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Assessment Report
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AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT

PREPARED FOR

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EXECUTIVE SUMMARY

The Kitsault Mine Project is located roughly 140 km north of Prince Rupert at the head of Alice Arm (Pacific Ocean). Meteorological and hydrological data have been collected at the project site since late 2008, and were also collected on site in various capacities from the 1960's through the 1990's. These data are presented and discussed in this report. Long-term values of various meteorological and hydrological parameters are estimated based on the available site and regional data. Climate change has not been considered explicitly in the hydrometeorological estimates, and appropriate allowances should be made where necessary.

This report includes hydrometeorological data up to November 2010 and provides an update to the Knight Piésold Hydrometeorology Report issued in July 2010 (Knight Piesold, 2010). The meteorological parameter estimates herein are for the Kitsault project site meteorological station, located at elevation 682 m.

<u>Climate</u>

Climate data were collected at the Kitsault project for a brief period from 1968 to 1972 by the Meteorological Service of Canada (MSC). Climate data collection resumed in November 2008 with the installation of an automated meteorological station; data are available from November 15, 2008 to November 18, 2010. These data were combined with the historical MSC data to develop a short-term climate record for the site, which was used in conjunction with long-term regional records to develop long-term meteorological estimates for the Kitsault project site. Many regional stations have since been deactivated, and the only station currently in operation is Stewart A. The primary climate analysis information is a follows:

The mean monthly temperature values were estimated based on a long-term synthetic record developed for the project site. The available site data were correlated to the concurrent monthly temperature data at Stewart using a simple linear regression analysis. The resulting synthetic temperature record has a mean annual temperature of 3.2 °C, with minimum and maximum mean monthly temperatures of -6.0 °C and 11.6 °C occurring in January and July, respectively.

No regional wind speed or relative humidity data are currently available in the project area, so the mean monthly values were based on the measured records from site. The mean annual wind speed is approximately 1.9 m/s, with the predominant wind direction from the east-southeast in winter and north-northeast in summer. The mean annual relative humidity is approximately 81%.

There are no site or regional evaporation datasets available, and therefore evaporation for the site was estimated according to common empirical equations for potential evapotranspiration (PET). PET values

are generally representative of lake evaporation. The empirical equations selected, known as Hargreaves and Thornthwaite, were used along with the measured site record and the long-term synthetic temperature record to estimate a mean annual lake evaporation (potential evapotranspiration) of 450 mm.

The mean annual precipitation for the site is estimated to be 2000 mm at an elevation of 650 m, with 45% falling as rain and 55% falling as snow. This estimate was based on limited site data and long-term regional data, and included consideration of the calibration results of a watershed model completed for the project site, which translates inputs of regional precipitation into corresponding flow values recorded in the project area. The historical record at Stewart was used as input to the watershed model.

Hydrology

Hydrologic data are currently being collected at four stations in the immediate project area; two stations on Lime Creek, one on Patsy Creek, and one on Clary Creek. At the time this report was issued, none of the stations had a complete year of record. Therefore, the available measured streamflow values are presented, along with the preliminary stage-discharge rating curves. Long-term streamflow records, as collected by the Water Survey of Canada (WSC) branch of Environment Canada, are available for Lime Creek (08DB010) and Patsy Creek (08DB012). A synthetic long-term record was created for Upper Clary Creek by prorating the WSC Patsy Creek record on the basis of drainage area.

The annual hydrographs for the creeks in the Kitsault Project area typically have a bi-modal shape, with the highest peak occurring in the spring freshet period and a secondary peak occurring in the late fall or early winter. The mean annual unit runoff for Lime Creek at the mouth is 45.7 $l/s/km^2$, for Patsy Creek at its confluence with Lime Creek it is 45.1 $l/s/km^2$, and for Upper Clary Creek it is estimated to be 45.1 $l/s/km^2$. Return period peak flows and 7-day low flows were estimated for all three creeks. The 200-year peak flow values are 140 m^3/s, 22 m^3/s, and 112 m^3/s for Lime Creek at the mouth, Patsy Creek at the Lime Creek confluence, and Upper Clary Creek, respectively. The respective 10-year 7-day low flow values are estimated to be 0.08 m^3/s, 0.01 m^3/s, and 0.06 m^3/s.

In order to create a long-term streamflow record based on the site data, it is recommended that data collection be continued at all four site stations.

The effective annual runoff coefficient for natural drainage areas in the project area is estimated to be approximately 0.70, based on the ratio of the mean annual runoff for Lime Creek (1422 mm) and mean annual precipitation (2000 mm).

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SECTION 1.0 - INTRODUCTION

1.1 PROJECT DESCRIPTION

The Kitsault Mine Project is located roughly 140 km north of Prince Rupert, British Columbia, near the head of Alice Arm (Pacific Ocean). The project area is in the Boundary Range of the Coast Mountains. While the general area is characterized by steep-sided, glaciated mountains and deeply incised creeks, the immediate project area is situated amongst mid-elevation terrain at the western side of a pass between Alice Arm and the Nass River. The elevation of the project area ranges from roughly 600 m to 1000 m above sea level. The project location is shown on Figure 1.1.

Three known molybdenum resources are located on the property, with the Kitsault open pit mine being the focus of planned operations. Mining operations at Kitsault were started by Kennco Exploration Ltd. in 1968, but closed in 1972 due to low metal prices. Climax Molybdenum Company of British Columbia purchased the property in 1973 and recommenced production in 1981. Mining was again halted because of low metal prices in 1982. Approximately 30 million pounds of Molybdenum were produced during these two periods of mining (BC MINFILE Report number 103P 120, Natural Resources Canada). The property was reclaimed between 1996 and 2006. Avanti Kitsault Mine Ltd. (Avanti) purchased the mine and surrounding mineral tenures in 2008. The project is currently being advanced through permitting and design phases. Project infrastructure will include:

- An open pit mine
- A processing plant
- Water management/process facilities
- A reagent handling and storage facility
- Assay and metallurgical laboratories
- Air supply
- Power supply and distribution
- Staff accommodations
- An explosives manufacturing facility and magazines, and
- Solid and waste water management facilities.

1.2 PREVIOUS STUDIES

Rescan installed and operated meteorological and hydrological data collection instruments for the Kitsault project site from 2008 through 2010. Baseline reports were issued by Rescan in 2010 summarizing the results of their data collection programs.

SECTION 2.0 - CLIMATE AND METEOROLOGICAL DATA

2.1 PROJECT SITE STATIONS

The Meteorological Service of Canada (MSC) operated two meteorological stations at the Kitsault project site between 1968 and 1972, during construction and operation of the original mine.

In November 2008, an automated meteorological station was installed at Kitsault near the proposed plant site, at elevation 682 m. This station is considered to be in roughly the same location as the previous MSC Kitsault Minesite station. The current site meteorological station monitors the following parameters:

- Air temperature
- Relative humidity
- Atmospheric pressure
- Precipitation (tipping bucket rain gauge with winter adapter kit)
- Snow depth (ultrasonic)
- Solar radiation
- Wind speed, and
- Wind direction.

Three snow course survey locations were defined in 2009 throughout the Kitsault project area. These are surveyed monthly throughout the winter periods to help define a winter precipitation gradient and to define the snowmelt patterns on site.

Data from the Kitsault meteorology station are available for the period from November 15, 2008 to November 18, 2010. Maintenance checks have been conducted on a nearly monthly basis throughout 2009. Details of the site stations are summarized in Table 2.1, and locations are shown on Figure 2.1.

2.2 REGIONAL STATIONS

Several climate stations are located in the general project region, as shown on Figure 2.2. Regional stations include multiple stations operated by the MSC as well as two stations located in Alaska and operated by the Alaska Climate Research Centre (ACRC). Many of the stations in the region have been deactivated, and thus do not have data that are concurrent with the recent site data collection. The regional stations, their locations, and their periods of record are summarized in Table 2.2.

2.3 TEMPERATURE ▲R1

Temperature data were collected at the Kitsault mine site from 1968 through 1972 by MSC. In addition, temperature data have been collected more recently (2008 – 2010) at the existing site weather station installed by Rescan. These data are summarized as monthly average values in Table 2.3. Averaging the available site data results in a mean annual temperature estimate of 3.1 °C. The available site data are incomplete for most years, however, and therefore these data were correlated with concurrent and longer term regional data to provide an alternate estimate, which is believed to be more representative of long-term conditions.

The available site data were compared with concurrent temperature data from the MSC operated meteorological stations in Stewart, BC. Temperature records from three stations, Stewart (ID 1067740), Stewart BCHPA (ID 1067745) and Stewart A (ID 1067742) were combined to form a single data set with approximately 101 complete years of record. Values from this combined record were correlated with the site data using simple linear regression for the concurrent period of record, and the two datasets were found to have a high degree of correlation ($R^2 = 0.96$). A synthetic long-term temperature record for Kitsault was then generated by applying the linear regression equation to the long-term temperature values for Stewart, and the resulting synthetic temperature series has a mean annual value of 3.2 °C, as shown in Table 2.3. Also provided in this table are estimates of long-term average monthly temperature values.

2.4 WIND SPEED AND DIRECTION ▲R1

The site meteorological station installed in November 2008 records wind speed and direction. These data are the only available wind speed data for the site, and are summarized in Table 2.4. The brief period of complete months of record (December 2008 to October 2010) indicates a mean wind speed of 1.9 m/s. Rescan has reported that the predominant wind direction in winter is east-southeast, and in the summer it is north-northwest.

Given the limited wind data available for the site, these statistics should be treated with appropriate caution.

2.5 RELATIVE HUMIDITY ▲R1

Relative humidity has been recorded at site only since the installation of the existing meteorological station in November, 2008. Mean monthly relative humidity is summarized in Table 2.5. The mean annual relative humidity as represented by the data is 80.9%.

The relative humidity statistics should be treated with appropriate caution due to the limited period of record.

2.6 EVAPOTRANSPIRATION ▲R1

Potential Evapotranspiration (PET) is defined as the amount of evapotranspiration that would occur given an infinite supply of water from a crop surface (Ponce, 1989). There is inherent uncertainty with any PET estimate when no reliable site specific data are available for calibration. Since evaporation values are difficult to measure and due to the lack of measured data available for the Kitsault Project, both site-specific and regional, the potential evapotranspiration (PET) was estimated based on empirical equations. Daily short-term temperature data collected at the site, as well as the synthetic long-term temperature values, were input into the Hargreaves and Thornthwaite equations to give monthly estimates of PET. The empirical methods used to calculate PET for the project site provide reasonable estimates of lake evaporation, according to Ponce (1989) and Maidment (1993). As water is assumed to be abundantly available, PET is independent of soil conditions, but rather is affected by climatic conditions and can be reasonably estimated from measured climate data. The resulting average monthly and annual values are summarized in Table 2.6.

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The Hargreaves equation uses mean, minimum and maximum temperature values, as well as the site latitude, to estimate PET, whereas the simpler Thornthwaite equation uses just mean temperatures and the site latitude to estimate PET. Mean, minimum and maximum monthly temperature data are available for the periods 1968 – 1972 and 2008 – 2010, as described above in Section 2.3, and these data were used to estimate PET with both equations, with resulting annual estimates of 503 mm and 389 mm. Additionally, the synthetic long-term monthly temperature series was used with the Thornthwaite equation to generate a mean annual PET estimate of 381 mm. These values represent quite a range, but it is generally consistent with the 400 mm to 500 mm range indicated in the *Canadian Hydrological Atlas* (Natural Resources Canada, 1978), and the approximate 500 mm value indicated in the *Manual of Operational Hydrology in British Columbia* (Coulson, 1991). It is not clear which estimate is most realistic, and therefore an intermediate value of 450 mm was selected for the project. Mean monthly values were then prorated from this according to the percent monthly distributions of the 503 mm and 389 mm estimates. The estimated long-term mean annual and monthly evaporation estimates for the Kitsault site are provided in Table 2.6.

2.7 PRECIPITATION

Site precipitation data are available from the current meteorological station, as well as from the historic Kitsault stations operated by MSC.

2.7.1 Mean Annual Precipitation ▲R1

The MAP values for the regional meteorological stations are summarized in Table 2.2, and the locations of the most relevant stations are shown on Figure 2.2. The Kitsault site precipitation data are summarized on a monthly basis in Table 2.7. Data from each month has been averaged, and those average values were summed to estimate a mean annual precipitation (MAP) of 1778 mm. However, there are concerns about the validity of the site station data, particularly for the winter months when catch efficiency of precipitation gauges is commonly much less than 100%, and may be as low as 50% or less, depending on conditions. Environment Canada has procedures to minimize this error, such as the use of wind shields, and also may apply adjustment factors to the data, so the MSC data are considered reasonably valid. The current meteorology station winter data, however, are likely erroneously low, and the exclusion of the 2008-2010 values results in a revised MAP estimate of 1985 mm. Although these estimates are based on data collected at site, this dataset has a limited period of record, and most years have data gaps.

In the previous analysis (Knight Piésold, 2010), the double-mass analysis method was used to compare the concurrent data from the Kitsault MSC stations and the regional stations to determine a long-term estimate of MAP of 2000 mm for the Kitsault project site. Given the uncertainty in precipitation gauge catch efficiency, it was necessary to derive an alternate means to validate the MAP for the Kitsault project area. A watershed model has been developed to assess the baseline surface and groundwater flow patterns in the area (Knight Piésold, 2011). Part of the model calibration process was to translate inputs of regional precipitation into corresponding flow values recorded in the project area. Data are available from the Stewart station (ID 1067740) from 1910 to 1967. When this station was discontinued the Stewart BCHPA

(ID 1067745) station was activated, from 1967 to 1976. Another station was activated nearby at the Stewart airport in 1974, Stewart A (ID 1067742), and is currently still in operation. Precipitation and temperature data from Stewart, Stewart BCHPA and Stewart A records were combined to provide a long-term record that was used to estimate the MAP at the Kitsault project site. A double-mass analysis (Ponce, 1989) was used to adjust the Stewart and Stewart BCHPA precipitation data to represent the conditions at Stewart A. Missing monthly values were in-filled based on the long-term monthly average values for the entire period of record of the Stewart stations. This combined record will be referred to below as the Stewart record.

The Stewart precipitation inputs to the watershed model were adjusted until best fits were reached between calculated and reliable measured streamflow values (Section 3.0). This required adjusting the monthly precipitation values for the winter months (November-March) by a multiplier of 1.24 and for the summer months (April-September) by a multiplier of 0.7. These adjustments, though empirical, account for differences in storm tracking and other climatic variabilities such as rain shadow effects, and for differences in gauge catch efficiencies, which are particularly notable during the winter months. Application of these factors to the long-term historical precipitation record at Stewart resulted in a MAP of 1950 mm for the site at an elevation of approximately 650 m. This value is consistent with the average of the MSC site data (1985 mm), and therefore the MAP for the Kitsault project site was assumed to be approximately 2000 mm for elevation 650 m.

The precipitation in the Kitsault project area is expected to vary with elevation due to the steep topography of the area and the corresponding orographic lift of moist maritime air masses. Suitable data are not available to quantify this orographic effect, but based on extensive experience with climate patterns in coastal British Columbia, it is anticipated that annual precipitation changes with elevation at a rate of approximately 10% per 100 m. An additional discussion on orographic effects is provided in Section 4.2.1 of this report.

2.7.2 Monthly Precipitation Distribution

The monthly distributions of precipitation for the Kitsault site stations and several regional stations are summarized in Table 2.8. All of the stations generally demonstrate comparable monthly proportions, and have a similar annual pattern with the majority of precipitation consistently occurring in the fall and winter months. The monthly distribution of precipitation at site was therefore estimated as the average of all the distributions shown in the table. The corresponding average monthly precipitation values, based on a MAP of 2000 mm, are provided in Table 2.8.

2.7.3 Rain/Snow Distribution

The monthly distribution of rain/snow at site has been estimated on the basis of the MSC site data collected during the period of 1968 – 1972 and confirmed with the watershed model (Section 2.7.1). These data indicate an annual distribution of approximately 45% rain and 55% snow, which seems reasonable and appropriate given the 637 m average elevation of the stations. For comparison, the split at Alice Arm, which is at a lower elevation of 314 m, is 63% rain and 37%

snow. The monthly rain/snow distributions for both Kitsault and Alice Arm are summarized in Table 2.9.

2.7.4 Snowmelt

Snow survey data were collected at site during the winter/spring periods of 2009 and 2010. These data were collected both by snow depth measurement at the site meteorological station and with snow course sampling at three locations on site. The period of record of these data is inadequate to estimate a long-term snowmelt pattern for the site.

Regional snowpack data from the Cedar-Kiteen Automated Snow Pillow (ID 4B18P) and the Bear Pass Snow Survey (ID 4B11A) were considered for estimating a snowmelt pattern for the Kitsault site. These two stations are operated by the BC River Forecast Centre, with data available through their website. The Cedar-Kiteen station is located 54 km southeast of the Kitsault site, at elevation 885 m. Archived snow-water-equivalent data at Cedar-Kiteen indicates an average snowmelt pattern of 15% in April, 60% in May, and 25% in June.

The Bear Pass manual survey site is located 77 km north of the Kitsault site, at elevation 437 m. Archived data from Bear Pass show an average snowmelt pattern of 16% in April, 79% in May, and 5% in June.

The Kitsault site is located at an approximate elevation of 650 m and thus the snowmelt pattern should be intermediate to the above regional stations. Correspondingly, a snowmelt pattern of 15% in April, 70% in May, and 15% in June was assumed for the Kitsault site.

2.8 EXTREME PRECIPITATION

Extreme rainfall values for the Kitsault site were estimated according to the values and procedure presented in the *Rainfall Frequency Atlas of Canada* (Hogg et al., 1985) (RFAC). Mean and standard deviations for annual rainfall extremes of various durations are presented on isohyetal maps in the RFAC. Frequency factors and equations are provided for determining rainfall events for any return period based on a Gumbel distribution. The atlas also recommends adjusting the values for coastal, mountainous catchments based on given orographic augmentation factors. The atlas suggests the application of Hershfield frequency factors for determining Probable Maximum Precipitation events of various durations.

Extreme precipitation events for the Kitsault site are presented in Table 2.10. The 24-hour extreme precipitation values for return periods of 10, 25, and 200 years are estimated to be 133 mm, 155 mm, and 204 mm, respectively.

Annual extreme precipitation events at regional stations were reviewed to validate the data from the RFAC. The Stewart A MSC station has 31 years of annual extreme daily precipitation records. These daily values were converted to equivalent 24 hour events using a standard scaling factor of 1.13 (Miller et al., 1973). The result is a mean annual 24 hour extreme precipitation of 86.4 mm and a standard deviation of 25.2 mm. These values are consistent with the isohyetal plots in the RFAC.

The Nass Camp MSC station has 24 years of extreme daily precipitation records. As above, these values were scaled by 1.13 to adjust them to 24 hour events. The result is a mean annual 24 hour extreme precipitation of 60.7 mm and a standard deviation of 20.1 mm. These values are consistent with the isohyetal plots in the RFAC.

These comparisons suggest that the results of the RFAC analysis are appropriate for estimating extreme rainfall at the Kitsault project site. It is worth noting that the five greatest rainfall events on record at both the Nass Camp and Stewart A stations occurred in the months of October to January, inclusive, and correspondingly extreme rainfall events at the Kitsault project area can be expected to occur during the same time of year.

SECTION 3.0 - HYDROLOGY DATA

3.1 PROJECT SITE STATIONS

The Water Survey of Canada (WSC) branch of Environment Canada operated two streamflow monitoring stations in the Kitsault project area, though both are now deactivated. This included one station on Patsy Creek that operated from 1987 to 1996, and one station on Lime Creek that operated from 1976 to 1996. These stations had average annual unit runoff values of 45.7 l/s/km^2 and 47.0 l/s/km^2, respectively. The data from these WSC stations form the primary basis for the hydrological analysis presented herein.

Streamflow data are currently being collected at four monitoring stations at the Kitsault site. There is one station installed on Clary Creek, one on Patsy Creek, and two on Lime Creek. Water level is recorded at each of these stations at 10 minute intervals based on measurements from submerged pressure transducers. The locations of the past and present site stations are shown on Figure 2.1, and the stations' characteristics are summarized in Table 3.1. The catchment boundaries of Clary Creek, Patsy Creek, and Lime Creek are shown on Figure 3.1.

