

BHP Billiton Canada Inc.
Operator of the EKATI Diamond Mine

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October 22, 2010

Mr. Bill Ross, Chair
Independent Environmental Monitoring Agency
Yellowknife, NT
Via email

Re. EKATI Diamond Mine, IEMA Review of the 2008 Air Quality Monitoring Program

BHP Billiton Canada Inc. (BHP Billiton) conducts air quality monitoring program (AQMP) annually at the EKATI Diamond Mine. Dust and ambient air is monitored every year. Ambient air is monitored at an on-site Continuous Air Monitoring Building, one of only a few such sophisticated facilities in the North and the only such facility operated by someone other than the Government of the Northwest Territories (GNWT). Further reaching snow and lichen samples are monitored every three years. The most recent three-year monitoring of snow and lichen was in 2008 and was reported by BHP Billiton in the report, *2008 Air Quality Monitoring Program*, which was circulated to all of the Aboriginal communities and to the government agencies. The next three-year sampling of snow and lichen will take place next year, in 2011.

BHP Billiton acknowledges the Independent Environmental Monitoring Agency (IEMA) for sharing its review of the 2008 AQMP Report and providing BHP Billiton the opportunity to discuss it. To date:

- BHP Billiton issued a response table to the IEMA review comments (as attached);
- there has been a technical meeting between BHP Billiton, IEMA, Environment Canada and GNWT;
- there has been a technical meeting between BHP Billiton's technical consultant, Rescan Environmental Services, and IEMA's technical consultant, Senes Consultants; and
- GNWT has provided additional technical information regarding snow core sampling.

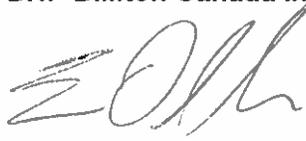
As a next step, we will be pleased to take part in a workshop on November 17 as a means of communicating this information and the status of the AQMP generally to representatives of aboriginal communities.

At this time as reported from the meeting of technical consultants, BHP Billiton understands that most of the technical comments provided by IEMA have been acceptably resolved through the information provided in the response table. The issues requiring further resolution were identified as tracking nos. 1, 2, 7, 11(a/b), 16 and 19. BHP Billiton will document and circulate all of these resolutions either as an addendum to the 2008 AQMP Report or as a revised report.

BHP Billiton appreciates the opportunity to have provided this letter and the attached response table for circulation along with IEMA's technical review.

Sincerely,

BHP Billiton Canada Inc.

A handwritten signature in black ink, appearing to read "ED", is positioned below the company name.

Eric Denholm, Superintendent – Traditional Knowledge and Permitting
EKATI Diamond Mine

