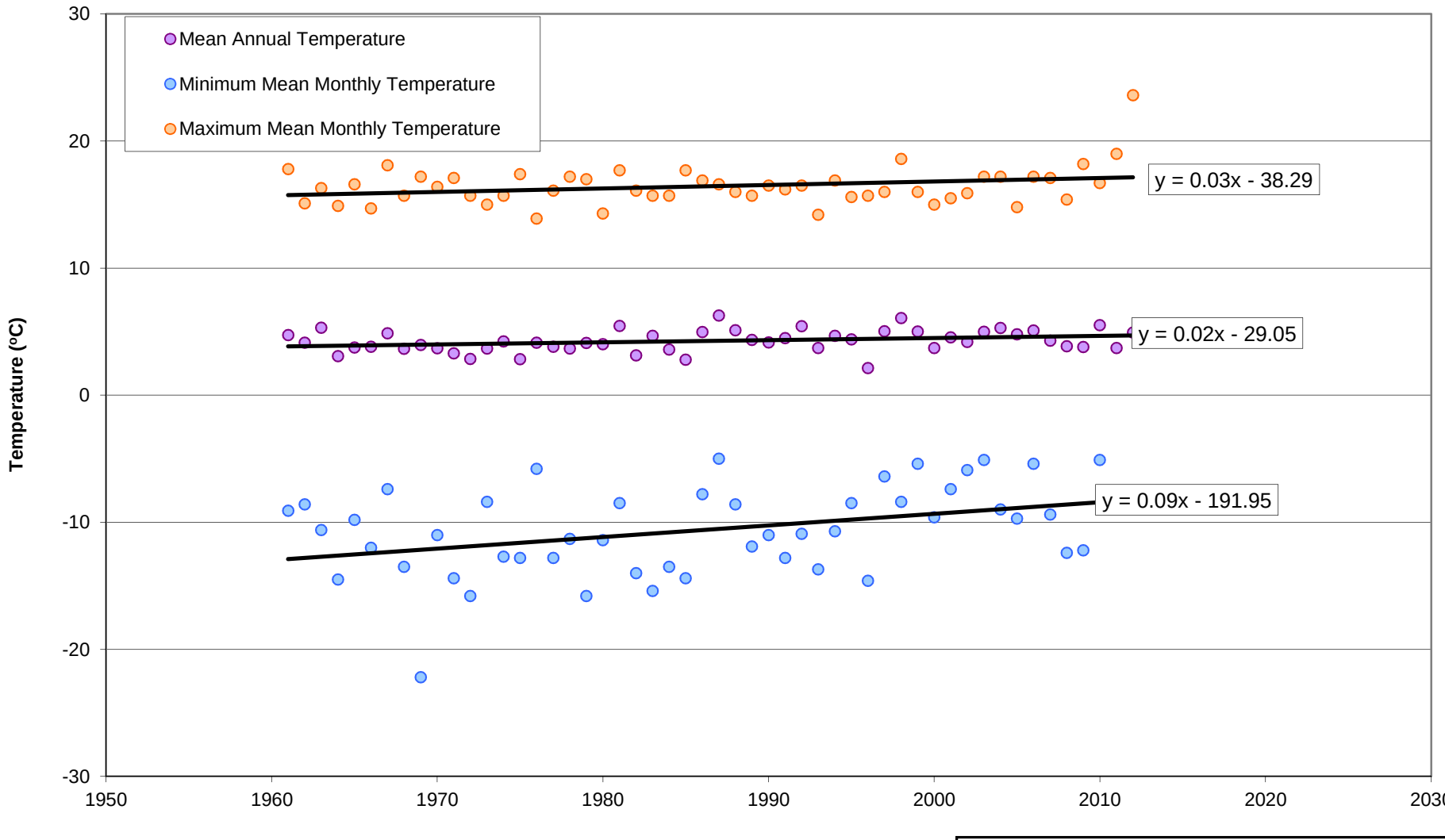
Knight Piésold CONSULTING

P/A NO. VA101-266/30

REF. NO. VA13-00268

FIGURE 18B-1

REV 0



NOTES:

1. THE ANNUAL TEMPERATURE AND MAXIMUM MONTHLY TEMPERATURE TREND ARE STATISTICALLY SIGNIFICANT AT THE 0.10 SIGNIFICANCE LEVEL.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15JAN'13	ISSUED WITH MEMO	ER	CN	JGC

TASEKO MINES LTD.