The streamflow station on Clary Creek (CCK-H1) is located upstream of Clary Lake, and monitors flow near the proposed location of the northeast tailings embankment. This station was installed in May 2010. The station on Patsy Creek (PCK-H1) was installed in late 2009, and monitors flow upstream of the confluence of Patsy Creek and Lime Creek. The Upper Lime Creek station (LCK-H1) was installed in 2009, and is located a short distance downstream of the confluence of the Patsy Creek confluence. The Lower Lime Creek station (LCK-H2) was originally installed in 2008, and then reinstalled in late 2009. Some data from the original installation has been lost. The locations of all the active project streamflow stations are shown on Figure 2.1. All the stations are removed for the winter season.

All of the site stations demonstrate a bi-modal annual hydrograph, with a snowmelt driven freshet peak flow period and a typically smaller but distinct fall storm induced peak flow period. None of the site stations have any glacier contribution in their watersheds.

3.2 REGIONAL STATIONS

The locations of regional streamflow stations are shown on Figure 2.2, and their characteristics are summarized in Table 3.2. These stations vary significantly in their catchment size and percent glaciated area. The mean annual unit runoff values in the region vary substantially, with station values ranging from 34.1 l/s/km^2 to 93.8 l/s/km^2.

The regional stations are not considered in depth in this analysis due to the availability of reliable, long-term site streamflow data.

3.3 MEASURED STREAMFLOW ▲R1

Measured streamflow records have been created for the four site stations currently in operation. This was achieved by applying a stage-discharge relationship to the 10 minute stage record collected at each station.

A rating curve was developed for each station based on the instantaneous discharge measurements collected. These measurements were generally completed using the area-velocity technique with a current meter, which was appropriate when flow conditions allowed for safe wading in the creeks, and using the dilution technique with rhodamine dye slug injections, when conditions were unsafe to wade and/or too turbulent for current meter use. Salt dilution methods have been used in the past by Rescan Environmental Services Ltd.

The rating curves were initially derived on the basis of a maximum-probability, least-squares fit to the calibration points, with direct consideration of the hydraulic characteristics of the control section at each station. The curve was then adjusted manually to provide a better "visual fit" to higher confidence measurements while treating the high error measurements conservatively (i.e. the curve is positioned close to the lower end of the discharge error bars), and while still conforming to the hydraulic constraints of the control section.

The basic form of the rating curve equation is based on general hydraulic theory pertaining to open channel flow, and the values of the coefficient and exponent are dependent on the hydraulic characteristics of the control section at the gauge, which provides a means of checking the validity of the derived equation (Maidment, 1993).

The error for current meter discharge measurements was estimated to be in the range +/- 5% to 15%. These error estimates are based on a combination of the accuracy between concurrent discharge measurements, the distribution of cross-sectional discharge within depth-velocity measurement cells (ideally each cell contains less than 10% of the total discharge), and a qualitative assessment of the measurement transect for areas of excessive turbulence or flow reversal. A larger error has been applied to the rhodamine dye measurements based on field observations of the quality of mixing. The overall uncertainty of the rating curves was determined by measuring the deviation of each measured discharge value from the rating curve prediction for the same stage. This difference was then divided by the mean of the measured and predicted values to get a percentage error. The percentage error for each measurement was then averaged to quantify the overall rating curve uncertainty.

Using the rating curves, daily hydrographs were developed for each station. This was achieved by applying the rating curve to the stage record collected by the gauge. Stage data, which were recorded on a 10 minute interval, were converted to equivalent discharges and then averaged over a 24 hour period to produce daily discharge values. The rating curves will need to be revised as more discharge measurements are collected, which will increase the accuracy of the rating curves.

The following sections describe the rating curve development for each station and the overall uncertainty associated with the curves.

It is recommended that the four site streamflow stations be maintained and continued in order to collect additional stage data and discharge measurements for refinement of the rating curves and measured records.

3.3.1 Upper Lime Creek

A total of 13 successful discharge measurements have been made at the Upper Lime Creek gauge (LCK-H1) since its installation. The discharge measurements and corresponding stage heights at the time of measurement are summarized in Table 3.3. Measurements range from a low of 0.001 m^3/s to a high of 7.50 m^3/s. These 13 measurements were used as the basis for developing a stage-discharge rating curve for the gauge, which is shown on Figure 3.2. The overall uncertainty of the rating curve was assessed at +/- 17%.

The daily hydrograph at the gauging station for the period of record from May to July 2009 and March to November 2010 is shown on Figure 3.3.

3.3.2 Lower Lime Creek

A total of 9 successful discharge measurements have been made at the Lower Lime Creek gauge (LCK-H2) since its installation. The discharge measurements and corresponding stage heights at the times of measurement are summarized in Table 3.4. The rating curve was developed using 2010 data only, due to the high scatter and uncertainty associated with measurements collected prior to 2010. Measurements range from a low of 0.48 m^3/s to a high of 4.84 m^3/s. Figure 3.4 shows the stage-discharge rating curve for this gauge, which was developed using the 9 successful measurements. The overall uncertainty of the rating curve was assessed at +/- 8%.

The daily hydrograph at the gauging station for the period of record from March to November 2010 is shown on Figure 3.5.

3.3.3 Patsy Creek

A total of 14 successful discharge measurements have been made at the Patsy Creek gauge (PCK-H1) since its installation. The discharge measurements and corresponding stage heights at the times of measurement are summarized in Table 3.5. Measurements range from a low of 0.001 m^3/s to a high of 1.60 m^3/s. Figure 3.6 shows the stage-discharge rating curve for this gauge, which was developed using the 14 successful measurements. The overall uncertainty of the rating curve was assessed at +/- 9%.

The daily hydrograph at the gauging station for the period of record from April to July 2009 and March to November 2010 is shown on Figure 3.7.

3.3.4 Clary Creek

A total of 7 successful discharge measurements have been made at the Clary Creek gauge (CCK-H1) since its installation. The discharge measurements and corresponding stage heights at the times of measurement are summarized in Table 3.6. Measurements range from a low of 0.01 m^3/s to a high of 0.47 m^3/s. Figure 3.8 shows the stage-discharge rating curve for this gauge, which was developed using the 7 successful measurements. The overall uncertainty of the rating curve was assessed at +/- 12%.

The daily hydrograph at the gauging station for the period of record from May to November 2010 is shown on Figure 3.9.

Summaries of the monthly flows and corresponding unit flows for each of the four site stations are provided in Table 3.7. These results, though preliminary and short-term, indicate that all three creeks have essentially the same annual hydrograph pattern, as expected, but that the unit flows, though similar, are notably different. Lime Creek appears to have the highest unit flows, followed by Patsy Creek and then Clary Creek. Furthermore, the two stations on Lime Creek demonstrate almost identical patterns, with a very slight delay in the onset of freshet flows and a more rapid decline of fall flows at the upper station, commensurate with its higher basin elevation and greater snow to rain ratio.

3.4 LONG-TERM PROJECT AREA STREAMFLOW

Ideally, the long-term streamflow record for the project stations would be developed using the measured on-site data and regressing it against regional data. In order to successfully do this, a WSC station with similar characteristics (glacier percentage, basin aspect, median elevation, etc.) to the project streams, and having a long-term record containing a period concurrent with the site data record, would be required. Unfortunately, the WSC stations on Lime Creek (08DB010) and Patsy Creek (08DB012) were discontinued prior to the installation of the site stations. Therefore, these stations cannot be used for the regression modelling. Alternately, correlation of the site data with data from the regional stations on the Nass River (08DB001), Ksedin Tributary (08DB014), and Ansedagan Creek (08DB013) were attempted, but did not produce satisfactory results. It is expected that the regression modelling can be improved once more site data become available. Furthermore, even if that is not possible, a reasonable period of site records would reveal any notable differences amongst the flow patterns of the various systems. Therefore, it is recommended that ongoing data collection be continued and another attempt be made to establish regression relationships when at least a full year of site data has been collected.

In the meantime, the analysis of long-term project area streamflow will consider flow on Lime Creek, Patsy Creek, and Clary Creek using the long-term records on the WSC Lime Creek (08DB010) and Patsy Creek (08DB012) stations. The following subsections will present streamflow records and statistics for those creeks. The catchment areas of the creeks are delineated on Figure 3.1.

3.4.1 Lime Creek

The WSC station on Lime Creek was located near the creek mouth and had a catchment area of 39.4 km^2. This station operated from 1976 to 1996, and the WSC archived data includes 15 complete years of daily flow records. The record indicates a mean annual discharge (MAD) of 1.8 m^3/s, which corresponds to a mean annual unit runoff (MAUR) of 45.7 $l/s/km^2$. A mean annual hydrograph for Lime Creek is presented on Figure 3.10, and the mean monthly flows are summarized in Table 3.8.

3.4.2 Patsy Creek

The WSC station on Patsy Creek operated from 1987 to 1996, with a total of 8 complete years of daily flow record available. This station had a catchment area of 4.68 km^2. This data was correlated to the WSC Lime Creek daily flow series using a ranked regression methodology. The resulting monthly regression relationships were then used to extend the Patsy Creek record through the period from 1976 to 1987. The result is a 15 year synthetic/measured daily flow series.

A mean annual hydrograph from the long-term Patsy Creek flow series is shown on Figure 3.11. The record indicates a MAD of 0.21 m^3/s, which corresponds to a MAUR of 45.1 $l/s/km^2$. A summary of mean monthly flows is provided in Table 3.9.

3.4.3 Clary Creek ▲R1

A synthetic streamflow series was created for Clary Creek at a point just downstream of the confluence of the Clary Creek main stem and the tributary supplying flows from Clary Lake. This location, which is identified as Upper Clary Creek on Figure 3.1, was selected because it represents the downstream extent of possible mine development activities in the Clary Creek watershed. A flow series for this site was developed by scaling the Patsy Creek synthetic/measured flow series according to the ratio of the Clary Creek and the Patsy Creek catchment areas. This approach was taken because the two catchments are located immediately adjacent to one another and they are similar in their median watershed elevation, aspect, and catchment characteristics. The direct proration of flows may seem a little inconsistent with the relatively lower unit flows demonstrated by the Clary Creek site records, but the site records are for a different location that is not believed to be as representative of conditions at Upper Clary Creek as are the flow records for Patsy Creek. However, this is a source of uncertainty that should be further investigated once additional site data are collected. For this reason, it is recommended that a streamflow gauge be installed at or near the Upper Clary Creek location.

The resulting synthetic long-term daily flow series has a MAD of 1.31 m^3/s, which for a catchment area of 29.1 km^2, corresponds to a MAUR of 45.1 $l/s/km^2$. A mean annual hydrograph for Clary Creek is shown on Figure 3.12, and a summary of estimated monthly flows is shown in Table 3.10.

3.5 WET AND DRY MONTHLY FLOWS

Wet and dry monthly flows were estimated for Lime Creek, Patsy Creek and Clary Creek for a recurrence interval of 10 years. The monthly return period values were estimated from the 15-year flow series in the creeks, using the distribution fitting application provided in Palisade Decision Tools @RISK statistical software program. The best fit distribution type, which was typically a Pearson Type 5 or Logistic distribution, was selected for each month. Ratios relating 10-year wet and dry monthly values to the mean values are presented in Table 3.11. 10-year recurrence interval monthly discharges for other locations within the catchments may be estimated by multiplying calculated monthly flows by these ratios.

3.6 7-DAY LOW FLOWS

Minimum 7-day average low flows typically occur during late summer or late winter within unglaciated watersheds in northern coastal watersheds in BC. Lime Creek, Patsy Creek and Clary Creek are located within subzone 'S' of the Skeena Streamflow Region, as delineated in *Streamflow in the Skeena Region* (Obedkoff, 2001). The data measured by WSC on Lime and Patsy Creeks are presented within the Obedkoff report. In the report, Obedkoff presents 10-year return period 7-day average low flows for both systems, as well as scaling curves for calculating 7-day low flows for other return periods up to 100 years. The scaling curves, which are presented on Figures 3.13 and 3.14 for Lime Creek and Patsy Creek, respectively, were applied to the Obedkoff 10-year return period values to derive return period 7-day low flows in each creek. The results are presented in Table 3.12. Because of watershed similarity, the Patsy Creek 7-day low flow values were scaled by drainage area to generate values for Clary Creek. These flow estimates are likely conservatively low because low flows often don't scale linearly with area, but rather tend to be proportionally higher for larger areas. However, a conservative approach is considered appropriate in this instance give the available information. Recognizing this limitation, the presented values may reasonably be scaled by drainage area to estimate 7-day low flow values for different locations within the respective watersheds.

3.7 PEAK FLOW ANALYSIS

Peak flows within the un-glaciated watersheds of subzone 'S' may occur either during the spring and early summer months as a result of snowmelt, or during the fall months as a result of extreme rainfall or rainfall combined with the melt of immature snowpacks. However, the largest runoff events typically result in the fall. Similar to the 7-day low flows presented above, 10-year return period peak instantaneous discharge values are presented for both Lime Creek and Patsy Creek in *Streamflow in the Skeena Region* (Obedkoff, 2001). Scaling curves for calculating peak discharge for other return periods are presented in the report, and are reproduced here on Figures 3.15 and 3.16 for Lime Creek and Patsy Creek, respectively. Return period peak discharges in Patsy Creek and Lime Creek were calculated using the scaling curves. Peak instantaneous return period discharge values were calculated for Clary Creek by scaling the Patsy Creek values by the ratio of drainage areas, and using an exponent of 0.9, which is typical for wet coastal watersheds (Cathcart, 2001). The exponent accounts for the relative decrease in runoff intensity experienced by larger watersheds due to a typical reduction in watershed averaged mean storm intensity, as well as increases in flow attenuation and in the time of concentration associated with the longer channel lengths. The results are presented in Table 3.13. A similar scaling approach can be applied to these results to estimate peak flows for other locations within each respective watershed.

SECTION 4.0 - WATER BALANCE MODELLING INPUTS

4.1 GENERAL

This section defines additional hydrometeorological parameters required for engineering design and water balance modelling. These parameters help to quantify the climatic and hydrologic variability in the project area.

4.2 PRECIPITATION

4.2.1 Orographic Effect

An orographic factor allows the long-term precipitation estimate at the Kitsault meteorological station to be adjusted for other elevations within the project area. In their *2008 – 2010 Meteorology, Air Quality, and Noise Baseline Report*, Rescan reported an average measured winter precipitation gradient of 23% per 100 m elevation increase. However, this value, which was based on a comparison of snow survey data from stations at elevations of 688 m and 1006 m, for the months of February, April, and May of 2009, appears to be quite high compared to orographic precipitation effects in many other coastal BC watersheds. It is suspected that measurements from the lower station may have been confounded by periods of thaw and possible rainfall, since the consistent snow line in the Coast Mountains is often in the 600 m to 800 m elevation band.

As stated in Section 2.7.1, suitable data are not available to reliably quantify the orographic effect in the project area, and therefore a generic rate of approximately 10% per 100 m elevation was estimated on the basis of extensive experience with climate patterns in coastal British Columbia.

4.2.2 Coefficient of Variation

The year-to-year variability of monthly precipitation in the project area is quantified with coefficient of variation (Cv) values that were derived from regional data. The Cv values are required as input for Monte Carlo simulations used in water balance modelling. The Cv values for precipitation at the Kitsault project were based on an average of the Cv values for the Stewart A and Nass Camp MSC stations, as summarized in Table 4.1.

4.3 TEMPERATURE

Similar to precipitation, the year-to-year variability of monthly temperatures at the Kitsault site was quantified with Cv values. Monthly Cv values were calculated for the Kitsault site based on an average of values from the Stewart A and Nass Camp MSC stations. Table 4.1 includes the estimated monthly Cv values for temperature.

4.4 EFFECTIVE RUNOFF COEFFICIENTS

The effective runoff coefficient is calculated as the ratio of the mean annual runoff and mean annual precipitation. It is recognized that runoff coefficients will vary from year to year, and month to month, and that they will generally be higher during wet periods and lower during dry periods, but an average value is typically suitable for most water balance modelling exercises. For the Kitsault site, the effective mean annual runoff coefficient was estimated to be approximately 0.70. This value was essentially determined from the ratio of the mean annual unit runoff for Lime Creek of 1441 mm (45.7 l/s/km^2) and the mean annual precipitation for the project climate station of 2000 mm.

SECTION 5.0 - CONCLUSIONS

The key findings of this study are summarized below. All meteorological results are presented for the location of the Kitsault climate station and adjustments may be required to apply them to other locations within the project area.

The key findings of this study are:

- The mean annual temperature is estimated to be 3.2 °C, with minimum and maximum mean monthly temperatures of -6.0 °C and 11.6 °C occurring in January and July respectively.
- The mean annual wind speed is approximately 1.9 m/s.
- The mean annual relative humidity is approximately 81%.
- The mean annual lake evaporation (potential evapotranspiration) is estimated to be 450 mm.
- The mean annual precipitation is estimated to be 2000 mm, with 45% falling as rain and 55% falling as snow.
- The mean annual unit runoff for Lime Creek at the mouth is 45.7 $l/s/km^2$.
- The mean annual unit runoff for Patsy Creek is 45.1 $l/s/km^2$.
- The mean annual unit runoff for Upper Clary Creek is estimated to be 45.1 $l/s/km^2$. This is based on a synthetic flow series developed from the Patsy Creek flow series.
- The annual hydrograph in the Kitsault project area typically has a bi-modal shape, with its highest peak in the freshet period and a secondary peak in late fall or early winter.
- Return period peak flows and 7-day low flows were estimated for Lime Creek at the mouth, Patsy Creek, and Upper Clary Creek. 200-year peak flows were 140 m^3/s, 22 m^3/s, and 112 m^3/s, respectively. 10-year 7-day low flows were estimated at 0.08 m^3/s, 0.01 m^3/s, and 0.06 m^3/s for the three creeks, respectively.
- The effective mean annual runoff coefficient for the project area is estimated to be approximately 0.70.
- Climate change has not been considered explicitly in the hydrometeorological estimates, and appropriate allowances should be made where necessary.

SECTION 6.0 - REFERENCES

Cathcart, J. (2001). *The Effects of Scale and Storm Severity on the Linearity of Watershed Response Revealed Through the Regional L-Moment Analysis of Annual Peak Flows*, Ph.D. Thesis, Department of Resource Management and Environmental Studies, University of British Columbia.

Coulson, C.H. (1991). *Manual of Operational Hydrology in British Columbia.* Ministry of Environment, Water Management Division, Hydrology Section. February 1991.

Hogg, W.D., Carr, D.A. (1985). Rainfall Frequency Atlas of Canada. Ministry of Environment, Canadian Climate Program, 1985.

Knight Piésold (2010). *Avanti Kitsault Mine Ltd., Kitsault Project – Engineering Hydrometeorology Report*. Ref no. VA101-343/9-1 Rev 0, July 15, 2010.

Knight Piésold (2011). *Avanti Kitsault Mine Ltd., Kitsault Project – Hydrogeology and Watershed Model*. Ref. No. VA101-343/9-3 Rev A, January 17, 2011.

Loukas, A. (1994). *Mountain Precipitation Analysis for the Estimation of Flood Runoff in Coastal British Columbia*. UBC, Faculty of Graduate Studies, Department of Civil Engineering. August 1994.

Maidment, D.R. (1993). *Handbook of Hydrology*. McGraw-Hill Inc, Washington, DC, USA

Miller, J.F., Frederick, R.H., Tracey, R.J. (1973). *Precipitation-Frequency Atlas of the Western United States – Volume IX – Washington.* National Oceanic and Atmospheric Administration, Washington, DC, USA

Natural Resources Canada, 1978. *Hydrologic Atlas of Canada – Mean Lake Evaporation.* Website: http://atlas.nrcan.gc.ca/site/english/maps/archive/hydrological_atlas_1978 .

Obedkoff, W. (2001). *Streamflow in the Skeena Region.* British Columbia Ministry of Environment, Resources Inventory Branch, Water Inventory Section. June 2001.

Ponce, M. P. (1989). *Engineering Hydrology – Principles and Practices.* Prentice-Hall Inc., New Jersey, USA

Raes, D. (2009). *The ETo Calculator, Reference Manual, Version 3.1, January 2009.* FAO United Nations, Rome, Italy.

Rescan Environmental Services Ltd. (2010). *Kitsault Project: 2008 – 2010 Meteorology, Air Quality and Noise Baseline Report, May 2010.*

Rescan Environmental Services Ltd. (2010). *Kitsault Project: 2009 Hydrology Baseline Report, April 2010.*

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SECTION 7.0 - CERTIFICATION

This report was prepared, reviewed and approved by the undersigned.