2006-2008 AIR QUALITY MONITORING PROGRAM (SENES DRAFT PEER REVIEW) – PRELIMINARY COMMENT/RESPONSE TABLE

Tracking Number	Comment ID	AQMP Section	Review Comment	BHP Billiton Response
HVAS				
1	SENES-2.1-1	2.3	<i>According to the 2008 AQMP reports sampling was conducted in accordance with an in house (ENVR-SOP-AIR-01) SOP. The SOP was not provided with the AQMP. It is important to note that SENES identified concerns with this SOP in 2003 [SENES, 2003], and without an up-to-date copy of this SOP (perhaps, attached as an Appendix to the AQMP report), we cannot verify if our concerns have been adequately addressed. For example, with regard to sample start times, SENES identified that the 2003 version of the SOP allowed for mid-day start times as opposed to the generally accepted practice of midnight-to-midnight sampling. By starting a sample in mid-day, a significant portion of a non-daily dust event such as blasting may be missed, resulting in a lower TSP concentration associated with the event.</i>	<p>The revised version (8 May 2007) of ENVR-SOP-AIR-01 is provided in Appendix A to this response table.</p> <p>In response to the comment regarding sampling times it should be noted that the EKATI Environment Department are bound to a 12 hour work day by the Mines Act. The use of timers has been investigated. However, as far as BHP Billiton is aware the timers run on an auto shut-off basis as opposed to an auto start function.</p> <p>Regardless of the start time samplers run for 24 hour periods and therefore will capture dust events during that time.</p>
2	SENES-2.1-2	2.3	<i>The 2008 AQMP states that sampling was not conducted in the winter months noting that “the electric motors... do not function properly in the winter conditions”. SENES has commented on this position previously in response to the 2003 AQMP noting that SENES personnel have operated Hi Vols successfully in sub-arctic climates with temperatures as low as -30°C.</i>	<p>In response to this comment EKATI Environment Staff consulted with their Hi-Vol contractors who advised that the current Hi-Vol units are designed to operate in the extreme weather conditions encountered at EKATI. However, the operational logistics of operating the Hi-Vols at the EKATI mine in the winter season are not without data quality risks and BHP Billiton does not necessarily see value in adding this into the AQMP at this time. During the most recent (2007/08) program review, which included Senes, Environment Canada and GNWT, some uncertainty existed as to the value of the Hi-Vol data in general. BHP Billiton is open to discussing efficient ways to collect data that is useful to the AQMP program and looks to the data being collected at the Continuous Air Monitoring Building (CAMB) as preferred over the Hi-Vols.</p>
3	SENES-2.1-3	2.3/3.4.1	<i>There is a significant gap in the HVAS monitoring data in that no data were collected under the HVAS program in 2006, with some statements implying sampling was completed in 2006.</i>	<p>The location of the TSP-2 unit has remained unchanged since its commissioning in 1999. During 2006, the sampler was out of commission while the AQMP program was undergoing review and redesign. The sampler was replaced with a new unit in 2007.</p> <p>Sections 2.3 and the Executive Summary of the AQMP state the “HVAS station TSP-2, located on the roof of the pump house at Grizzly Lake has operated annually since 1997, and continued to operate from 2006 to 2008”. BHP Billiton notes that downtime occurred at TSP-2 during 2006.</p>
4	SENES-2.1-4	2.3/3.4.1	<i>The AQMP is silent of the reason why TSP-2 in particular, and the HVAS monitoring program in general, was not operational for all of 2006.</i>	<p>During 2006 the AQMP program was under review and a major re-design of the program occurred. The review of the AQMP program at EKATI was conducted in consultation with the Independent Environmental Monitoring Agency (IEMA), Environment Canada’s Environmental Protection Division (EC EPD) and the Government of the Northwest Territories Environment and Natural Resources Environmental Protection Services (GNWT ENR EPS). The AQMP was modified based on previous AQMP results at EKATI and up to date information on air quality monitoring methodology. Sampling procedures and monitoring locations were revised and improved where necessary, and additional monitoring was initiated. As a result of this review Hi-Vol monitoring at TSP-2 during 2006 was suspended.</p>
5	SENES-2.1-5	3.4.1	<i>It is not clear why geometric means, which are typically used to report annual average TSP concentrations, were not calculated for 2008, as this calculation was completed for all previous monitoring periods.</i>	<p>2008 Geometric Mean:</p> <ul style="list-style-type: none"> • TSP-2: 5.36 µg/m³ • TSP-3: 9.75 µg/m³
6	SENES-2.1-6	3.4.1	<i>The AQMP states “The average TSP was considerably less in 2007 than previously measured and that measured in 2008 (Table 3.4-1)”. However, in reviewing data, the arithmetic average for 2007 at TSP-2 is similar to TSP-2 results for 2 of the 6 previous years and TSP-2 data for 2008 is similar to TSP-2 results for 3 of the 6 years over the 1999 to 2005 period, suggesting TSP-2 data over this monitoring review period are generally consistent with historical data.</i>	<p>Refer to Appendix C of this response table for a figure illustrating annual mean TSP at station TSP-2 compared to the mean TSP generated from data from the life of the monitoring program at this site (1999-2008 – excluding 2006). As SENES noted the arithmetic average for 2007 at TSP-2 is similar to TSP results for 2 of the 6 previous years (1999 and 2005). However, the mean TSP recorded for 2007 is substantially lower than the program mean of 14.9 µg/m³ calculated for the life of the monitoring program. The mean concentration recorded for 2008 (14.5 µg/m³) is more consistent with historical data recorded at this site over the 8 year period.</p>