NEW PROSPERITY PROJECT

WILLIAMS LAKE
ANNUAL TEMPERATURE TRENDS

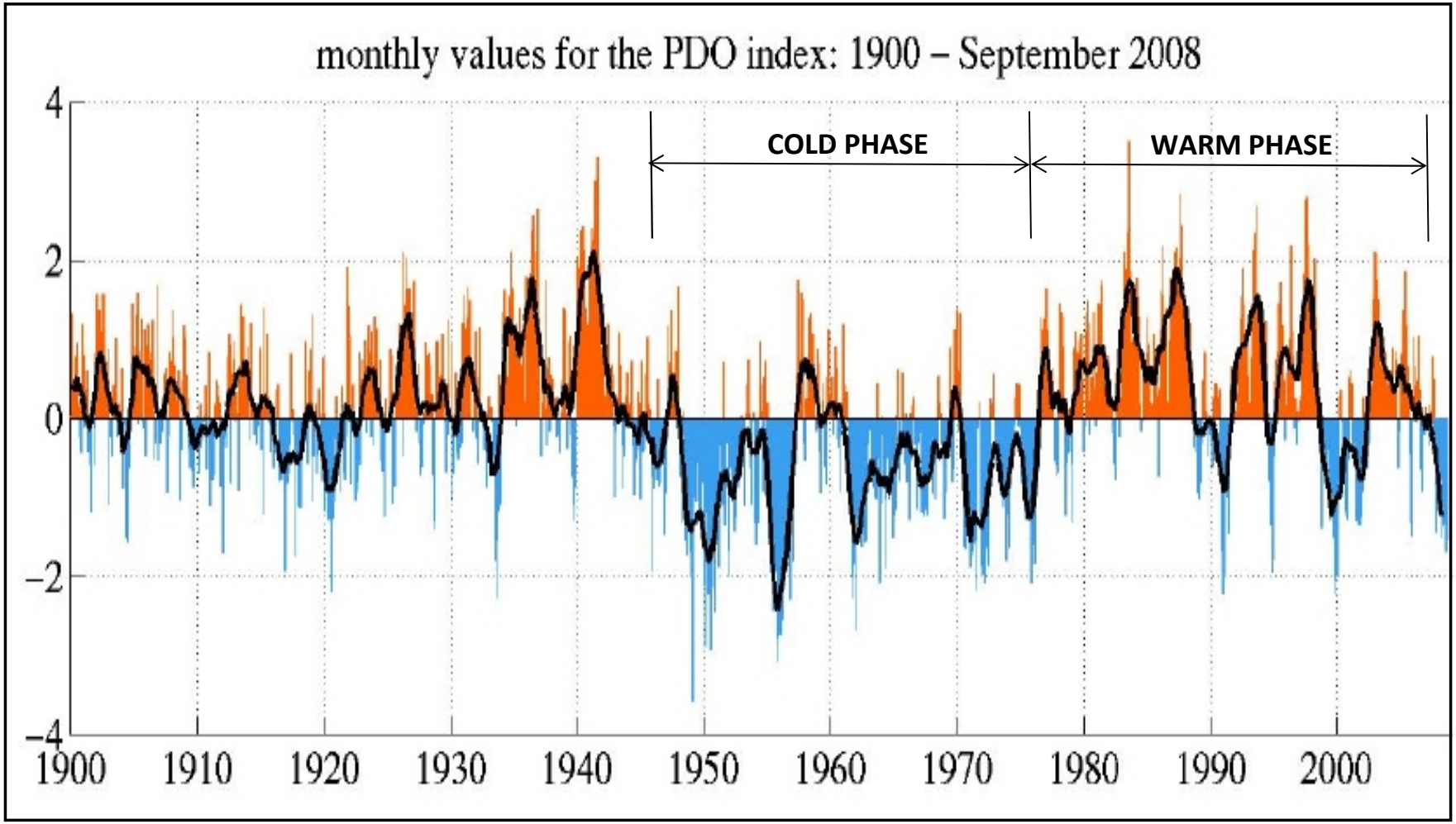
Knight Piésold CONSULTING

P/A NO. VA101-266/30

REF. NO. VA13-00268

FIGURE 18B-2

REV 0



NOTES:

1. SOURCE: JOINT INSTITUTE FOR THE STUDY OF THE ATMOSPHERE AND OCEAN
   http://jisao.washington.edu/pdo

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15JAN'13	ISSUED WITH MEMO	KT	KT	JGC

TASEKO MINES LTD.