Prepared: Erin Rainey, P.Eng.
Project Engineer

Mediha Hodzic, E.I.T.
Staff Engineer

PROFESSIONAL ENGINEER J. G. CATHCART BRITISH COLUMBIA

Jan 17, 2011

Reviewed: Jaime Cathcart, Ph.D., P.Eng.
Specialist Hydrotechnical Engineer

Approved: Ken Brouwer, P.Eng.
Managing Director

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TABLE 2.1

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
SUMMARY OF SITE METEOROLOGY STATIONS

Print 01/17/11 11:32

No.	Station Name	Station ID.	Years of Record	No. of Years Complete Record	Start Year	End Year	Latitude	Longitude	Elevation (m)	Mean Annual Precipitation (mm)
1	Kitsault	KITS	3	0	2008	2010	55^o 25'	129^o 25'	682	-
2	Kitsault Minesite	1074330	4	1	1969	1972	55^o 30'	129^o 00'	652	2303
3	Kitsault Minesite	1064329	2	0	1968	1969	55^o 26'	129^o 28'	621	-

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[AES_WSC_stations.xls]Table 2.1

NOTES:

1. DATA FOR STATION 1, KITS, OBTAINED FROM THE SITE CLIMATE STATION.
2. DATA FOR STATIONS 2 AND 3 OBTAINED FROM THE METEOROLOGICAL SERVICES OF CANADA BRANCH (MSC) OF ENVIRONMENT CANADA.
3. MEAN ANNUAL PRECIPITATION VALUES BASED ON COMPLETE YEARS OF RECORD ONLY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
1	04JAN'11	UPDATED 2010 DATA	MH	ER	JGC
0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	AMD	JWV	JGC

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TABLE 2.2

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
SUMMARY OF REGIONAL METEOROLOGY STATIONS

Print 01/17/11 11:34

No.	Station Name	Station ID.	Years of Record	No. of Years Complete Record	Start Year	End Year	Latitude	Longitude	Elevation (m)	Mean Annual Precipitation (mm)
1	Alice Arm	1060331	6	1	1973	1978	55^o 28'	129^o 28'	2	1423
2	Alice Arm	1060330	17	13	1948	1964	55^o 41'	129^o 30'	314	2082
3	Anyox	1060446	20	16	1916	1935	55^o 27'	129^o 48'	113	2051
4	Stewart	1067740	58	45	1910	1967	55^o 57'	129^o 59'	4.6	1733
5	Stewart A	1067742	36	33	1974	2010	55^o 56'	129^o 59'	7	1872
6	Stewart BCHPA	1067745	10	8	1967	1976	55^o 57'	129^o 59'	12.2	1800
7	Premier	1066420	35	28	1926	1996	56^o 03'	130^o 01'	410	2202
8	Nass Camp	1075384	35	22	1973	2007	55^o 14'	129^o 2'	290	1090
9	Aiyansh	1070150	48	42	1924	1971	55^o 14'	129^o 1'	229	1073
10	Annete (Alaska)	500352	58	53	1949	2006	55^o 02'	131^o 34'	0	2775
11	Beaver Falls (Alaska)	500657	58	38	1949	2006	55^o 23'	131^o 28'	0	3813

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[AES_WSC_stations.xls]Table 2.2

NOTES:

1. DATA OBTAINED FROM THE METEOROLOGICAL SERVICES OF CANADA BRANCH (MSC) OF ENVIRONMENT CANADA.
2. MEAN ANNUAL PRECIPITATION VALUES BASED ON COMPLETE YEARS OF RECORD ONLY.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
1	05JAN'11	UPDATED 2010 DATA	MH	ER	JGC
0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	AMD	JWV	JGC

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TABLE 2.3

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
MEAN TEMPERATURE AT KITSAULT METEOROLOGY STATION

Print 1/17/11 11:36

Year	Mean Temperature (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1968	-	-1.6	1.3	0.6	7.9	9.3	13.2	12.2	7.7	3.0	-0.2	-	-
1969	-15.0	-4.1	-	-	11.9	15.4	11.1	9.1	8.6	5.5	-	-0.9	-
1970	-	0.4	-	1.6	4.8	9.8	9.9	10.3	7.1	4.4	-2.2	-6.5	-
1971	-7.9	-4.0	-3.8	1.3	4.6	9.3	-	-	-	-	-1.0	-	-
1972	-	-7.3	-	-1.0	-	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-	-	-	-	-7.2	-
2009	-4.2	-4.4	-3.4	2.1	5.6	10.8	15.1	12.5	8.8	3.4	-0.8	-6.4	3.3
2010	-1.3	1.3	0.6	3.2	7.5	8.7	11.3	12.6	9.5	4.0	-	-	-
Average	-7.1	-2.8	-1.3	1.3	7.0	10.6	12.1	11.3	8.4	4.1	-1.1	-5.2	3.1
est. Long-term	**-6.0**	**-3.7**	**-0.9**	**2.9**	**7.3**	**10.3**	**11.6**	**10.9**	**7.9**	**3.5**	**-1.3**	**-4.6**	**3.2**

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[Temperature Analysis.xlsx]Table 2.3

NOTES:

1. DATA FROM FEB 1969 TO OCTOBER 1969 FROM MSC STATION 1074330 (KITSAULT MINESITE).
2. DATA FROM DEC 1969 TO APR 1972 FROM MSC STATION 1074329 (KITSAULT MINESITE).
3. DATA FROM DEC 2008 TO OCTOBER 2010 FROM SITE MET STATION.
4. ESTIMATED LONG-TERM AVERAGE BASED ON 101 YEAR SYNTHETIC RECORD GENERATED THROUGH LINEAR REGRESSION WITH MSC DATA FROM STEWART CLIMATE STATIONS.

1	05JAN'11	UPDATED 2010 DATA	MH	ER	JGC
0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	JWV	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE 2.4

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
MEAN WIND SPEED AT KITSAULT METEOROLOGY STATION

Print 1/17/11 11:40

Year	Mean Wind Speed (m/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2008	-	-	-	-	-	-	-	-	-	-	-	2.1	-
2009	1.9	1.6	1.9	1.8	2.0	1.9	1.7	1.9	1.4	1.9	1.7	2.1	1.8
2010	2.4	1.9	1.7	2.1	1.8	2.0	2.1	1.7	1.9	1.7	-	-	-
Average	**2.1**	**1.7**	**1.8**	**2.0**	**1.9**	**1.9**	**1.9**	**1.8**	**1.7**	**1.8**	**1.7**	**2.1**	**1.9**

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[Wind Analysis.xlsx]Table 2.4

NOTE:

1. DATA FROM SITE MET STATION.

1	17DEC'10	UPDATED 2010 DATA	MH	ER	JGC
0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	JWV	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE 2.5

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
MEAN RELATIVE HUMIDITY AT KITSAULT METEOROLOGY STATION

Print 1/17/11 12:07

Year	Relative Humidity (%)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2008	-	-	-	-	-	-	-	-	-	-	-	74.5	-
2009	83.8	77.6	80.4	74.7	77.0	75.6	76.2	82.4	90.0	81.4	90.9	76.7	80.6
2010	81.4	79.1	86.0	72.5	75.0	83.9	84.1	83.1	75.3	90.2	-	-	-
Average	**82.6**	**78.3**	**83.2**	**73.6**	**76.0**	**79.7**	**80.1**	**82.7**	**82.7**	**85.8**	**90.9**	**75.6**	**80.9**

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[Humidity Analysis.xlsx]Table 2.5

NOTE:

1. DATA FROM SITE MET STATION.

1	17DEC'10	UPDATED 2010 DATA	MH	ER	JGC
0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	JWV	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE 2.6

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
ESTIMATED LONG-TERM SITE POTENTIAL EVAPOTRANSPIRATION

Print Jan/17/11 12:08

Method	Temperature Record		Evapotranspiration (mm)												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Hargreaves equation	1968-1972, 2008-2010	mm	4	10	18	35	72	95	97	79	49	27	10	7	503
		% annual	0.9%	2.0%	3.6%	6.9%	14.3%	18.9%	19.3%	15.7%	9.7%	5.3%	2.0%	1.3%	100%
Thornthwaite equation	1968-1972, 2008-2010	mm	0	3	5	18	54	73	75	71	57	33	0	0	389
		% annual	0.0%	0.8%	1.4%	4.5%	13.9%	18.9%	19.3%	18.3%	14.5%	8.4%	0.0%	0.0%	100%
	Long-term est.	mm	0	0	3	26	53	67	74	70	55	30	2	0	381
		% annual	0.0%	0.1%	0.9%	6.9%	13.8%	17.7%	19.3%	18.5%	14.5%	7.9%	0.5%	0.0%	100%
Long-term est.		**mm**	**2**	**6**	**11**	**26**	**64**	**85**	**87**	**76**	**55**	**31**	**4**	**3**	**450**
		% annual	**0.4%**	**1.4%**	**2.5%**	**5.7%**	**14.1%**	**18.9%**	**19.3%**	**17.0%**	**12.1%**	**6.9%**	**1.0%**	**0.7%**	**100%**

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[PET_calculator_20101221.xlsx]Summary

NOTES:

1. POTENTIAL EVAPOTRANSPIRATION (PET) VALUES CALCULATED USING HARGREAVES EQUATION WERE BASED ON THE DAILY MINIMUM, MEAN AND MAXIMUM TEMPERATURE VALUES RECORDED AT THE KITSAULT SITE WEATHER STATION FOR 2008-2010. IT WAS ASSUMED THAT WHEN THE MEAN DAILY TEMPERATURE WAS BELOW -17.8 DEGREES CELSIUS ZERO OR THE MAXIMUM DAILY TEMPERATURE WAS BELOW ZERO DEGREES CELSUIS, THAT PET WAS EQUAL TO ZERO.
2. POTENTIAL EVAPOTRANSPIRATION VALUES CALCULATED USING THE THORNTHWAITE EQUATION WERE BASED ON MEAN MONTHLY TEMPERATURE VALUES FOR THE HISTORICAL DATA SET (1968-1972) AND THE CURRENT TEMPERATURE RECORD COLLECTED IN 2008-2010. THESE ESTIMATES WERE COMPARED TO THE PET CALCULTATED USING THE LONG-TERM SYNTHETIC TEMPERATURE RECORD DEVELOPED FOR THE SITE. THE THORNTHWAITE EQUATION ASSUMES THAT THE PET IS ZERO WHEN THE MEAN MONTHLY TEMPERATURE IS ZERO.
3. THE LONG-TERM POTENTIAL EVAPOTRANSPIRATION DISTRIBUTION WAS BASED ON AN AVERAGE OF THE THORNTHWAITE EQUATION AND THE RESULTS OF THE HARGREAVES EQUATION FOR THE YEARS WITH SITE TEMPERATURE RECORD.

1	04JAN'11	UPDATED 2010 DATA	MH	ER	JGC
0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	ER	JV	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE 2.7

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
PRECIPITATION DATA COLLECTED AT THE MINE SITE

Print 1/17/11 13:56

Year	Total Precipitation (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1968	-	79	105	189	45	75	95	105	244	176	115	-	-
1969	76	103	-	-	58	85	115	287	122	-	-	155	-
1970	147	61		117	123	62	128	127	155	163	84	207	-
1971	422	91	323	155	25	88	23	146	131	217	367	313	2303
1972	480	413	254	214	-	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-	-	-	-	160	-
2009	250	-	-	77	73	50	38	99	183	167	176	43	-
2010	58	18	104	50	62	116	54	85	149	260	-	-	-
Average 1968-2010	**239**	**127**	**196**	**134**	**64**	**79**	**75**	**141**	**164**	**197**	**185**	**176**	**1778**
Average 1968-1972	**281**	**149**	**227**	**169**	**63**	**78**	**90**	**166**	**163**	**185**	**189**	**225**	**1985**

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[Precipitation Analysis.xlsx]Table 2.7

NOTES:

1. DATA FROM FEB 1969 TO OCTOBER 1969 FROM MSC STATION 1074330 (KITSAULT MINESITE).
2. DATA FROM DEC 1969 TO APR 1972 FROM MSC STATION 1074329 (KITSAULT MINESITE).
3. DATA FROM DEC 2008 TO OCT 2010 FROM SITE MET STATION.
4. WINTER DATA IN 2008 - 2010 LIKELY ERRONEOUS.

1	04JAN'11	UPDATED 2010 DATA	MH	ER	JGC
0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	JWV	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 2.8

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
SUMMARY OF REGIONAL TOTAL PRECIPITATION DISTRIBUTIONS

Print 1/17/11 12:11

MSC Station	Period of Record	Distance from Site (km)	Mean Total Precipitation													
			Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Alice Arm ID 1060330	1948 - 1964	27.9	mm	196	194	150	131	69	74	74	119	196	357	245	282	2087
			%	9%	9%	7%	6%	3%	4%	4%	6%	9%	17%	12%	14%	100%
Anyox ID 1060446	1916 - 1935	21.6	mm	245	180	150	82	61	55	66	107	150	300	335	276	2007
			%	12%	9%	7%	4%	3%	3%	3%	5%	7%	15%	17%	14%	100%
Kitsault Minesite ID 1074330, 1064329	1968 - 1972	0	mm	281	149	227	169	63	78	90	166	163	185	189	225	1985
			%	14%	8%	11%	8%	3%	4%	5%	8%	8%	9%	9%	11%	100%
Nass Camp ID 1075384	1973 - 2007	35.5	mm	135	68	46	43	48	57	59	74	113	162	129	132	1066
			%	13%	6%	4%	4%	5%	5%	5%	7%	11%	15%	12%	12%	100%
Stewart A ID 1067742	1975 - 2010	64.2	mm	219	139	122	85	72	66	74	116	207	291	225	222	1838
			%	12%	8%	7%	5%	4%	4%	4%	6%	11%	16%	12%	12%	100%
Estimated Long-term Kitsault Minesite	**N/A**	**N/A**	**mm**	**240**	**163**	**155**	**113**	**70**	**74**	**81**	**129**	**185**	**288**	**250**	**253**	**2000**
			%	**12%**	**8%**	**8%**	**6%**	**3%**	**4%**	**4%**	**6%**	**9%**	**14%**	**13%**	**13%**	**100%**

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[Precip Distribution.xlsx]Table 2.8

1	04JAN'11	UPDATED 2010 DATA	MH	ER	JGC
0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	JWV	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 2.9

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
MONTHLY RAIN/SNOW DISTRIBUTION

Print 1/17/11 12:10

Description	Period of Record	Elevation (m)	Precip.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Alice Arm ID 1060330	1968 - 1972	314	Rain	18%	30%	34%	75%	98%	100%	100%	100%	100%	94%	52%	25%	63%
			Snow	82%	70%	66%	25%	2%	0%	0%	0%	0%	6%	48%	75%	37%
Kitsault Minesite ID 1064329, 1074330	**1968 - 1972**	**652**	**Rain**	**3%**	**2%**	**12%**	**22%**	**97%**	**100%**	**100%**	**100%**	**99%**	**75%**	**28%**	**6%**	**45%**
			Snow	**97%**	**98%**	**88%**	**78%**	**3%**	**0%**	**0%**	**0%**	**1%**	**25%**	**72%**	**94%**	**55%**

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[Precip Distribution.xlsx]Table 2.9

NOTE:

1. DATA FROM METEOROLOGICAL SERVICE OF CANADA.

0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	JWV	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE 2.10

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
ESTIMATED PROJECT SITE RAINFALL INTENSITY DURATION FREQUENCY VALUES

Print: 1/17/11 13:55

Annual Rainfall Extremes (mm)

Duration	Mean	St Dev	Augmentation Factor	Augmented Mean	Augmented St Dev
5 min	3.0	1.0	1.5	4.5	1.5
10 min	4.0	1.5	1.5	6.0	2.3
15 min	5.5	1.5	1.5	8.3	2.3
30 min	7.5	2.0	1.5	11.3	3.0
1 hr	10.0	3.0	1.5	15.0	4.5
2 hr	14.5	4.0	1.8	26.1	7.2
6 hr	19.0	7.5	1.8	34.2	13.5
12 hr	27.0	13.0	2.0	54.0	26.0
24 hr	47.0	15.0	2.0	94.0	30.0

Frequency Factors for PMP

Duration	K_{PMP}
1 hr	16.03
6 hr	16.07
24 hr	15.42

Gumbel Frequency Factors

Return Period	2	5	10	15	20	25	50	100	200	1000
K_T	-0.1640	0.719	1.305	1.635	1.866	2.044	2.592	3.137	3.679	4.936

Return Period Rainfall Amounts (mm)

Duration	2 yrs	5 yrs	10 yrs	15 yrs	20 yrs	25 yrs	50 yrs	100 yrs	200 yrs	1000 yrs	PMP
5 min	4	6	6	7	7	8	8	9	10	12	
10 min	6	8	9	10	10	11	12	13	14	17	
15 min	8	10	11	12	12	13	14	15	17	19	
30 min	11	13	15	16	17	17	19	21	22	26	
1 hr	14	18	21	22	23	24	27	29	32	37	87
2 hr	25	31	35	38	40	41	45	49	53	62	
6 hr	32	44	52	56	59	62	69	77	84	101	242
12 hr	50	73	88	97	103	107	121	136	150	182	
24 hr	**89**	**116**	**133**	**143**	**150**	**155**	**172**	**188**	**204**	**242**	**557**

Rainfall Intensity (mm/hr)

Duration	2 yrs	5 yrs	10 yrs	15 yrs	20 yrs	25 yrs	50 yrs	100 yrs	200 yrs	1000 yrs	PMP
5 min	51	67	77	83	88	91	101	110	120	143	
10 min	34	46	54	58	61	64	71	78	86	103	
15 min	32	39	45	48	50	51	56	61	66	77	
30 min	22	27	30	32	34	35	38	41	45	52	
1 hr	14	18	21	22	23	24	27	29	32	37	87
2 hr	12	16	18	19	20	20	22	24	26	31	
6 hr	5.3	7.3	8.6	9.4	9.9	10.3	11.5	12.8	14.0	16.8	40
12 hr	4.1	6.1	7.3	8.0	8.5	8.9	10.1	11.3	12.5	15.2	
24 hr	**3.7**	**4.8**	**5.5**	**6.0**	**6.2**	**6.5**	**7.2**	**7.8**	**8.5**	**10.1**	**23**

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[24 hr rainfall_20100622.xls]Summary Table

NOTES:

1. MEAN ANNUAL 24 HOUR EXTREME RAINFALL AND STANDARD DEVIATION WERE ESTIMATED USING THE RAINFALL FREQUENCY ATLAS OF CANADA.
2. AUGMENTATION FACTORS APPLIED AS SUGGESTED IN THE RFAC FOR COASTAL, MOUNTAINOUS WATERSHEDS.
3. RETURN PERIOD RAINFALL AMOUNTS COMPUTED ASSUMING A GUMBEL TYPE DISTRIBUTION.
4. FREQUENCY FACTORS FOR PMP ARE ESTIMATED USING THE HERSHFIELD EQUATION, AS SUGGESTED IN THE RFAC.
5. AUGMENTATION FACTORS AS SUGGESTED IN THE RFAC.