2006-2008 AIR QUALITY MONITORING PROGRAM (SENES DRAFT PEER REVIEW) – PRELIMINARY COMMENT/RESPONSE TABLE

Tracking Number	Comment ID	AQMP Section	Review Comment	BHP Billiton Response
7	SENES-2.1-7	2.3/3.4.1	<i>In a discussion of ambient monitoring results it is generally prudent to include a brief discussion of the QA/QC measures taken to ensure the reported data are of acceptable quality. For instance regular calibrations of Hi-Vols are vital to accurate data reporting. There should be some discussion with regard to calibration intervals, and any other measures of note that were taken to improve data quality. In particular some discussion would assist the reader in understanding the QA/QC issues associated with why over 10% of the 2008 filters returned a negative value and whether this was indicative of a generally low bias in sample weights. Unless Hi-Vol units were not turned on, negative values are not expected for Hi-Vol filters collecting TSP samples.</i>	<p>Calibration is required under the following conditions: after three months or 400 sampling hours, after motor maintenance and upon initial installation. Brush changes are required every 400 running hours. If it is recognized during sampling that any of these conditions apply a technician is notified immediately to perform the task.</p> <p>Calibration of the unit is performed using the Graseby G2835 (Vari-Flo) calibration kit. The exact procedure is covered in the Maintenance and Calibration SWP and can be found on Pg. 10-22 in the Operations Manual for Tisch Environmental Model TE-5170 Series. The results of the calibration determine the correlation coefficient r which must be 0.990 or larger for the calibration to be acceptable. Further details on the QA/QC and calibration approach for sampling can be found in ENVR-SOP-AIR-01 (Appendix A).</p> <p>During 2008 over 10% of the Hi-Vol filters returned negative values following analysis. During this time monitoring technicians were having problems with portions of the filter paper sticking to the rubber edge of the filter cassette, hence leading to negative TSP values being returned from the lab.</p> <p>A QA/QC section will be provided in future AQMP reports.</p>
8	SENES-2.1-8	3.4.1	<i>While potential causes of the two TSP exceedances at TSP-3 in 2008 are provided in the AQMP report, there is no correlation made between metrological parameters or to site activities, with exceedances attributable to natural sources. Further comment would provide additional context to these exceedances.</i>	<p>A review of meteorological data was conducted for the two days showing exceedances in TSP (19/7/2008 & 15/9/2008). For July 19, hourly wind speeds ranged from 1.6 to 10.5 m/s, and wind direction was from the South and SouthWest (167 to 223'). No precipitation was recorded for the few days prior to July 19, so dry, dusty conditions could be a potential cause for elevated TSP levels. On September 15, wind speeds ranged from 2.0 to 7.6 m/s, and wind direction was from the North and NorthEast (0' to 115'). 1.8 mm of precipitation was recorded on Sept 13.</p> <p>The results of this analysis do not suggest a strong correlation between metrological conditions and elevated TSP coming from mine activities (i.e. wind direction not from the E or SE).</p> <p>According to EKATI records there were no mine related activities occurring on site during these days that would likely attribute to higher concentrations than previous days.</p>
9	SENES-2.1-9	2.3	<i>The AQMP report states that TSP-3 “sited downwind of main camp area (based on the predominant easterly direction...)”, with this station located northwest of the main sources. Other monitoring stations (e.g. CMP, Fox and Sable Haul Road dustfall jars) are sited southwest of the main sources being monitored. The reason for this discrepancy is not clear.</i>	<p>The wind rose presented in the AQMP report shows predominant wind direction annually for data collected from 2000 to 2008. The primary component is from the ENE, E and ESE (24%). An analysis of summer wind directions using meteorological data from 2000 to 2008 shows winds with more of a multidirectional pattern (Appendix B). As HVAS is occurring during the summer months the placement of sampling units strategically downwind of emissions sources is not as clear based on the outputs of the summer wind rose. Due to the annual predominant easterly component each sampling station was placed west of the main source to capture the easterly wind. TSP-3 was sited downwind of the main camp area and Fox and Sable Haul roads sited on the westerly side of the haul roads downwind of its emissions sources. Dustfall monitoring stations related to the haul roads are located in a line perpendicular to the road in order to provide the distance-from-source data. The lines are located in accessible areas that allow for monitoring 1 km from the road. The most recent (2008/09) program, review in fact, resulted in the relocation of the Fox road sampling line for this purpose. The lines extend perpendicularly 1 km in the approximate downwind direction as well as a near-field station in the opposite direction.</p>
10	SENES-2.1-10	3.4.1	<i>As a side note regarding Table 3.4.1, it does not appear as though the footnote reference numbers are included in the table body as super-script formatting, making them appear as though they are an additional significant digit on the reported number.</i>	Noted