NEW PROSPERITY PROJECT

THE PACIFIC DECADAL OSCILLATION INDEX FOR THE 20TH CENTURY

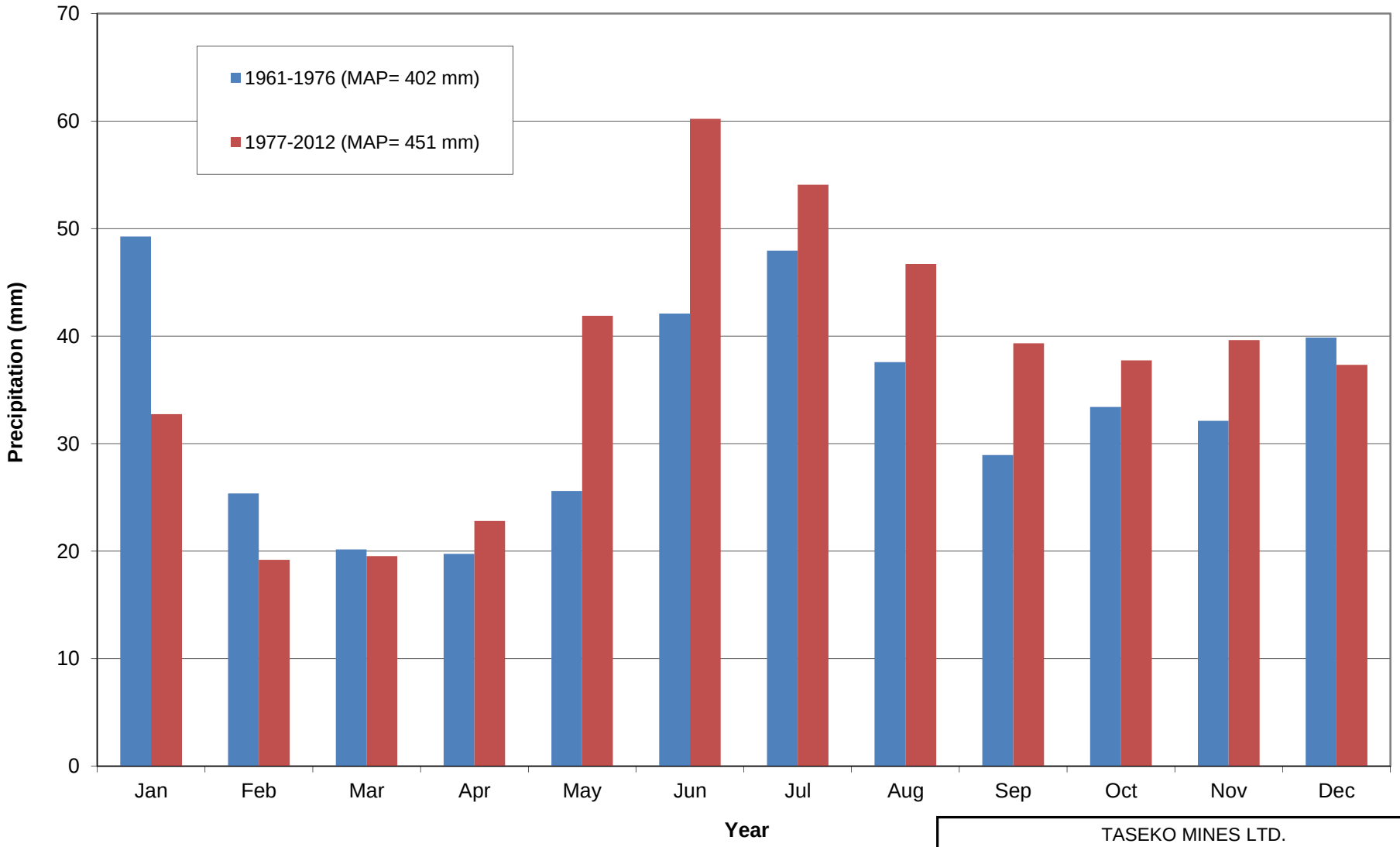
Knight Piésold CONSULTING

P/A NO. VA101-266/30

REF. NO. VA13-00268

FIGURE 18B-3

REV 0



NOTES:

1. MAP = MEAN ANNUAL PRECIPITATION.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15JAN'13	ISSUED WITH MEMO	ER	CN	JGC

TASEKO MINES LTD.