0	05JAN'11	ISSUED WITH REPORT VA101-343/9-1	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.1

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
SUMMARY OF SITE STREAMFLOW STATIONS

Print 1/17/11 12:27

Station Name	Station ID	Years of Record	No. of Years of Complete Record	Start Year	End Year	Latitude	Longitude	Drainage Area (km^2)	Mean Annual Discharge (m^3/s)	Average Annual Unit Runoff ($l/s/km^2$)	Elevation (m)	Glacier Fraction (%)
Lime Creek near the mouth (WSC)	08DB010	21	15	1976	1996	55° 27' 18"	129° 28' 48"	39.4	1.8	45.7	30	0
Patsy Creek near the mouth (WSC)	08DB012	10	8	1987	1996	55° 25' 8"	129° 24' 57"	4.68	0.21	45.1	473	0
Lower Lime Creek	LCK-H2	1	0	2010	2010	55° 27' 18"	129° 28' 48"	39.7	-	-	17	0
Upper Lime Creek	LCK-H1	2	0	2009	2010	55° 25' 26"	129° 26' 4"	25.1	-	-	455	0
Patsy Creek	PCK-H1	2	0	2009	2010	55° 25' 9"	129° 25' 6"	9.5	-	-	575	0
Clary Creek	CCK-H1	1	0	2010	2010	55° 26' 48"	129° 21' 34"	3.8	-	-	740	0

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[AES_WSC_stations.xls]SITE HYDR

NOTE:

1. DATA OBTAINED FROM THE WATER SURVEY OF CANADA (WSC) FOR 08DB010 AND 08DB012.

1	05JAN'11	UPDATED 2010 DATA	MH	ER	JGC
0	07JUL'10	ISSUED WITH REPORT VA101-343/9-1	AMD	JWV	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.2

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
SUMMARY OF REGIONAL STREAMFLOW STATIONS

Print 1/17/11 12:30

	Station Name	Station ID	Years of Record	No. of Years of Complete Record	Start Year	End Year	Latitude	Longitude	Drainage Area (km^2)	Mean Annual Discharge (m^3/s)	Average Annual Unit Runoff ($l/s/km^2$)	Elevation (m)	Glacier Fraction (%)
Active	Ansedagan Creek near New Aiyansh	08DB013	14	13	1997	2010	55° 7' 58"	129° 21' 23"	26.1	1.03	39.5	40	0
Active	Ksedin Tributary No. 2 Cr. near New Aiyansh	08DB014	14	13	1997	2010	55°1'5"	129°20'32"	17.4	0.594	34.1	160	0
Active	Nass River above Shumal Creek	08DB001	82	51	1929	2010	55°15'50"	129°5'10"	18400	778	42.3	30	12
Inactive	Kitsault River above Klayduc	08DB011	16	14	1981	1996	55° 33' 40"	129° 30' 11"	242	22.7	93.8	91	11
Inactive	Bear River above Bitter Creek	08DC006	33	31	1967	1999	56° 2' 34"	129° 55' 30"	350	25.2	72.0	76	31

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\[AES_WSC_stations.xls]REG HYDR

NOTE:

1. DATA OBTAINED FROM THE WATER SURVEY OF CANADA (WSC), BRANCH OF ENVIRONMENT CANADA.

1	05JAN'11	UPDATED 2010 DATA	MH	ER	JGC
0	07JUL'10	ISSUED WITH REPORT VA101-343/9-1	AMD	JWV	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.3

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

UPPER LIME CREEK HYDROLOGIC STATION
SUMMARY OF GAUGE CALIBRATION DISCHARGE MEASUREMENTS

Print Jan/17/11 10:06:33

Date	Time	Method	Recorded Stage (m)	Measured Discharge (m^3/s)
25-Mar-09	8:00	EST	99.47	0.001
21-May-09	16:00	CM	99.75	2.04
17-Jun-09	11:12	SD	99.86	3.25
24-Jul-09	11:00	CM	99.69	1.10
23-Sep-09	11:00	CM	99.70	1.16
9-Nov-09	8:01	CM	99.66	0.52
19-Apr-10	15:50	CM	99.89	4.04
25-Apr-10	12:45	CM	99.67	0.70
26-May-10	13:33	RD	99.96	7.50
2-Jun-10	12:29	CM	99.82	2.81
26-Jun-10	7:10	CM	99.66	0.50
28-Jul-10	15:58	CM	99.61	0.26
21-Nov-10	9:00	EST	99.62	0.36

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\Analysis\LCK-H1\[Rating Curve_1.xlsx]Table 3.3

NOTE:

1. METHOD ABBREVIATION LEGEND: CM - CURRENT METER, RD - RHODAMINE DYE INJECTION, EST - ESTIMATE, SD - SALT DILUTION.

0	05JAN'11	ISSUED WITH REPORT VA101-343/9-1	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.4

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

LOWER LIME CREEK HYDROLOGIC STATION
SUMMARY OF GAUGE CALIBRATION DISCHARGE MEASUREMENTS

Print Jan/17/11 14:10:52

Date	Time	Method	Recorded Stage (m)	Measured Discharge (m^3/s)
19-Apr-10	13:25	CM	99.68	4.62
25-Apr-10	11:44	CM	99.44	1.19
26-May-10	9:01	CM/RD	99.68	4.59
1-Jun-10	17:02	CM	99.66	4.04
26-Jun-10	11:30	CM	99.36	0.66
28-Jul-10	7:40	CM	99.33	0.48
26-Aug-10	14:07	CM	99.38	1.01
12-Oct-10	8:10	RD	99.76	4.84
16-Nov-10	14:25	CM	99.48	1.55

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\Analysis\LCK-H2\[Rating Curve.xlsx]Table 3.4

NOTE:

1. METHOD ABBREVIATION LEGEND: CM - CURRENT METER, RD - RHODAMINE DYE INJECTION, EST - ESTIMATE

0	05JAN'11	ISSUED WITH REPORT VA101-343/9-1	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.5

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

PATSY CREEK HYDROLOGIC STATION
SUMMARY OF GAUGE CALIBRATION DISCHARGE MEASUREMENTS

Print Jan/17/11 11:06:18

Date	Time	Method	Recorded Stage (m)	Measured Discharge (m^3/s)
21-Apr-09	15:50	CM	99.37	0.22
20-May-09	13:30	CM	99.52	0.87
16-Jun-09	13:36	SD	99.55	1.20
24-Jul-09	8:15	CM	99.33	0.14
23-Sep-09	16:00	CM	99.44	0.42
10-Nov-09	10:00	CM	99.37	0.23
2-Mar-10	11:00	CM	99.30	0.07
20-Apr-10	7:10	CM	99.60	1.60
25-Apr-10	14:00	CM	99.41	0.33
26-May-10	9:00	CM	99.52	0.85
1-Jun-10	15:37	CM	99.50	0.79
26-Jun-10	9:15	CM	99.30	0.10
29-Jul-10	7:30	CM	99.29	0.05
26-Aug-10	15:00	CM	99.37	0.21

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\Analysis\PCK-H1\[Rating Curve .xlsx]Table 3.5

NOTE:

1. METHOD ABBREVIATION LEGEND: CM - CURRENT METER, RD - RHODAMINE DYE INJECTION, EST - ESTIMATE, SD - SALT DILUTION.

0	05JAN'11	ISSUED WITH REPORT VA101-343/9-1	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE 3.6

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

CLARY CREEK HYDROLOGIC STATION
SUMMARY OF GAUGE CALIBRATION DISCHARGE MEASUREMENTS

Print Jan/17/11 11:19:11

Date	Time	Method	Recorded Stage (m)	Measured Discharge (m^3/s)
25-May-10	16:05	CM	97.68	0.28
1-Jun-10	14:10	CM	97.45	0.04
20-Jun-10	17:25	CM	97.38	0.01
29-Jul-10	10:34	CM	97.38	0.01
26-Aug-10	12:27	CM	97.57	0.11
12-Oct-10	10:35	CM	97.80	0.47
16-Nov-10	12:10	CM	97.59	0.14

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\Analysis\CCK-H1\[Rating Curve.xlsx]Table 3.6

NOTE:

1. METHOD ABBREVIATION LEGEND: CM - CURRENT METER.

0	05JAN'11	ISSUED WITH REPORT VA101-343/9-1	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.7

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
SUMMARY OF MEAN MONTHLY DISCHARGES AND UNIT RUNOFFS AT SITE STATIONS

Print Jan/17/11 12:36:41

Station	Mean Monthly Discharge (m^3/s)												
	Apr-09	May-09	Jun-09	Jul-09	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10
CCK-H1	-	-	-	-	-	-	0.14	0.06	0.04	0.03	0.13	0.29	0.22
LCK-H1	-	3.06	5.55	1.73	0.28	0.98	2.48	1.58	0.68	0.38	1.49	2.49	1.10
LCK-H2	-	-	-	-	0.63	1.77	3.67	2.23	0.96	0.58	2.02	4.31	2.88
PCK-H1	0.28	1.56	1.65	0.32	0.13	0.47	0.91	0.35	0.17	0.12	0.40	0.84	0.55
	Mean Monthly Unit Discharge ($l/s/km^2$)												
CCK-H1	-	-	-	-	-	-	37	17	12	7	35	77	57
LCK-H1	-	122	221	69	11	39	99	63	27	15	59	99	44
LCK-H2	-	-	-	-	16	45	92	56	24	15	51	109	73
PCK-H1	29	164	173	33	14	49	96	37	18	12	42	89	58

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\[Site Data Summary.xlsx]Table 3.7

NOTES:

1. THE DRAINAGE AREAS OF CCK-H1, LCK-H1, LCK-H2, AND PCK-H1 ARE 3.8 KM^2, 25.1 KM^2, 39.7 KM^2, AND 9.5 KM^2, RESPECTIVELY.
2. THE SHADED CELLS INDICATE INCOMPLETE MONTHS.
3. ONLY RELEVANT MONTHS/YEARS ARE SHOWN IN TABLE. IF DATA WAS NOT COLLECTED AT ANY OF THE FOUR SITES DURING A SPECIFIC MONTH (I.E. JANUARY 2010), THEN THAT MONTH IS NOT DISPLAYED.

0	13JAN'11	ISSUED WITH REPORT VA101-343/9-1	MH	JGC	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.8

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
LIME CREEK LONG-TERM MEAN MONTHLY STREAMFLOW RECORD

Print Jan/17/11 9:39:14

Year	Mean Monthly Discharge (m^3/s)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1977	0.49	0.85	0.40	2.46	3.79	4.01	1.29	0.54	0.62	3.01	0.68	0.31	1.54
1981	0.67	0.44	0.60	1.03	6.21	3.62	1.23	0.43	3.14	1.95	2.03	0.36	1.81
1982	0.22	0.18	0.18	0.53	3.63	4.60	1.16	0.46	1.18	1.40	0.57	0.21	1.19
1984	0.75	0.81	0.99	1.97	4.18	3.22	2.08	1.17	0.56	0.70	0.22	0.24	1.41
1985	0.39	0.67	0.29	0.80	5.86	6.69	3.79	1.01	1.94	1.91	0.38	0.18	2.00
1986	0.28	0.22	1.16	1.26	3.71	5.20	1.45	0.68	1.18	4.40	1.27	0.58	1.79
1987	0.69	0.59	0.39	1.77	4.59	4.60	1.83	0.49	2.96	2.59	2.56	0.60	1.97
1988	0.11	0.13	0.27	2.12	5.24	3.60	2.09	1.68	2.82	3.69	1.22	0.99	2.00
1989	0.67	0.60	0.53	1.78	4.01	2.84	1.37	0.91	1.18	2.55	1.22	1.28	1.59
1990	0.46	0.36	0.90	1.97	4.44	3.66	1.52	0.50	0.76	2.15	0.89	1.02	1.56
1991	0.88	1.23	0.42	2.43	6.87	8.17	5.34	1.99	1.86	6.16	2.53	2.34	3.36
1992	1.17	1.17	1.28	2.52	3.75	4.40	0.89	0.30	3.41	2.98	1.54	0.27	1.97
1993	0.48	1.78	0.65	2.77	5.15	2.00	0.92	0.46	0.78	1.61	5.12	1.23	1.91
1994	1.15	0.42	0.87	2.40	3.26	2.73	1.28	0.71	3.62	2.08	0.58	0.31	1.62
1995	0.26	0.43	0.68	2.24	3.73	1.87	0.75	1.47	0.94	2.72	1.13	0.63	1.41
Average	0.58	0.66	0.64	1.87	4.56	4.08	1.80	0.85	1.80	2.66	1.46	0.70	1.81
Min	0.11	0.13	0.18	0.53	3.26	1.87	0.75	0.30	0.56	0.70	0.22	0.18	1.19
Max	1.17	1.78	1.28	2.77	6.87	8.17	5.34	1.99	3.62	6.16	5.12	2.34	3.36

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\[Lime Creek Daily Streamflow Record (08DB010).xlsx]Table

NOTES:

1. THE STREAMFLOW DATA PRESENTED ABOVE WERE COLLECTED BY THE WATER SURVEY OF CANADA AT THE MOUTH OF LIME CREEK (WSC 08DB010).
2. THE DRAINAGE ARE AT THIS LOCATION IS 39.4 km^2.

0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	KT	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.9

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
PATSY CREEK LONG-TERM MEAN MONTHLY MEASURED / ESTIMATED STREAMFLOW SERIES

Print Jan/14/11 11:31:24

Year	Mean Monthly Discharge (m^3/s)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1	0.05	0.08	0.03	0.30	0.65	0.48	0.06	0.04	0.05	0.35	0.08	0.03	0.18
2	0.06	0.04	0.04	0.09	1.02	0.43	0.06	0.03	0.35	0.23	0.21	0.04	0.22
3	0.03	0.02	0.01	0.04	0.62	0.55	0.06	0.03	0.12	0.17	0.07	0.02	0.14
4	0.07	0.08	0.07	0.20	0.72	0.38	0.10	0.10	0.04	0.09	0.04	0.03	0.16
5	0.04	0.06	0.02	0.06	0.95	0.80	0.19	0.08	0.21	0.22	0.05	0.02	0.23
6	0.03	0.02	0.09	0.12	0.63	0.62	0.07	0.05	0.12	0.50	0.14	0.06	0.21
7	0.07	0.06	0.03	0.18	0.78	0.55	0.09	0.01	0.30	0.31	0.28	0.07	0.23
1988	0.03	0.02	0.03	0.24	0.78	0.45	0.17	0.14	0.29	0.35	0.13	0.10	0.23
1989	0.06	0.05	0.03	0.27	0.81	0.33	0.05	0.08	0.13	0.25	0.31	0.33	0.23
1990	0.08	0.03	0.04	0.25	0.91	0.49	0.10	0.02	0.16	0.32	0.09	0.11	0.22
1991	0.08	0.11	0.06	0.18	0.90	0.80	0.12	0.11	0.16	0.91	0.18	0.18	0.32
1992	0.07	0.09	0.12	0.40	0.67	0.65	0.03	0.01	0.40	0.36	0.14	0.03	0.25
1993	0.04	0.20	0.05	0.32	0.80	0.21	0.09	0.06	0.08	0.19	0.43	0.06	0.21
1994	0.10	0.04	0.08	0.32	0.63	0.28	0.08	0.09	0.36	0.23	0.09	0.04	0.20
1995	0.03	0.03	0.03	0.20	0.68	0.17	0.04	0.13	0.07	0.36	0.11	0.06	0.16
Average	0.06	0.06	0.05	0.21	0.77	0.48	0.09	0.07	0.19	0.32	0.16	0.08	0.21
Min	0.03	0.02	0.01	0.04	0.62	0.17	0.03	0.01	0.04	0.09	0.04	0.02	0.14
Max	0.10	0.20	0.12	0.40	1.02	0.80	0.19	0.14	0.40	0.91	0.43	0.33	0.32

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\[Patsy Creek Long-Term Daily Streamflow Series (08DB012)_KT_June 18, 2010.xlsx]Table

NOTES:

1. THE STREAMFLOW DATA PRESENTED ABOVE FOR YEARS 1-7 WERE GENERATED BY RANKED REGRESSION CORRELATION WITH DATA COLLECTED ON LIME CREEK (WSC 08DB010).
2. THE STREAMFLOW DATA PRESENTED ABOVE FOR YEARS 8-15 (1988 TO 1995) WERE COLLECTED BY WATER SURVEY OF CANADA ON PATSY CREEK (WSC 08DB012).
3. THE DRAINAGE AREA AT THE STATION IS 4.68 km^2.

0	09JUL'10	ISSUED WITH REPORT 101-343/9-1	KT	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.10

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
UPPER CLARY CREEK LONG-TERM MEAN MONTHLY SYNTHETIC STREAMFLOW SERIES

Print Jan/17/11 9:45:28

Year	Mean Monthly Discharge (m^3/s)												
	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1	0.33	0.51	0.18	1.87	4.05	2.96	0.39	0.25	0.31	2.15	0.50	0.21	1.15
2	0.40	0.26	0.28	0.53	6.36	2.67	0.37	0.18	2.18	1.41	1.28	0.24	1.35
3	0.17	0.11	0.08	0.23	3.86	3.40	0.35	0.20	0.73	1.03	0.44	0.14	0.90
4	0.45	0.48	0.45	1.24	4.48	2.38	0.64	0.61	0.28	0.54	0.24	0.16	1.00
5	0.26	0.40	0.13	0.37	5.93	4.94	1.17	0.52	1.29	1.39	0.33	0.12	1.41
6	0.21	0.13	0.53	0.75	3.90	3.84	0.44	0.33	0.73	3.12	0.84	0.39	1.27
7	0.42	0.35	0.18	1.13	4.87	3.40	0.55	0.08	1.84	1.95	1.76	0.44	1.42
8	0.16	0.15	0.18	1.47	4.83	2.78	1.07	0.86	1.83	2.20	0.78	0.60	1.41
9	0.38	0.28	0.18	1.67	5.01	2.05	0.31	0.49	0.80	1.57	1.90	2.06	1.40
10	0.50	0.17	0.24	1.55	5.63	3.05	0.62	0.12	0.99	1.98	0.57	0.67	1.35
11	0.52	0.66	0.35	1.11	5.57	4.97	0.77	0.71	1.02	5.68	1.11	1.13	1.98
12	0.43	0.57	0.73	2.51	4.14	4.04	0.21	0.08	2.49	2.23	0.84	0.18	1.53
13	0.28	1.24	0.29	1.96	4.97	1.30	0.54	0.35	0.47	1.19	2.68	0.36	1.30
14	0.63	0.27	0.47	1.98	3.92	1.74	0.53	0.55	2.22	1.40	0.53	0.27	1.21
15	0.18	0.16	0.18	1.23	4.20	1.03	0.28	0.83	0.42	2.24	0.66	0.35	0.99
Average	0.35	0.38	0.30	1.31	4.78	2.97	0.55	0.41	1.17	2.01	0.96	0.49	1.31
Min	0.16	0.11	0.08	0.23	3.86	1.03	0.21	0.08	0.28	0.54	0.24	0.12	0.90
Max	0.63	1.24	0.73	2.51	6.36	4.97	1.17	0.86	2.49	5.68	2.68	2.06	1.98

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\[Clary Creek at Clary Lake Outlet Long-Term Daily Streamflow Series_KT_June 18, 2010.xlsx]Table

NOTES:

1. THE STREAMFLOW DATA PRESENTED ABOVE WERE CALCULATED BY SCALING THE PATSY CREEK LONG-TERM STREAMFLOW SERIES BY DRAINAGE AREA TO CLARY CREEK AT CLARY LAKE OUTET.
2. THE DRAINAGE AREA AT UPPER CLARY CREEK IS 29.1 km^2.

0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	KT	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE 3.11

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
WET AND DRY 10-YEAR RETURN PERIOD FLOWS AS A PERCENTAGE OF MEAN MONTHLY FLOWS

Print Jan/14/11 11:39:59

Location	Return Period	10-Year Return Period Discharge as a Percentage of Monthly Mean Discharge											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lime Creek at the Mouth	10 Year Dry % of Mean	37%	32%	42%	59%	77%	57%	49%	44%	38%	48%	27%	31%
	10 Year Wet % of Mean	174%	192%	172%	149%	132%	150%	177%	181%	194%	161%	204%	209%
Patsy Creek at the Mouth	10 Year Dry % of Mean	52%	35%	42%	39%	78%	50%	51%	17%	32%	46%	37%	31%
Clary Creek at Clary Lake Outlet	10 Year Wet % of Mean	153%	201%	178%	163%	120%	149%	165%	183%	193%	166%	190%	212%

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\[Wet and Dry Flows.xlsx]TABLE

NOTES:

1. ANALYSIS WAS DONE USING PALISADE DECISION TOOLS @RISK DISTRIBUTION FITTING SOFTWARE.
2. CLARY CREEK AND PATSY CREEK VALUES ARE IDENTICAL BECAUSE CLARY CREEK RECORD IS SCALED FROM PATSY CREEK RECORD.