2006-2008 AIR QUALITY MONITORING PROGRAM (SENES DRAFT PEER REVIEW) – PRELIMINARY COMMENT/RESPONSE TABLE

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Dustfall Monitoring Program				
11	SENES-2.2-1	3.5	<i>The AQMP report notes the following with regard to the B.C. objective level: “that for some months, reference concentrations at AQ-49 and AQ-54 exceed these guidelines, suggesting that the guidelines may not be appropriate for the EKATI area”. A review of analytical data in Appendix 2 indicates that this assertion overstates the issue, with only one reference sample (AQ-49 for June 2008) being above the B.C. objective. With this data point removed, all reference levels were below the B.C. standard. While the report states that monthly samples were collected, Figure 3.5-1 shows only a single entry for each control site in each year, with this value appearing to be the average at each reference site for each sampling year. If the June 2008 data point is removed, the average reference concentration at AQ-49 for 2008 (0.76 mg/dm²/day) is close to the 2007 average (0.66 mg/dm²/day).</i>	<p>Results for reference sites AQ-49 and AQ-54 were presented in graphical form as the average annual dustfall based on monthly sampling data during summer. Following removal of the outlier on the 5/6/2008 (total dustfall recorded at 11.3 mg/dm²/day) the revised average reference concentration of total dustfall at AQ-49 (0.76 mg/dm²/day) is close to the 2007 average at the same site (0.66 mg/dm²/day).</p> <p>Based on this change all data collected at reference sites AQ-49 and AQ-54 from 2006 to 2008 was within the B.C. mining industry target range for dustfall between 1.7 and 2.9 mg/dm²/day.</p> <p>The graphs presented in Figure 3.5.1 were updated to reflect this change in annual average total dustfall at AQ-49 in 2008 (see Appendix B).</p> <p>Potential reasons for sample bias causing this outlier in June 2008 may be due to a number of factors including contamination of the sample lid when screwed on to the collector or the helicopter landing too close to the dustfall collector and stirring up particulate.</p>
12	SENES 2.2-2	2.5	<i>The report identifies that easterly winds are predominant in this area, which means that reference stations (AQ-49 and AQ-54) are located downwind of the site (based on the reported easterly predominant winds), albeit 21.5 and 36 km away respectively. These locations therefore may not be a true representation of background conditions.</i>	Based on the results of the EKATI CALPUFF modeling published in 2006, the reference stations AQ-49 and AQ-54 have been placed far enough away that the mine will not influence the results on dustfall. The CALPUFF modeling determined the zone of influence for fugitive dusts as 14 to 20km from the mine. Sampling outside of this zone will be indistinguishable from background. Locating the reference stations AQ-49 and AQ-54 21.5 and 36 km respectively from mine sources according to the CALPUFF modeling (taken into account predominant winds) will provide representative data collection of background conditions.
13	SENES 2.2-3	3.5	<i>There appears to be no discussion regarding outliers, such as the above elevated concentration at one of the reference locations for one sample event. There are also two instances in which the maximum dustfall levels occur at the furthest measured distance from the haul road. This situation occurs at the Fox Haul Road in 2007 and 2008, and both times were in the month of July. It does not appear as though any investigation into the rationale for these outliers took place. For example, in the discussion of exceedances in the HVAS program it was noted that there were forest fires in July 2008. The preceding information raises questions such as whether it is possible that these fires may have contributed in some way to elevated dustfall in this area, or whether there is some other event that would affect July results in this area. Field notes describing the condition of the sample jar upon receipt by the technician, as well as records of any other local occurrences are useful in assessing potential rationale for such outliers.</i>	<p>Two major outliers were recorded in the dustfall data during the AQMP monitoring period of 2006 to 2008:</p> <ol style="list-style-type: none"> 1/7/2007 Fox D300 = 35.2 mg/dm²/day (average at this site over the three years excluding this outlier is 1.3 mg/dm²/day) 5/7/2008 Fox D1000 = 8.52 mg/dm²/day (average at this site over the two months of monitoring in 2008 excluding this outlier is 0.38 mg/dm²/day) <p>These outliers go against the expected trend of decreasing total dustfall with distance from the road centerline. As described above possible causes of outliers in dustfall data could be due to contaminated sample jars or the helicopter landing too close to the sampling site stirring up excessive particulate. It is possible that the outlier observed in July of 2008 is attributable to the tundra fire noted on the field data sheet for the HVAS program. Given that dustfall monitors are left to collect particulate for a period of a month it is possible that fugitive emissions from a tundra fire could significantly influence the results of this sample.</p> <p>Field data sheets for the above two samples were reviewed to ascertain any unusual conditions. Technician notes for these days did not identify any conditions/mine activities that may have led to elevated total dustfall results.</p>
14	SENES 2.2-4	3.5	<i>Section 3.5 of the AQMP report states “The 2006 and 2007 results show that dust deposition was highest at the Fox haul road, followed by Misery and then Sable roads. This result is commensurate with the level of activity experienced on each road during those years.” Data does not support this generalization, with higher dustfall concentrations noted near field for Misery Road in 2007 than for Fox Road in either 2007 or 2008.</i>	<p>The results of the dustfall monitoring program are aligned with site activity for the monitoring years from 2006 to 2008. In 2006 and particularly 2007 total dustfall nearby the Misery haul road (less than 90 m from the road centerline) was higher than observed in 2008 when all hauling activity along Misery road had ceased.</p> <p>In 2008 total dustfall was higher near field to the Fox haul road compared to the Misery haul road. The Fox haul road continued to be used during 2008 when the Misery road had been deactivated.</p> <p>The above descriptions provide more specific explanations of observed trends.</p>