NEW PROSPERITY PROJECT

WILLIAMS LAKE
MONTHLY PRECIPITATION TRENDS

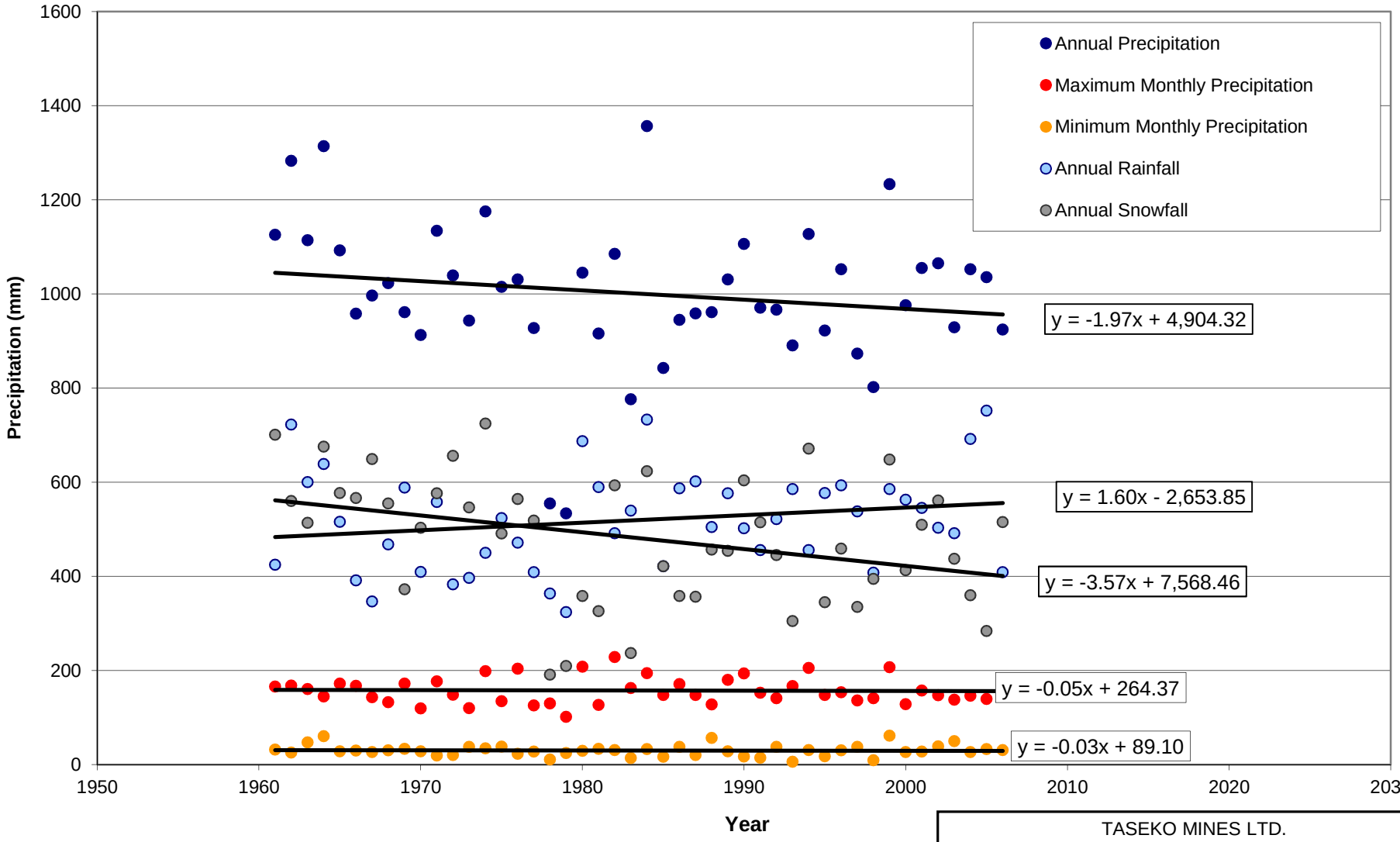
Knight Piésold CONSULTING

P/A NO. VA101-266/30

REF. NO. VA13-00268

FIGURE 18B-4

REV 0



NOTES:

1. THE ANNUAL SNOWFALL TREND IS STATISTICALLY SIGNIFICANT AT THE 0.1 SIGNIFICANCE LEVEL.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24JAN'13	ISSUED WITH MEMO	ER	JGC	KJB