0	08JUL'10	ISSUED WITH REPORT VA101-343/9-1	KT	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.12

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
7-DAY LOW FLOW DISCHARGES FOR VARIOUS RETURN PERIODS

Print Jan/17/11 14:05:38

Location	DA (km^2)	Return Period 7-Day Low Flow Discharge (m^3/s)					
		Mean	5 year	10 year	20 year	50 year	100 year
Lime Creek at the Mouth	39.4	0.17	0.10	0.08	0.06	0.05	0.04
Patsy Creek	4.68	0.02	0.01	0.01	0.01	0.00	0.00
Clary Creek at Clary Lake Outlet	29.1	0.11	0.08	0.06	0.04	0.02	0.01

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\[Low Flows.xlsx]Summary

NOTE:

1. DATA FROM OBEDKOFF ANALYSIS "STREAMFLOW IN THE SKEENA REGION".

0	08JUL'10	ISSUED WITH REPORT VA101-343/9-1	KT	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE 3.13

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
PEAK INSTANTANEOUS DISCHARGES FOR VARIOUS RETURN PERIODS

Print Jan/17/11 14:07:25

Location	DA (km^2)	Return Period Peak Instantaneous Discharge (m^3/s)						
		Mean	5 year	10 year	20 year	50 year	100 year	200 year
Lime Creek at the Mouth	39.4	32.70	49.88	66.50	83.13	106.40	123.03	140.32
Patsy Creek	4.68	6.14	9.11	11.60	14.04	17.17	19.37	21.69
Clary Creek at Clary Lake Outlet	29.1	31.80	47.16	60.08	72.70	88.92	100.34	112.35

M:\1\01\00343\09\A\Data\Task 200 (Hydrometeorology)\Rev 1\Hydrology\[Peak Flows.xlsx]Summary

NOTE:

1. DATA FROM OBEDKOFF ANALYSIS "STREAMFLOW IN THE SKEENA REGION".

0	08JUL'10	ISSUED WITH REPORT VA101-343/9-1	KT	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE 4.1

AVANTI KITSAULT MINE LTD.
KITSAULT PROJECT

ENGINEERING HYDROMETEOROLOGY REPORT
COEFFICIENT OF VARIATION VALUES FOR WATER BALANCE MODELLING

Print 1/17/11 12:31

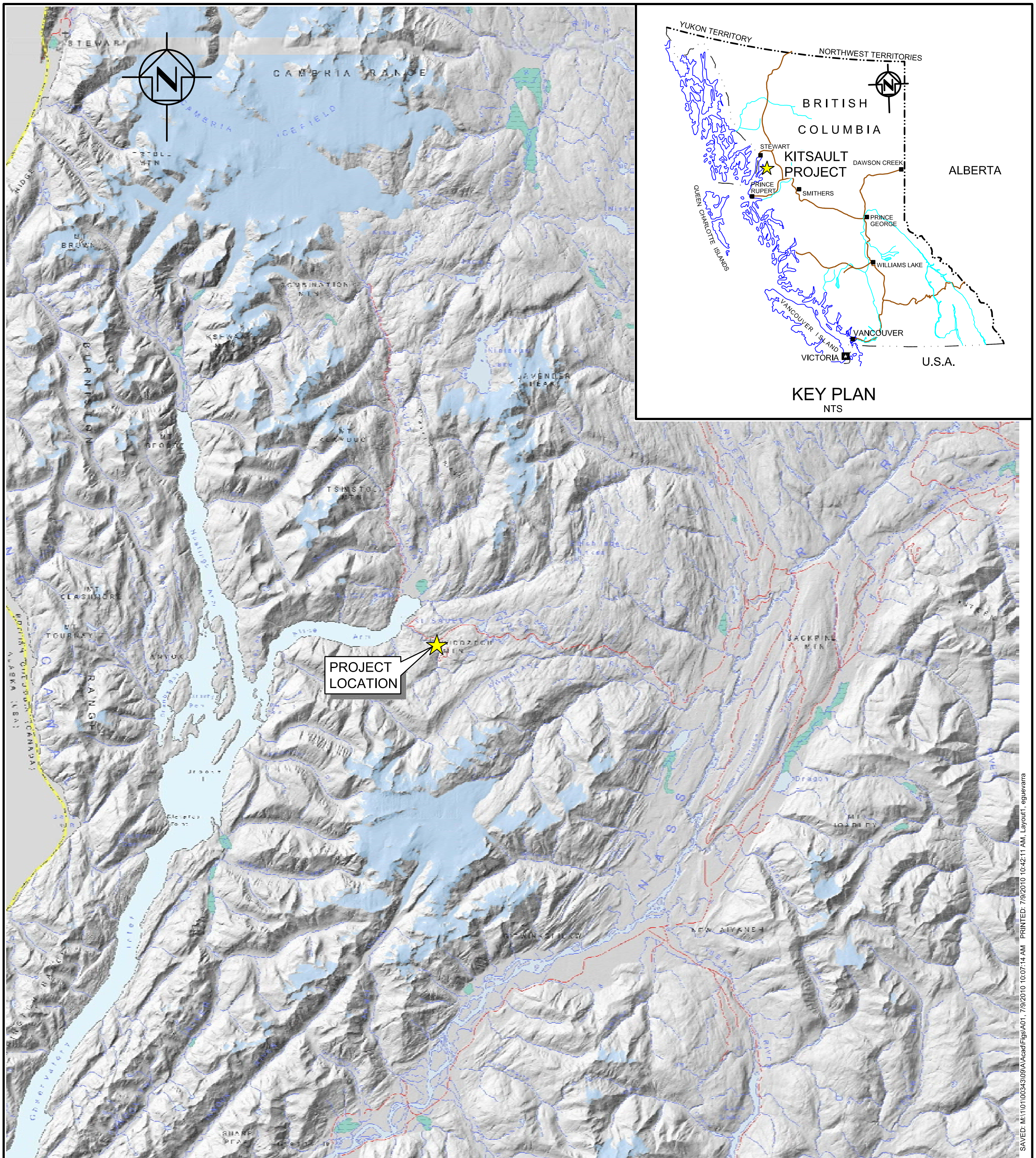
Location	Parameter	Coefficient of Variation											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stewart A	Mean Temperature	0.83	1.76	0.80	0.20	0.14	0.09	0.06	0.07	0.07	0.15	3.95	1.06
	Total Precipitation	0.47	0.49	0.40	0.54	0.46	0.41	0.46	0.46	0.41	0.33	0.38	0.46
Nass Camp	Mean Temperature	0.66	1.07	1.34	0.19	0.15	0.10	0.06	0.08	0.10	0.18	3.15	0.80
	Total Precipitation	0.58	0.57	0.55	0.57	0.42	0.49	0.59	0.42	0.46	0.42	0.55	0.54
Kitsault Project Site	**Mean Temperature**	**0.50**	**0.94**	**0.71**	**0.13**	**0.10**	**0.06**	**0.04**	**0.05**	**0.06**	**0.11**	**2.37**	**0.62**
	Total Precipitation	**0.35**	**0.35**	**0.32**	**0.37**	**0.30**	**0.30**	**0.35**	**0.29**	**0.29**	**0.25**	**0.31**	**0.34**

M:\1\01\00343\09\A\Data\Meteorology\[Coef Variation.xlsx]Summary

NOTES:

1. COEFFICIENT OF VARIATION = STANDARD DEVIATION / MEAN
2. STEWART A VALUES BASED ON MSC MONTHLY DATA FROM 1975 - 2007.
3. NASS CAMP VALUES BASED ON MSC MONTHLY DATA FROM 1973 - 2007.
4. KITSAULT VALUES BASED ON AN AVERAGE OF STEWART A AND NASS CAMP VALUES.

0	09JUL'10	ISSUED WITH REPORT VA101-343/9-1	JWV	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



LOCATION MAP

Scale 5 0 5 10 15 20 25 km

AVANTI KITSAULT MINE LTD.	
KITSAULT PROJECT	
PROJECT LOCATION MAP	
P/A NO. VA101-343/9	REF NO. 1
FIGURE 1.1	REV 0

Knight Piésold CONSULTING

REV	DATE	DESCRIPTION	DESIGN	DRAWN	CHK'D	APP'D
0	09JUL'10	ISSUED WITH REPORT	JWV	NSD	GLS	KJB

XREF FILE(S): IMAGE FILE(S): bc_103p_xc10m_utm09_20070115

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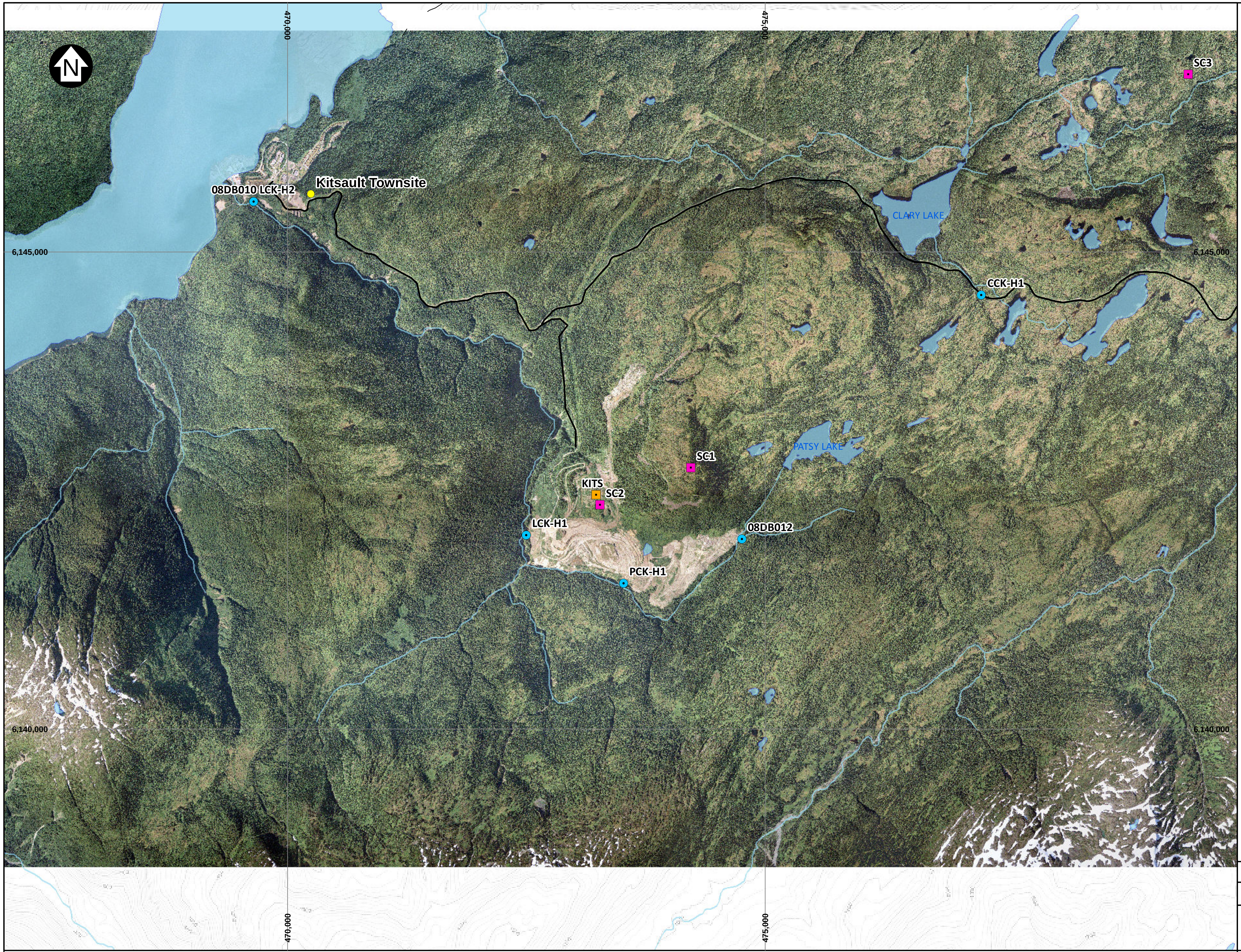
VANCOUVER B.C.



LEGEND:

- HYDROLOGY STATION
- METEOROLOGY STATION
- SNOW SURVEY STATION
- ACCESS ROAD

NOTES:

1. BASE MAP: LIDAR IMAGERY AND BC TRIM CONTOURS FROM GEOBC (WMS)
2. CO-ORDINATE GRID IS IN METRES. DATUM: NAD 83 PROJECTION: UTM ZONE 9.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:40,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTOUR INTERVAL IS 20 METRES.

SCALE 0.4 0.2 0 0.4 0.8 1.2 1.6 2 km

AVANTI KITSAULT MINING LTD.

KITSAULT PROJECT

SITE METEOROLOGY AND STREAMFLOW STATIONS

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-343/9	1

FIGURE 2.1 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	09JUL'10	ISSUED WITH REPORT	KS	KS	JWV	JGC

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LEGEND:

GENERAL

- MSC CLIMATE STATION
- WSC STREAMFLOW GAUGE
- SNOW SURVEY STATION
- MINE SITE
- RIVER / CREEK
- LAKE

NOTES:

1. BACKGROUND IMAGERY COPYRIGHT MICROSOFT BING MAPS.
2. ROAD, HYDRO AND WATERSHED DATA OBTAINED FROM BC GOVERNMENT GEOBC.
3. CO-ORDINATE GRID IS IN METRES. DATUM IS NAD83 AND PROJECTION IS UTM ZONE 9.
4. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:500,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	09JUL'10	ISSUED WITH REPORT	AMD	AMD	JWV	JGC

AVANTI KITSAULT MINE LTD.

KITSAULT PROJECT

REGIONAL CLIMATE STATIONS AND STREAMFLOW GAUGES

Knight Piésold CONSULTING

P/A NO. VA101-343/9 | REF NO. 1

FIGURE 2.2 | REV 0

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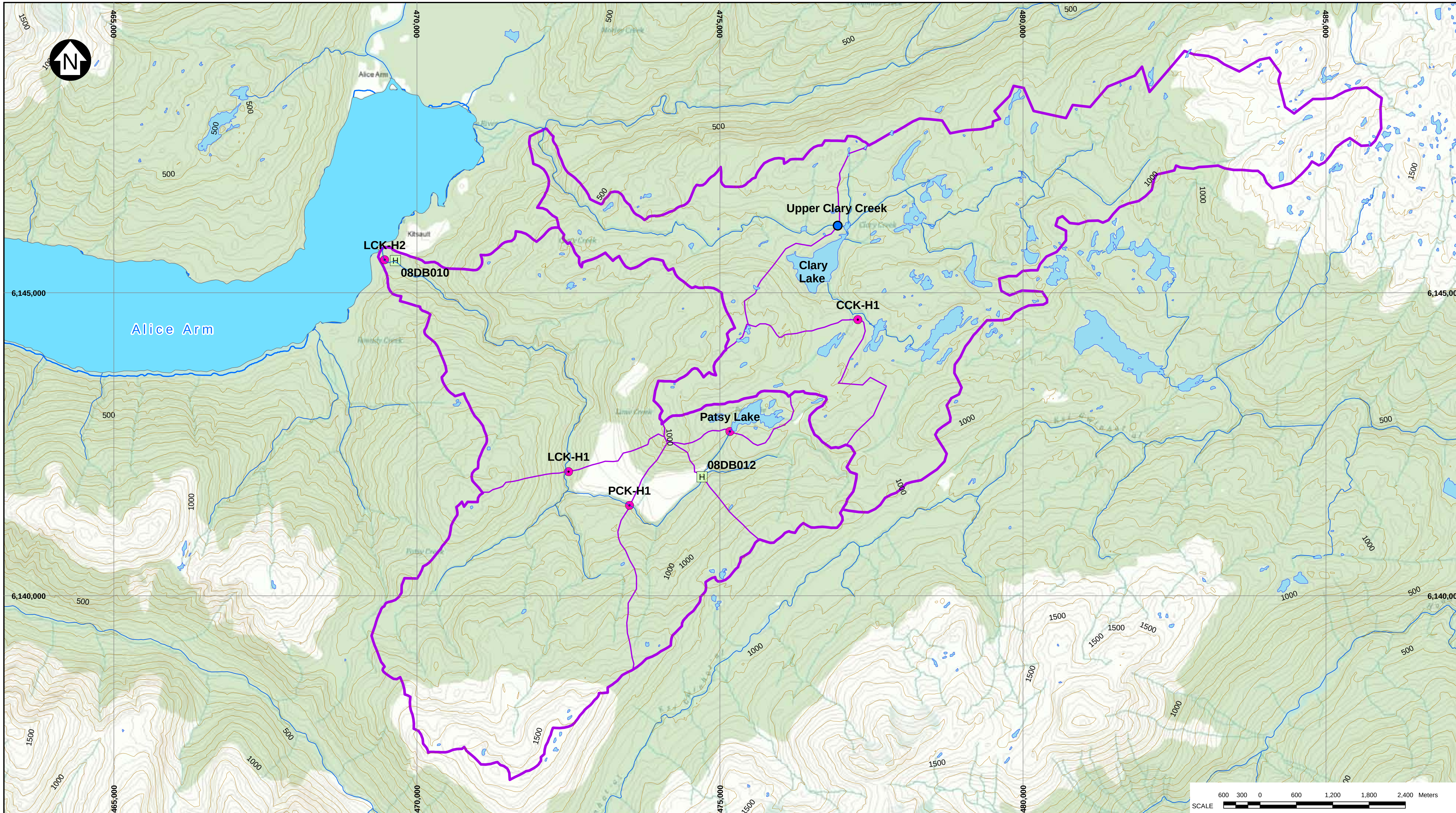


LEGEND:

GENERAL

- HYDROLOGY STATION
- WSC STREAMFLOW GAUGE
- POINT OF FLOW ESTIMATION
- RIVER
- 100 M CONTOUR
- WATERSHED BOUNDARY
- SUBCATCHMENT BOUNDARY
- LAKE
- OCEAN

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
1	14JAN'11	ISSUED WITH REPORT	AMD	AMD	JGC	JPH
0	09JUL'10	ISSUED WITH REPORT	AMD	AMD	JWV	JGC

NOTES:

1. BASE MAP: ARCGIS ONLINE TOPOGRAPHIC MAP.
2. CO-ORDINATE GRID IS IN METRES. DATUM: NAD83 PROJECTION: UTM ZONE #9
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:60,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTOUR INTERVAL IS 100 METRES.

AVANTI KITSAULT MINE LTD

KITSAULT PROJECT

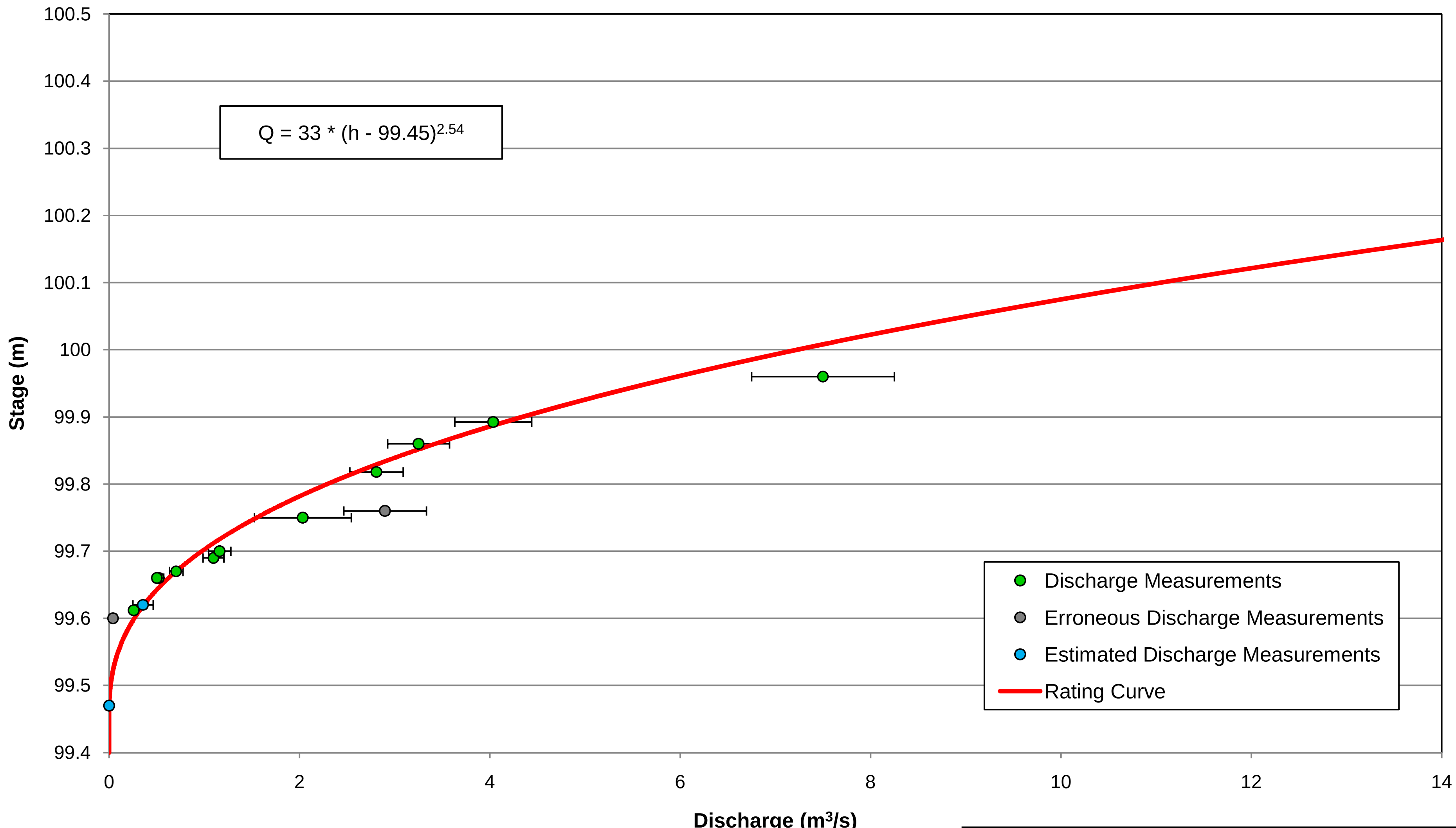
KITSAULT PROJECT AREA CATCHMENT BOUNDARIES

Knight Piésold CONSULTING

P/A NO. VA101-343/9 | REF NO. 1

FIGURE 3.1 | REV 1

SAVED: M:\1\01\00343\09\A\GIS\ArcView\figures\Figure_3.1_ProjectArea.mxd; 14 Jan 2011 11:01:45 AM adinca



NOTE:
1. MAXIMUM STAGE RECORDED WAS 100.5 m.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	03JAN'11	ISSUED WITH REPORT	MH	EER	JGC

AVANTI KITSAULT MINE LTD.