2006-2008 AIR QUALITY MONITORING PROGRAM (SENES DRAFT PEER REVIEW) – PRELIMINARY COMMENT/RESPONSE TABLE

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15	SENES 2.2-5	2.5	<i>The “downwind” Misery Haul Road dustfall monitors are located south of the haul road, while the prevailing winds are reported to be from the east. The Fox Haul Road and Sable Haul Road dustfall monitors are arranged suitably given the prevailing wind direction.</i>	<p>The wind rose presented in the AQMP report shows predominant wind direction annually for data collected from 2000 to 2008. The primary component is from the ENE, E and ESE (24%). An analysis of summer wind directions using meteorological data from 2000 to 2008 shows winds with more of a multidirectional pattern (Appendix B). Therefore the primary component from the ENE, E & ESE remains, and a secondary component appears from the WNW. As dustfall monitoring is occurring during the summer months the placement of sampling units strategically downwind of emissions sources is not as clear given the multidirectional pattern.</p> <p>Dustfall monitoring stations related to the haul roads are located in a line perpendicular to the road in order to provide the distance-from-source data. The lines are located in accessible areas that allow for monitoring 1 km from the road. The most recent (2008/09) program, review in fact, resulted in the relocation of the Fox road sampling line for this purpose. The lines extend perpendicularly 1 km in the approximate downwind direction as well as a near-field station in the opposite direction. In the case of the Misery samplers specifically, these have been in place for several years and BHP Billiton does not see value in relocating them at this time. In addition because the road is linear the source emissions will be captured by the dustfall monitors regardless of exact wind direction.</p>