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NEW PROSPERITY PROJECT

BARKERVILLE
ANNUAL PRECIPITATION TRENDS

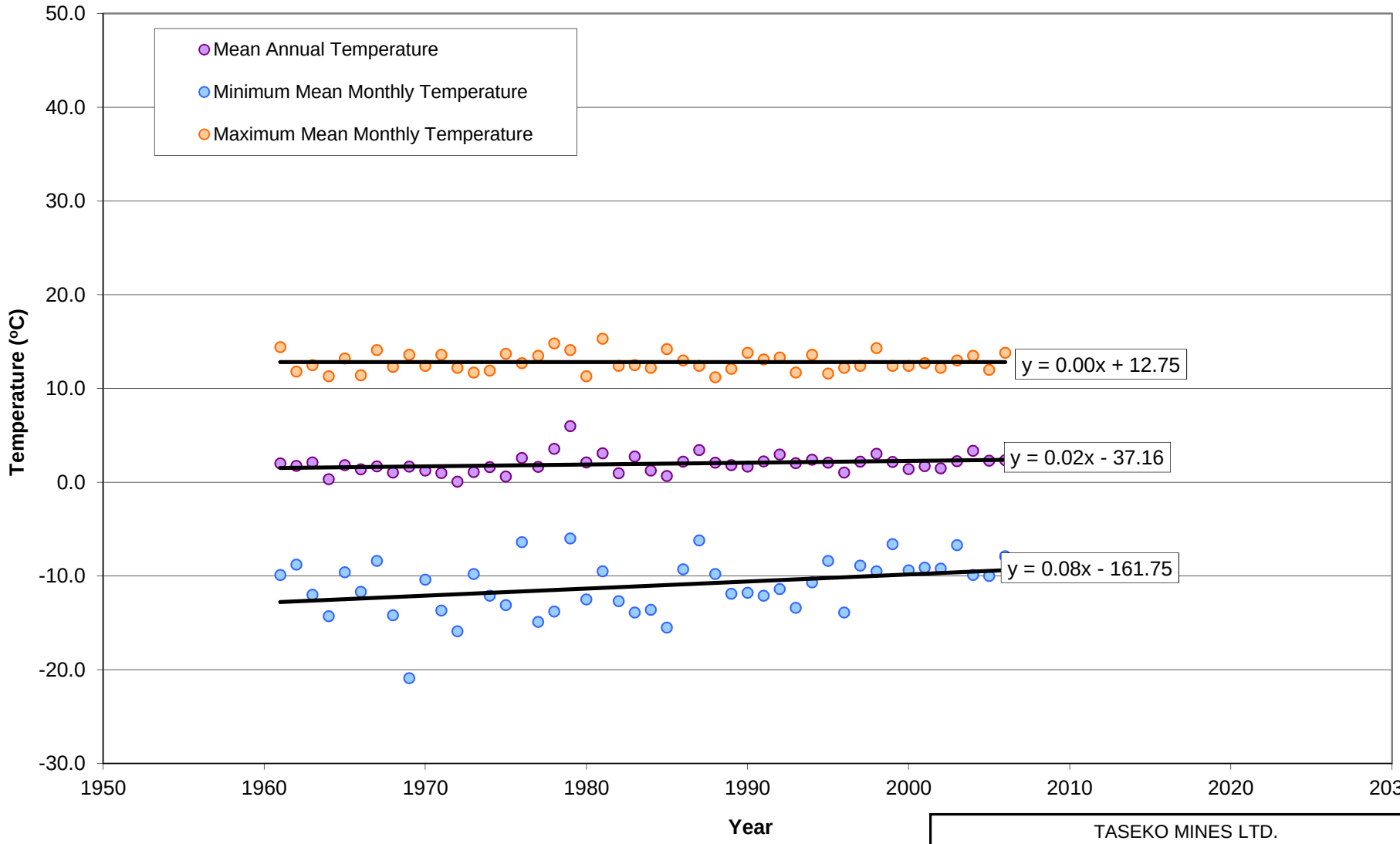
Knight Piésold CONSULTING

P/A NO. VA101-266/30

REF. NO. VA13-00268

FIGURE 18B-5

REV 0



NOTES:

1. THE MEAN ANNUAL TEMPERATURE AND MAXIMUM MEAN MONTHLY TEMPERATURE TRENDS ARE STATISTICALLY SIGNIFICANT AT THE 0.10 SIGNIFICANCE LEVEL.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24JAN'13	ISSUED WITH MEMO	ER	JGC	KJB

TASEKO MINES LTD.

NEW PROSPERITY PROJECT

BARKERVILLE
ANNUAL TEMPERATURE TRENDS

Knight Piésold CONSULTING

P/A NO. VA101-266/30

REF. NO. VA13-00268

FIGURE 18B-6

REV 0