KITSAULT MINE

UPPER LIME CREEK: LCK-H1
RATING CURVE

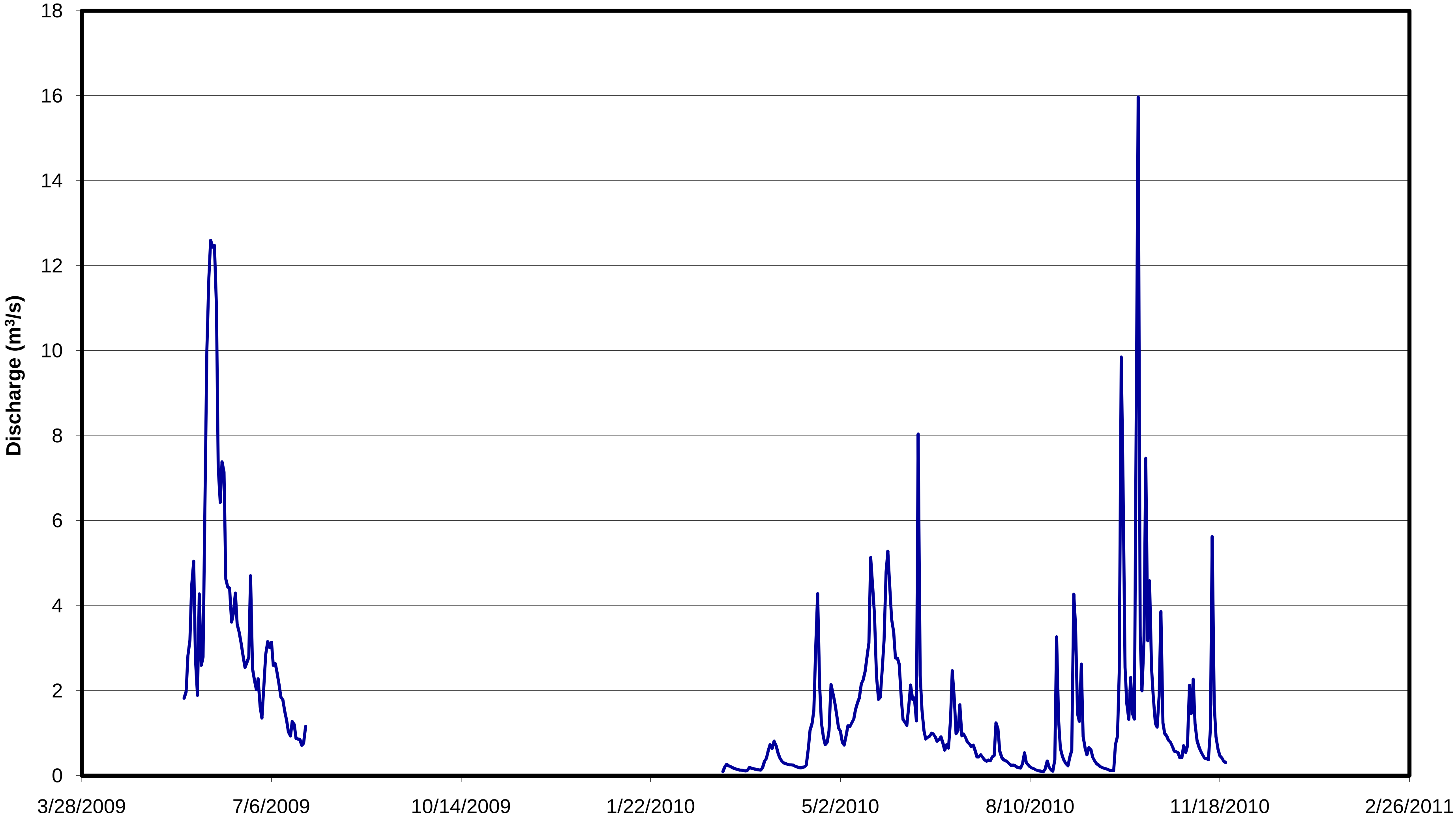
Knight Piésold CONSULTING

P/A NO. VA101-343/9

REF. NO. 1

FIGURE 3.2

REV 0



AVANTI KITSAULT MINE LTD.

KITSAULT MINE

UPPER LIME CREEK: LCK-H1
DAILY MEASURED DISCHARGE

Knight Piésold CONSULTING

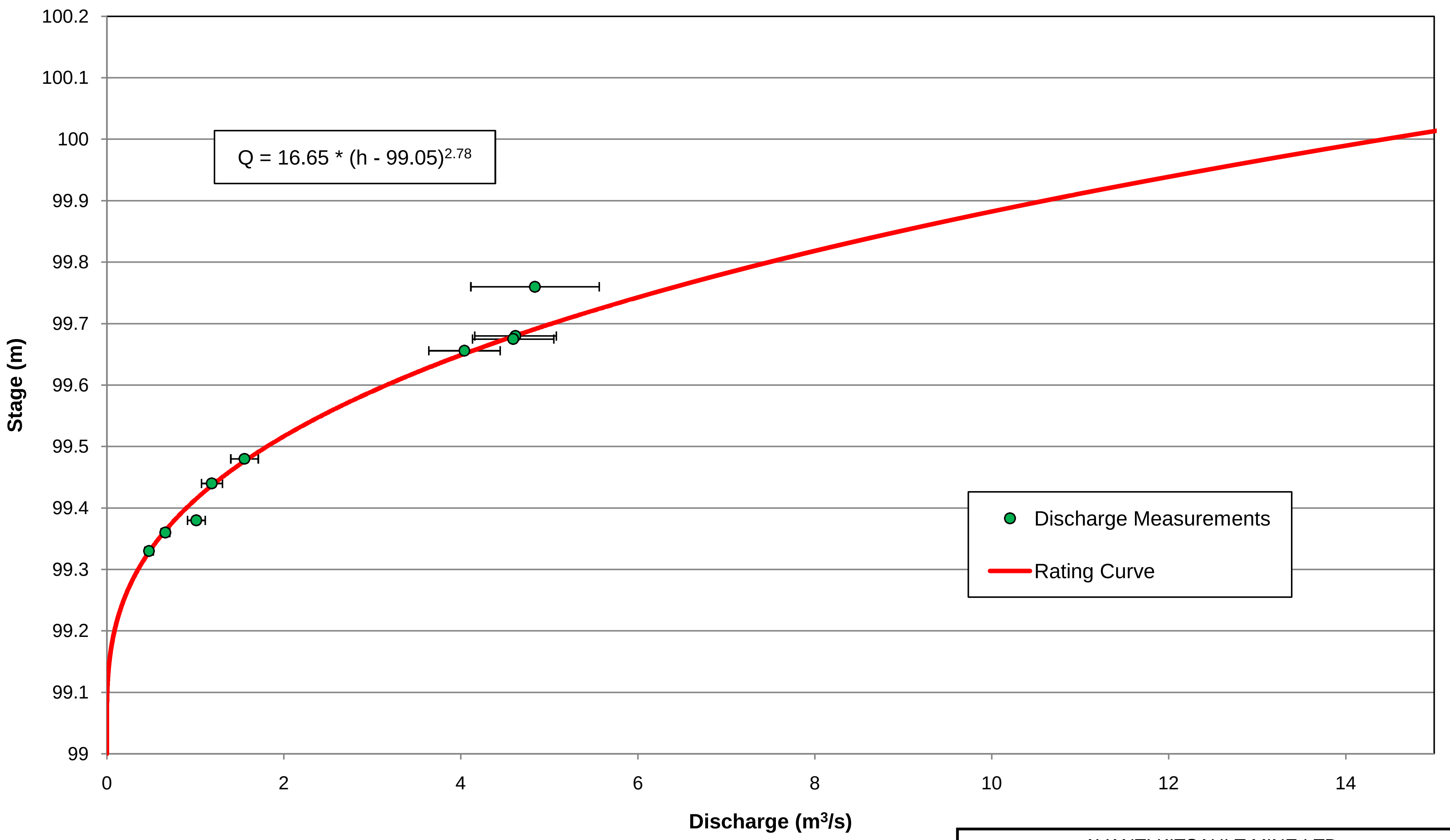
P/A NO. VA101-343/9

REF. NO. 1

FIGURE 3.3

REV 0

0	09DEC'10	ISSUED WITH REPORT	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTE:
1. MAXIMUM STAGE RECORDED WAS 100.3 m.

AVANTI KITSAULT MINE LTD.

KITSAULT MINE

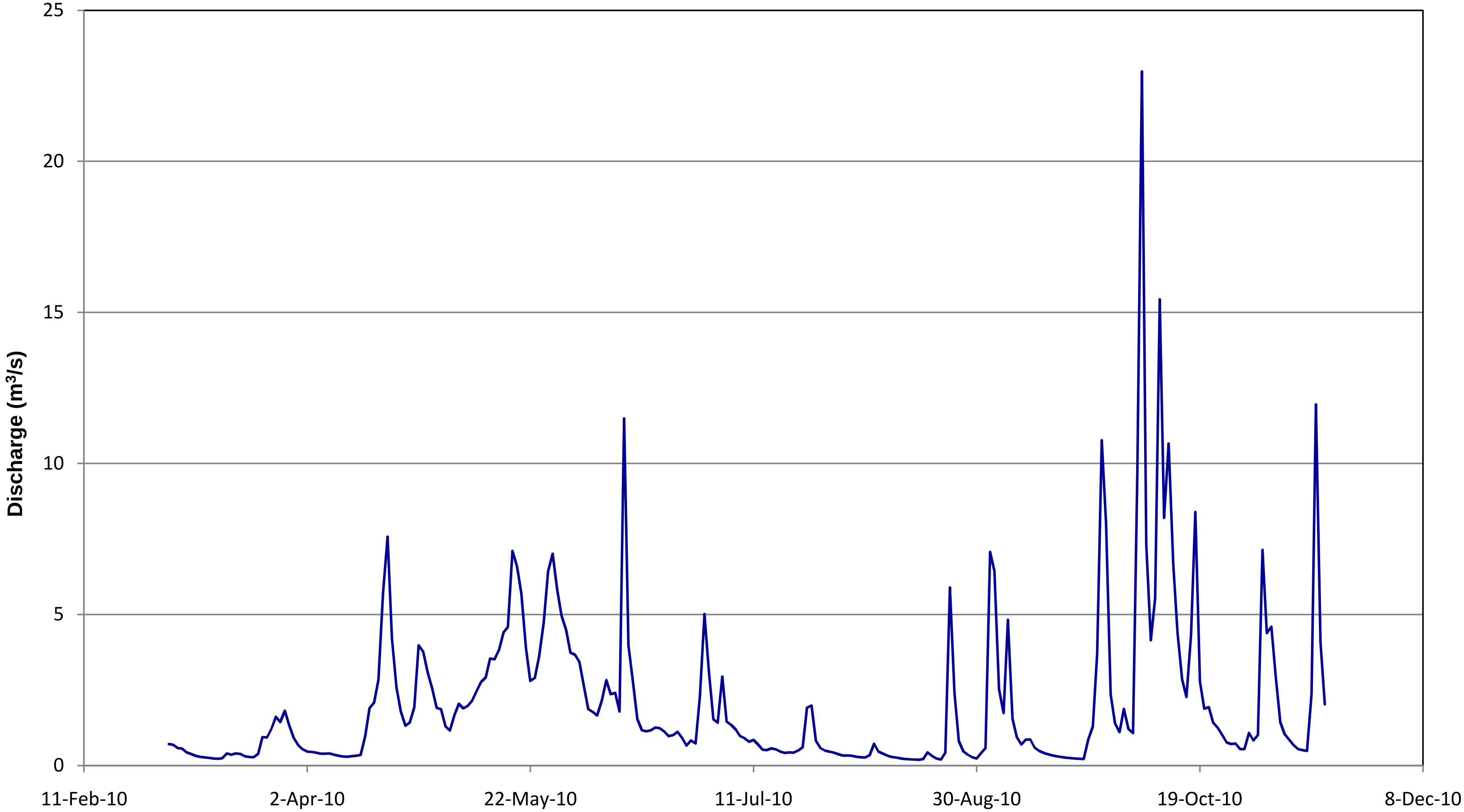
LOWER LIME CREEK: LCK-H2
RATING CURVE

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-343/9	1

FIGURE 3.4 REV 0

0	03JAN'11	ISSUED WITH REPORT	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



AVANTI KITSAULT MINE LTD.

KITSAULT MINE

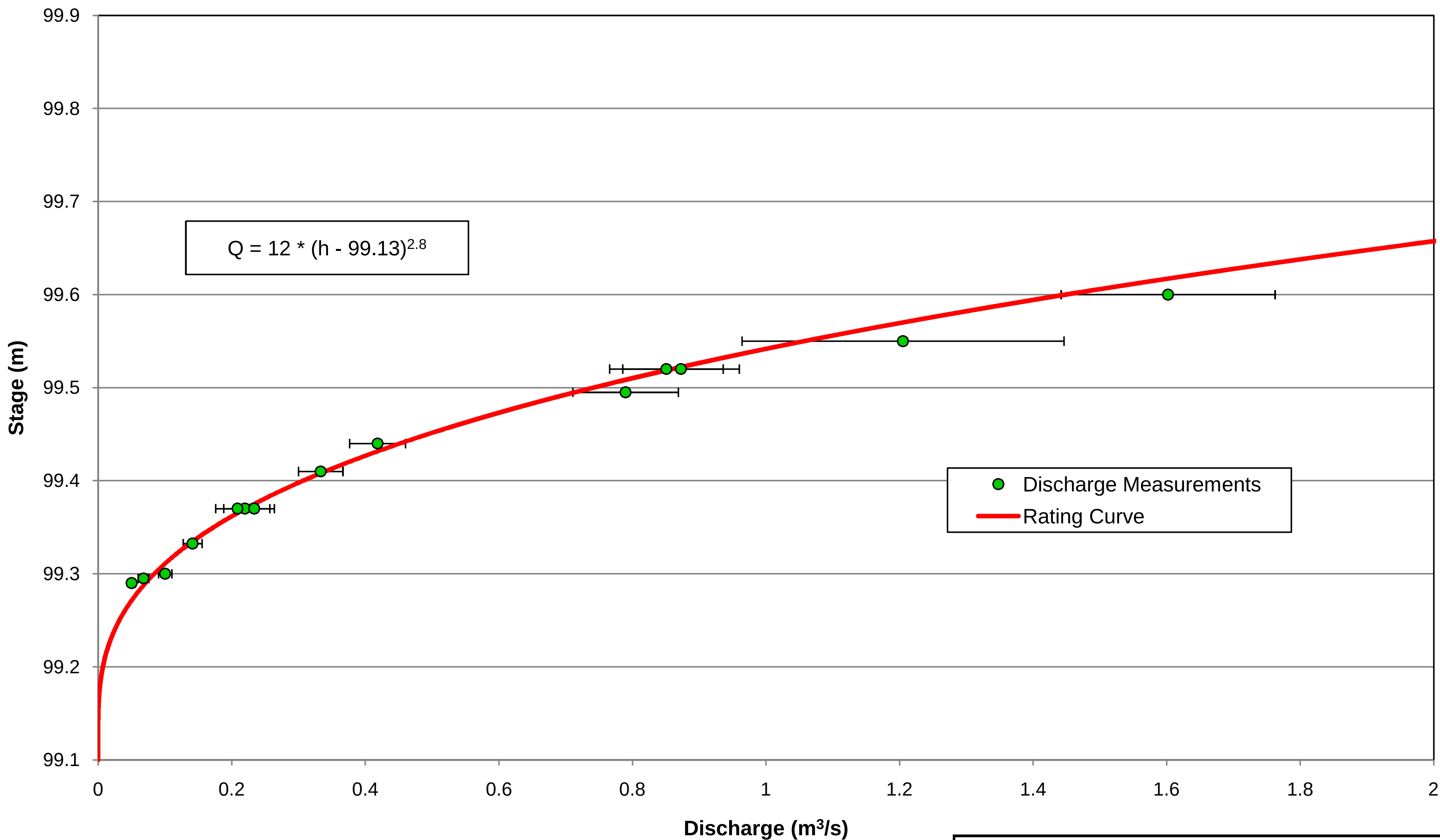
LOWER LIME CREEK: LCK-H2
DAILY MEASURED DISCHARGE

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-343/9	1

FIGURE 3.5 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	03JAN'11	ISSUED WITH REPORT	MH	EER	JGC



NOTE:
1. MAXIMUM STAGE RECORDED WAS 99.9 m.

0	03JAN'10	ISSUED WITH REPORT	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

AVANTI KITSAULT MINE LTD.

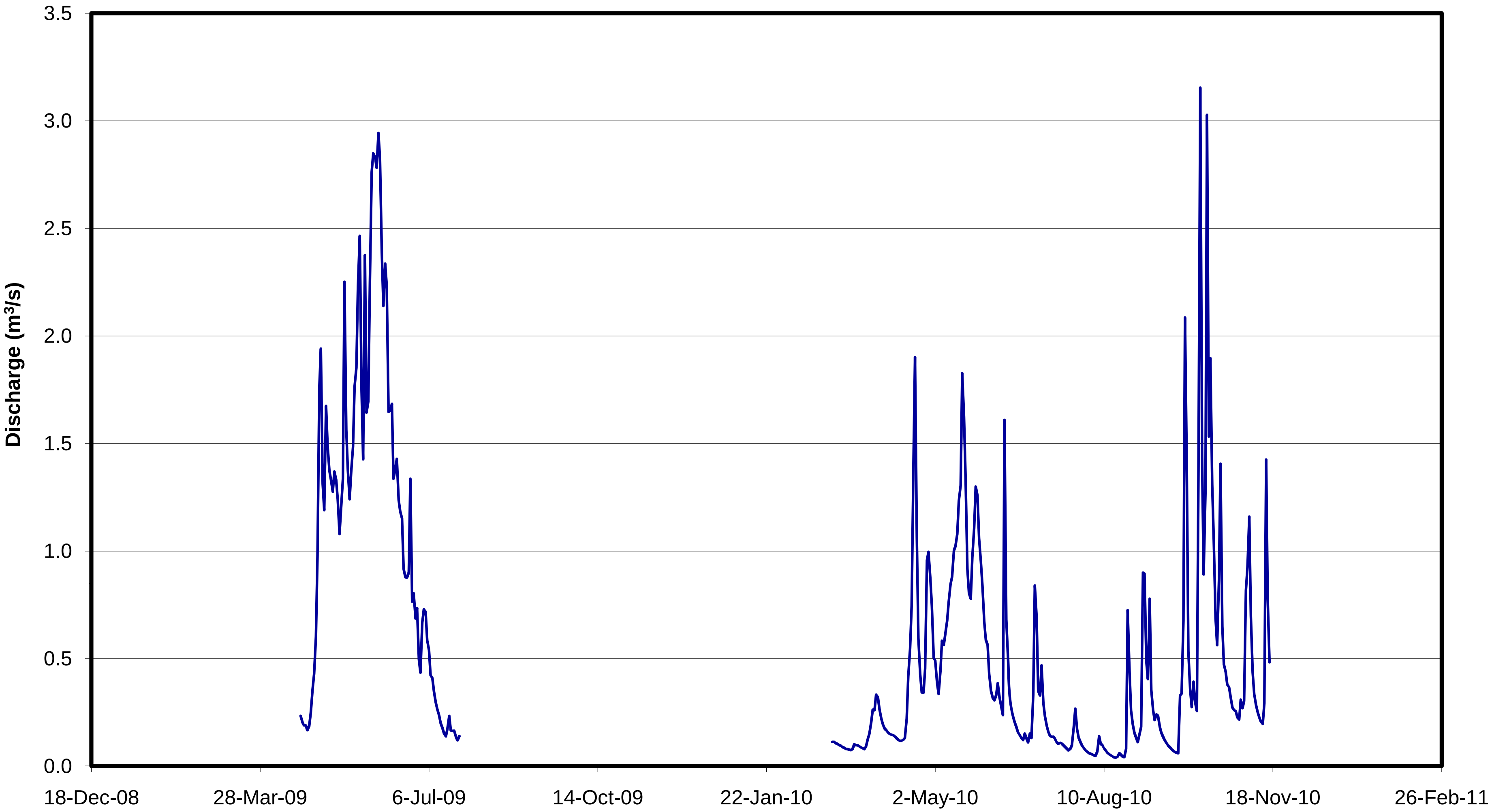
KITSAULT MINE

PATSY CREEK: PCK-H1
RATING CURVE

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-343/9	1

FIGURE 3.6 REV 0



AVANTI KITSAULT MINE LTD.

KITSAULT MINE

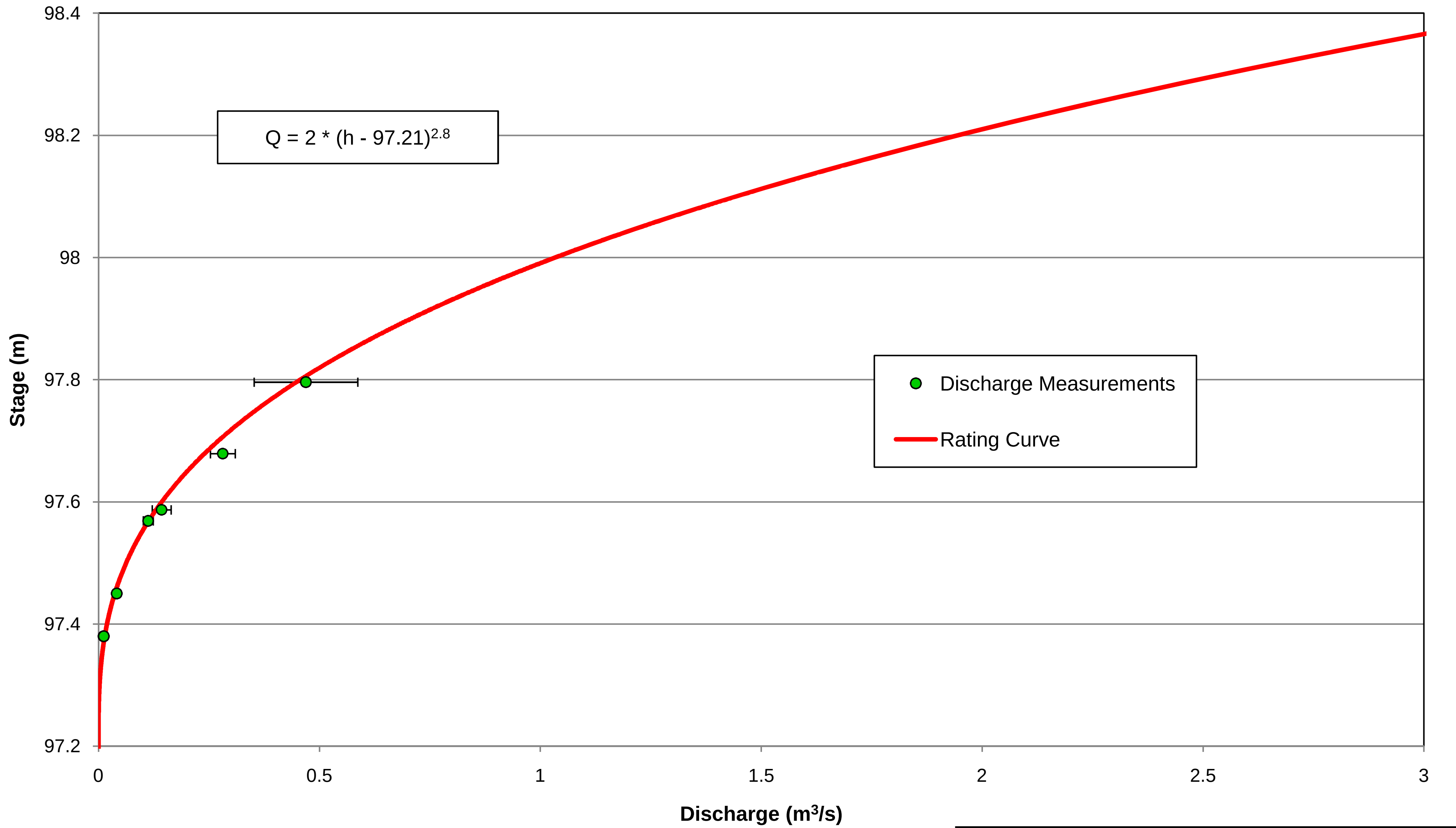
PATSY CREEK: PCK-H1
DAILY MEASURED DISCHARGE

Knight Piésold CONSULTING

P/A NO. VA101-343/9 | REF. NO. 1

FIGURE 3.7 | REV 0

0	09DEC'10	ISSUED WITH REPORT	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTE:
1. MAXIMUM STAGE RECORDED WAS 98.4 m.

0	03JAN'11	ISSUED WITH REPORT	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

AVANTI KITSAULT MINE LTD.

KITSAULT MINE

CLARY CREEK: CCK-H1
RATING CURVE

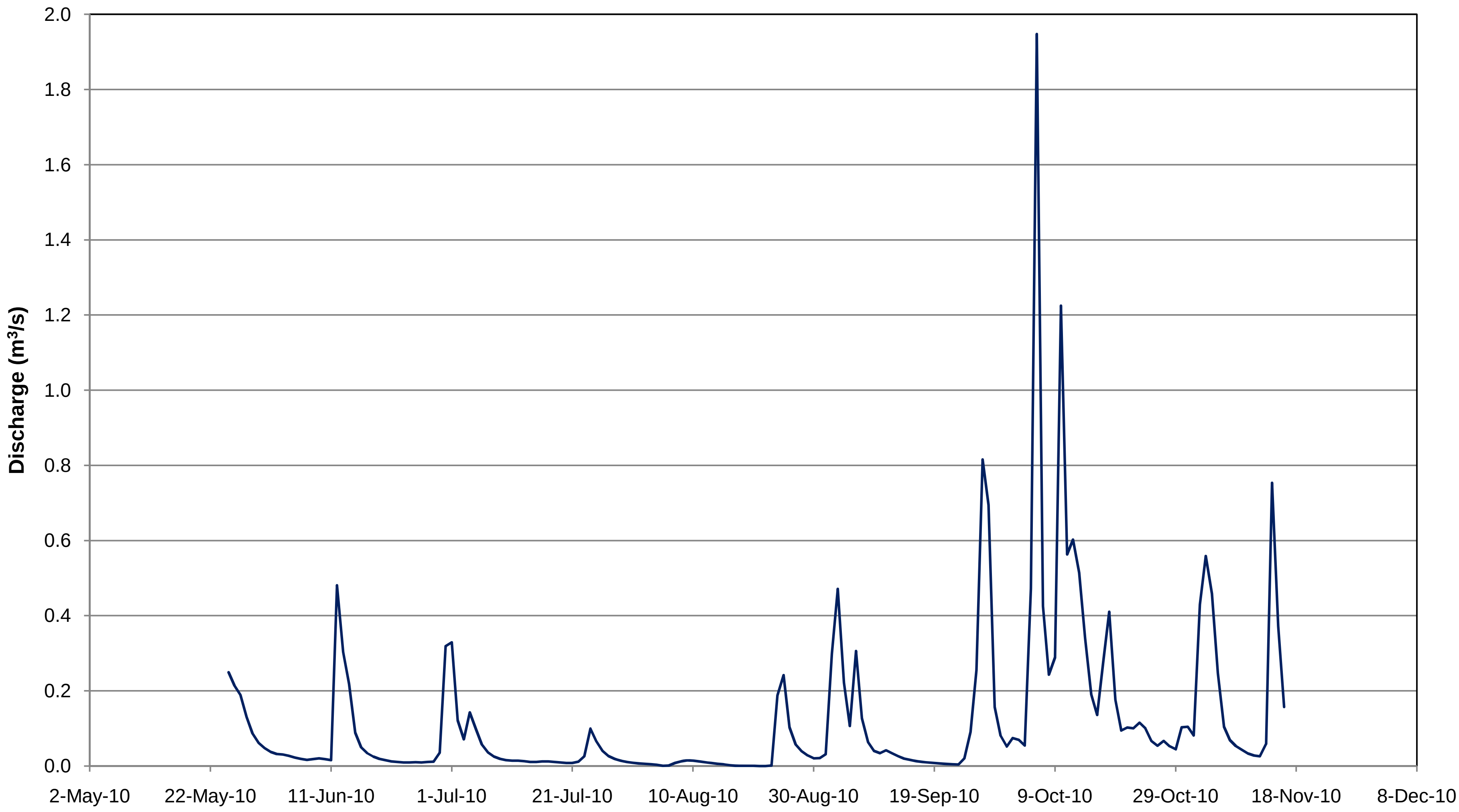
Knight Piésold CONSULTING

P/A NO. VA101-343/9

REF. NO. 1

FIGURE 3.8

REV 0



AVANTI KITSAULT MINE LTD.

KITSAULT MINE

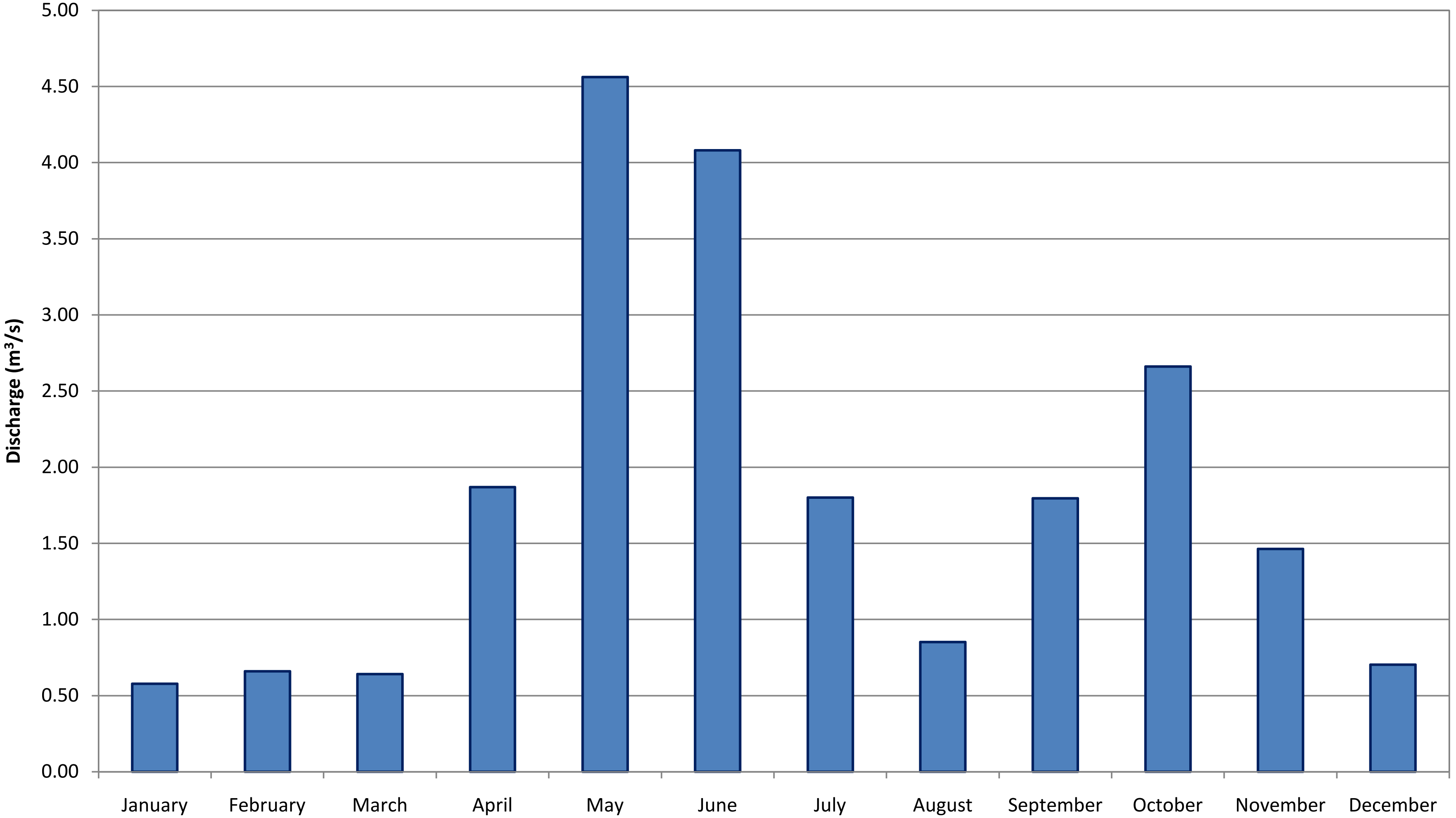
CLARY CREEK: CCK-H1
DAILY MEASURED DISCHARGE

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-343/9	1

FIGURE 3.9 REV 0

0	03JAN'11	ISSUED WITH REPORT	MH	EER	JGC
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



0	08JUL'10	ISSUED WITH REPORT	KT	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

AVANTI KITSAULT MINE LTD.

KITSAULT PROJECT

LIME CREEK
MEAN ANNUAL HYDROGRAPH

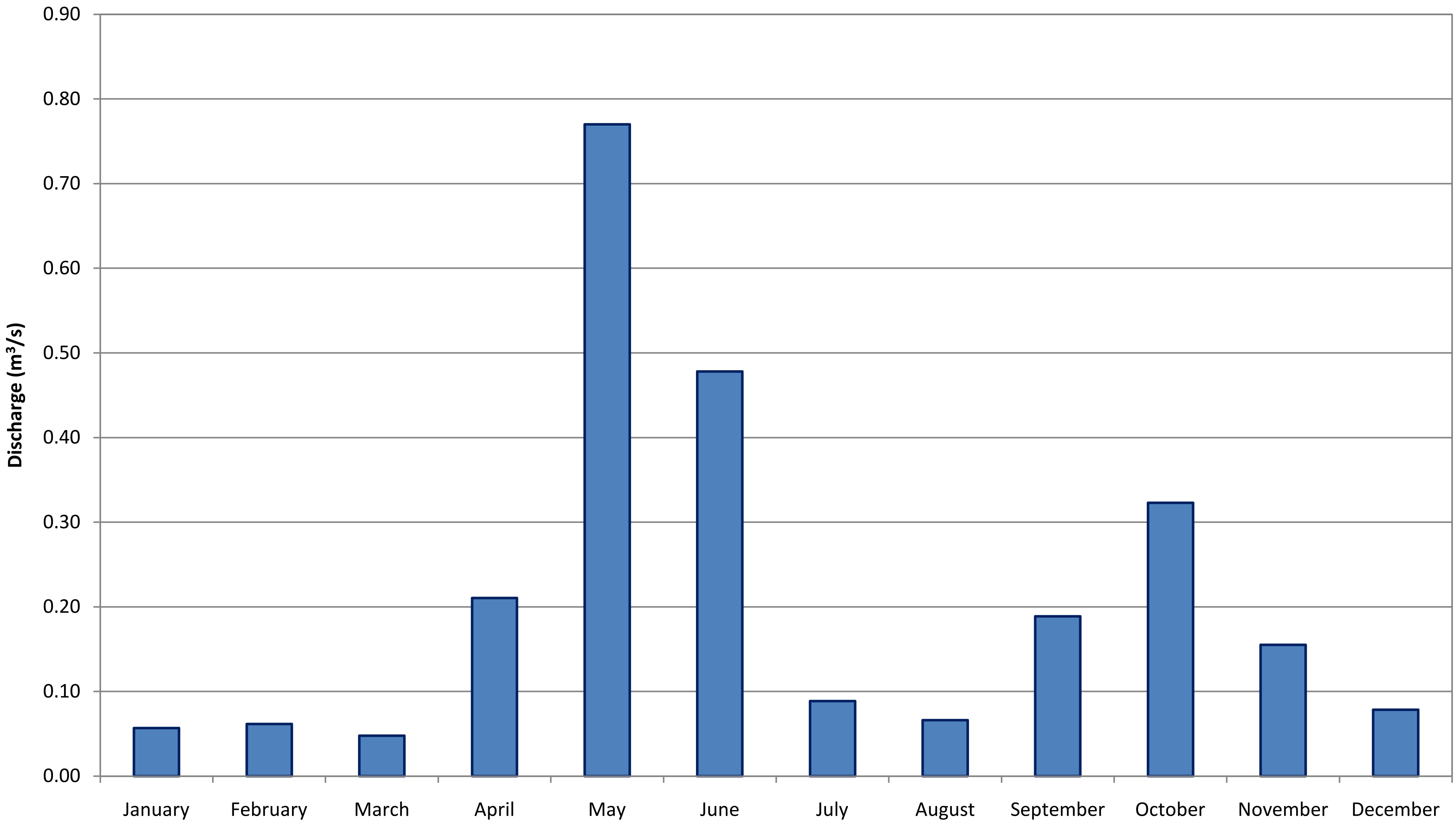
Knight Piésold CONSULTING

P/A NO. VA101-343/9

REF. NO. 1

FIGURE 3.10

REV 0



AVANTI KITSAULT MINE LTD.

KITSAULT PROJECT

PATSY CREEK
MEAN ANNUAL HYDROGRAPH

Knight Piésold CONSULTING

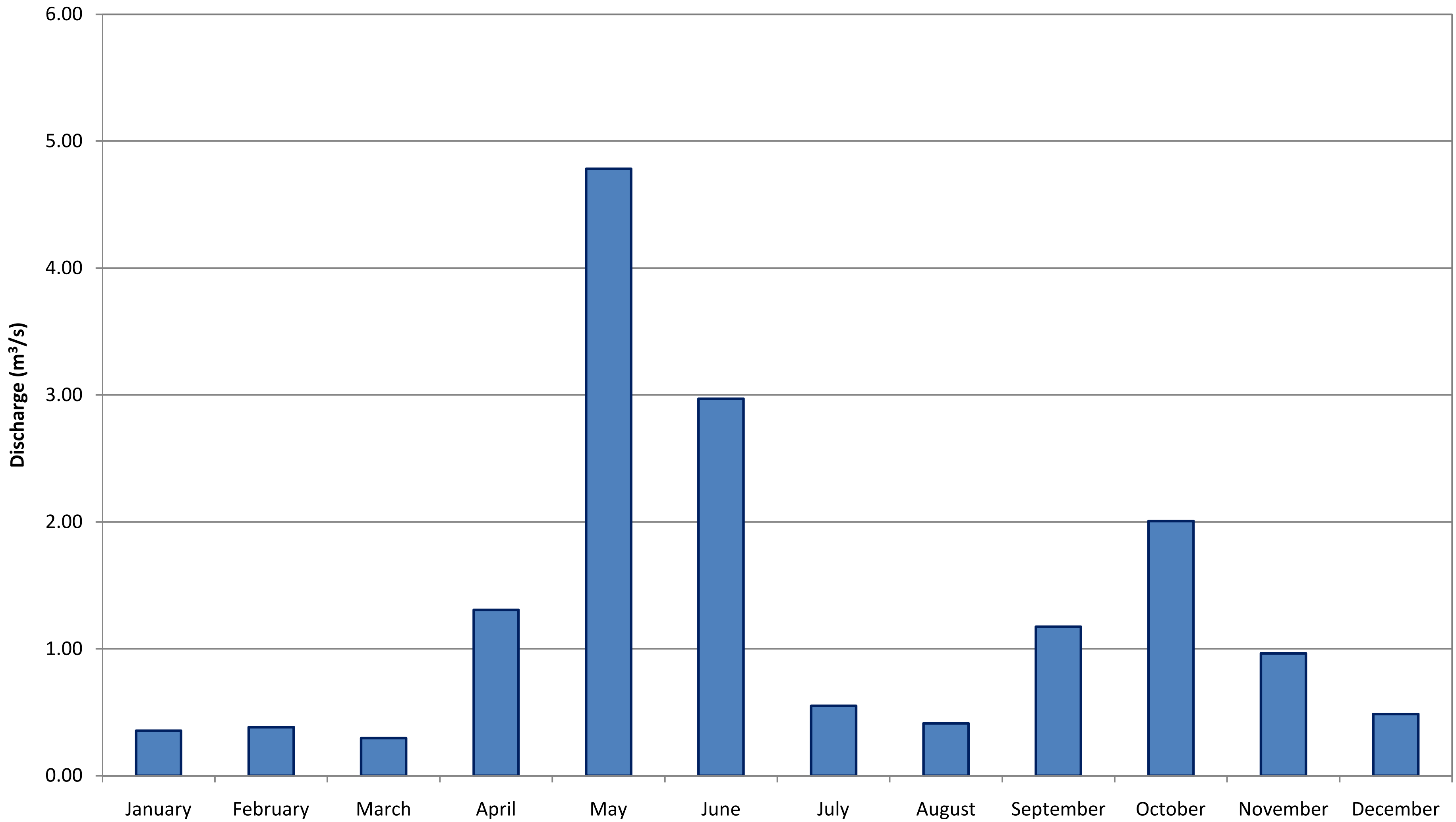
P/A NO. VA101-343/9

REF. NO. 1

FIGURE 3.11

REV 0

0	08JUL'10	ISSUED WITH REPORT	KT	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



AVANTI KITSAULT MINE LTD.

KITSAULT PROJECT

UPPER CLARY CREEK
MEAN ANNUAL HYDROGRAPH

Knight Piésold CONSULTING

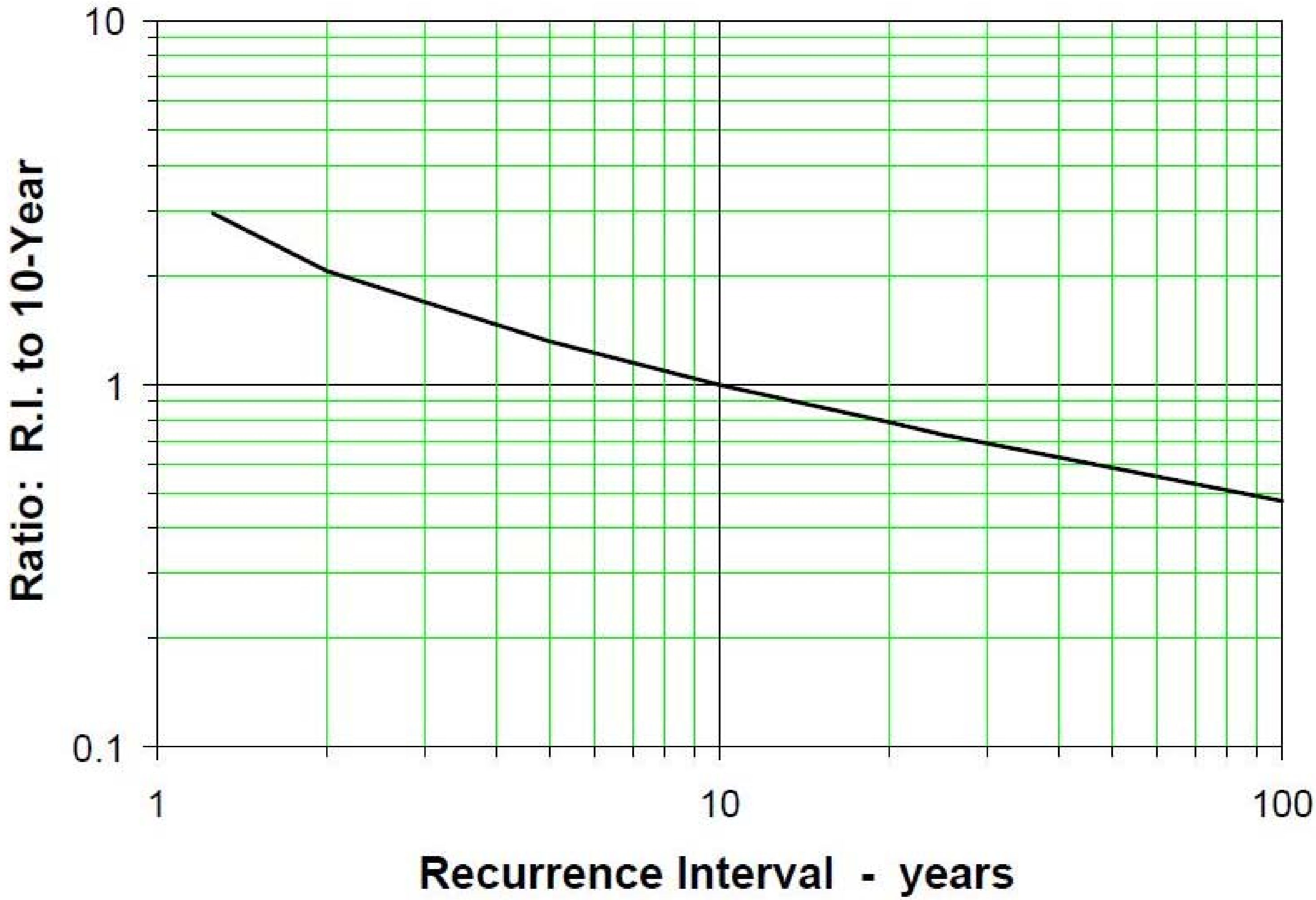
P/A NO. VA101-343/9

REF. NO. 1

FIGURE 3.12

REV 0

0	08JUL'10	ISSUED WITH REPORT	KT	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FROM OBEDKOFF "STREAMFLOW IN THE SKEENA REGION"".
2. RATIOS FROM THIS GRAPH ARE TO BE APPLIED TO THE 10-YEAR RECURRANCE INTERVAL 7-DAY LOW FLOW VALUE TO DETERMINE 7-DAY LOW FLOW VALUES FOR OTHER RECURRANCE INTERVALS

0	08JUL'10	ISSUED WITH REPORT	JWV	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

AVANTI KITSAULT MINE LTD.

KITSAULT PROJECT

LIME CREEK
ANNUAL 7-DAY LOW FLOW SCALING CURVE

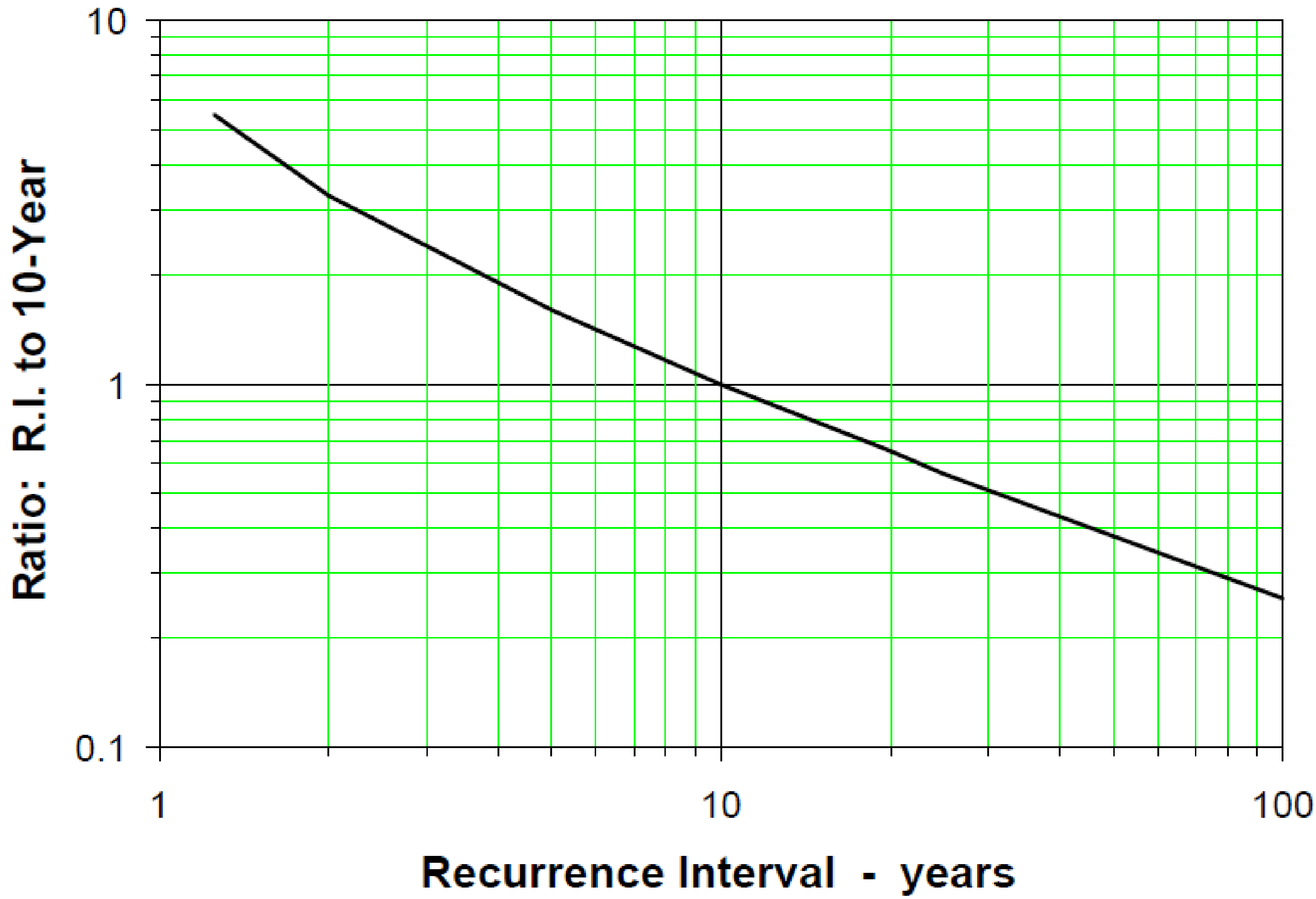
Knight Piésold CONSULTING

P/A NO. VA101-343/9

REF. NO. 1

FIGURE 3.13

REV 0



NOTES:
1. FROM OBEDKOFF "STREAMFLOW IN THE SKEENA REGION".
2. RATIOS FROM THIS GRAPH ARE TO BE APPLIED TO THE 10-YEAR RECURRANCE INTERVAL 7-DAY LOW FLOW VALUE TO DETERMINE 7-DAY LOW FLOW VALUES FOR OTHER RECURRANCE INTERVALS.
3. RATIOS FROM THIS GRAPH MAY BE ALSO BE APPLIED TO THE CLARY CREEK 10-YEAR RECCURANCE INTERVAL 7-DAY LOW FLOW.

0	08JUL'10	ISSUED WITH REPORT	JWV	JGC	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

AVANTI KITSAULT MINE LTD.

KITSAULT PROJECT

PATSY CREEK
ANNUAL 7-DAY LOW FLOW SCALING CURVE

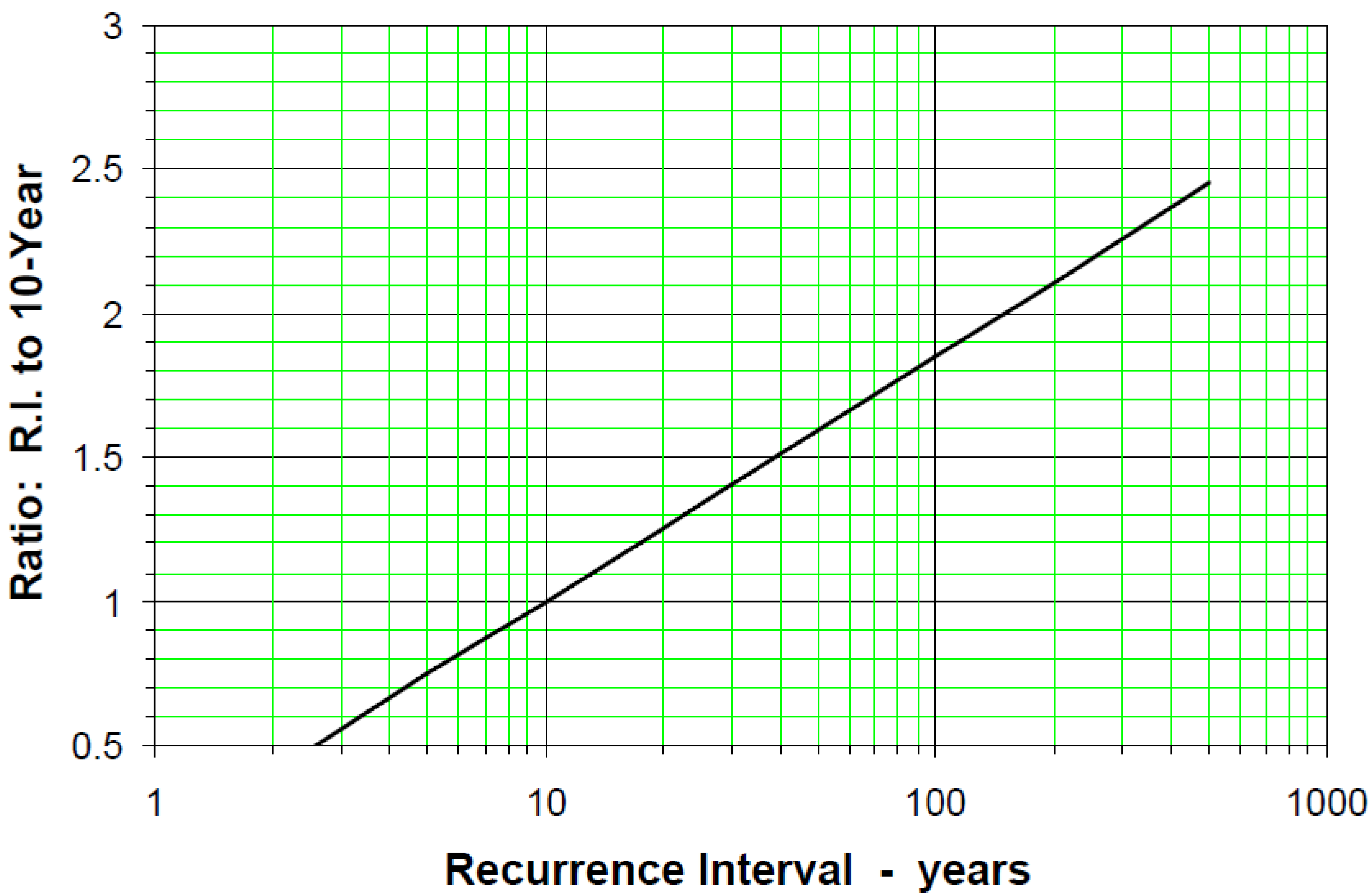
Knight Piésold CONSULTING

P/A NO. VA101-343/9

REF. NO. 1

FIGURE 3.14

REV 0



NOTES:

1. FROM OBEDKOFF "STREAMFLOW IN THE SKEENA REGION".
2. RATIOS FROM THIS GRAPH ARE TO BE APPLIED TO THE 10-YEAR RECURRANCE INTERVAL PEAK FLOW VALUE TO DETERMINE PEAK FLOW VALUES FOR OTHER RECURRANCE INTERVALS.

AVANTI KITSAULT MINE LTD.

KITSAULT PROJECT

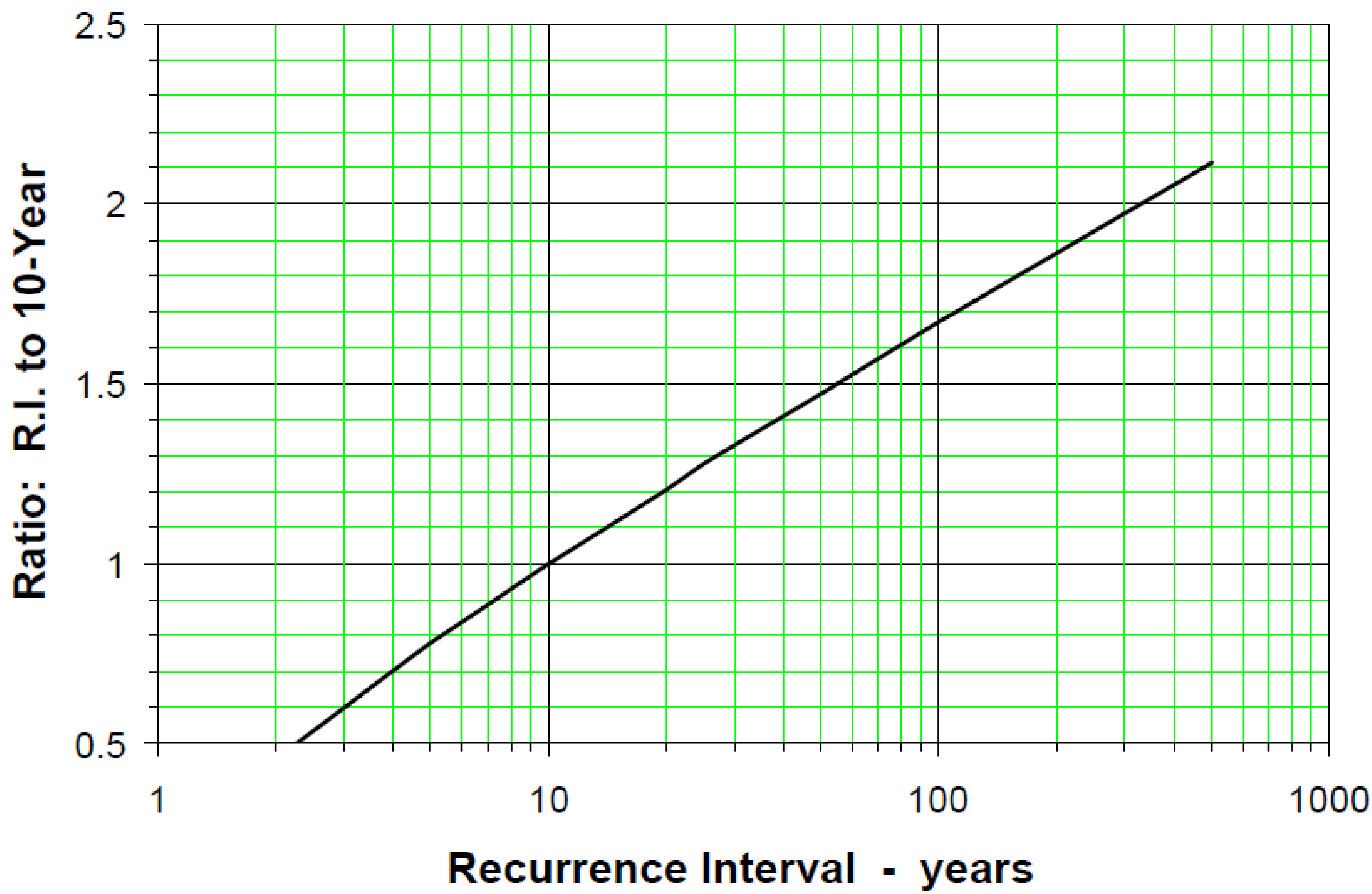
LIME CREEK
INSTANTANEOUS PEAK FLOW SCALING CURVE

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-343/9	1

FIGURE 3.15 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08JUL'10	ISSUED WITH REPORT	JWV	JGC	KJB



NOTES:

1. FROM OBEDKOFF "STREAMFLOW IN THE SKEENA REGION".
2. RATIOS FROM THIS GRAPH ARE TO BE APPLIED TO THE 10-YEAR RECURRANCE INTERVAL PEAK FLOW VALUE TO DETERMINE PEAK FLOW VALUES FOR OTHER RECURRANCE INTERVALS.

AVANTI KITSAULT MINE LTD.

KITSAULT PROJECT

PATSY CREEK
INSTANTANEOUS PEAK FLOW SCALING CURVE

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-343/9	1

FIGURE 3.16 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08JUL'10	ISSUED WITH REPORT	JWV	JGC	KJB