2006-2008 AIR QUALITY MONITORING PROGRAM (SENES DRAFT PEER REVIEW) – PRELIMINARY COMMENT/RESPONSE TABLE

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16	SENES 2.2-6	3.5	<i>In the description of the snow core sampling program in the AQMP report, it is noted that nitrate and sulphate are substances of concern as they are known to be harmful to terrestrial and aquatic ecosystems. According to the chain of custody reports for the dustfall samples, concentrations of these parameters were specifically requested however there is no discussion of the results in the report. A cursory review of the lab reports indicates that the concentrations near the haul roads are higher than those at the control location. It is unclear whether there has been any investigation into the measured nitrate and sulphate levels in dustfall, and whether there is any literature which suggests levels at which they may be of concern. Given that these parameters have been identified elsewhere in the AQMP report as being of concern, and the fact that they appear on the dustfall laboratory reports, it is recommended that these also be addressed to some extent when discussing the dustfall results.</i>	<p>Acid deposition is primarily a result of sulphur dioxide (SO₂) and nitrogen oxides (NO_x) emissions from industrial facilities. Environment Canada measures deposition in terms of 'critical load', which is defined as the amount of acid deposition a particular region can receive without being adversely affected. Chemical indicators of deposition are sulphate and nitrate anions. The units commonly used to quantify acid deposition and critical loads are kg/ha/yr. Deposition measurements taken from dustfall samples were in mg/dm²/d.</p> <p>Estimates of critical load ranges have been established for both aquatic and terrestrial ecosystems for many areas of Canada. Terrestrial critical loads have yet to be established for the NWT or another region characterized by Tundra. The Table below shows the range of established critical loads for soil in other Canadian jurisdictions that can be compared to loadings at EKATI to provide some context as to the likely effect of the mine on acid deposition (EC 2004).</p> <table border="1"> <thead> <tr> <th>Province</th> <th>Median (kg/ha/yr)</th> </tr> </thead> <tbody> <tr> <td>Newfoundland</td> <td>28</td> </tr> <tr> <td>Nova Scotia</td> <td>39</td> </tr> <tr> <td>Prince Edward Island</td> <td>99</td> </tr> <tr> <td>New Brunswick</td> <td>56</td> </tr> <tr> <td>Quebec</td> <td>25</td> </tr> <tr> <td>Ontario</td> <td>26</td> </tr> </tbody> </table> <p>A review of the ALS dustfall results shows that for 2006 and 2007 sulphate and nitrate anions were reported in concentrations of mg/L (Rescan are currently liaising with ALS to obtain sample volumes for 2006/07 data). During 2008 ALS reported the sulphate and nitrate results in loadings of mg/dm²/day. The maximum concentration for sulphate and nitrate deposition observed in dustfall samples at any site during 2006 and 2007 is presented below:</p> <ul style="list-style-type: none"> Nitrate - 0.73 mg/L (1/7/07 Mis D30); and Sulphate - 20.4 mg/L (2/8/07 SAB U30). <p>The maximum loadings of sulphate and nitrate reported for 2008 are provided below:</p> <ul style="list-style-type: none"> Nitrate – 0.00249 mg/dm²/d/ 0.909 kg/ha/yr (5/8/08 MIS D1000) Sulphate – 0.0536 mg/dm²/d/ 19.56 kg/ha/yr (5/7/08 LLCF-PA-P) <p>The results for 2008 show that acid deposition (20.47 kg/ha/yr) was below median critical loads reported for different parts of Canada in the above table. The 20.47 kg/ha/yr value is the sum of the sulphate and nitrate potential deposition and it is the one month worst case scenario that has been extrapolated to one year. Hence, these estimates are quite conservative because it is unlikely that these maximum monthly values would extend for 12 months. In addition, it is important to note that the acid deposition calculations neglect to consider any neutralizing compounds found in dustfall and soil. Actual loading is likely well below this prediction.</p> <p>Assessment of acid, sulphate and nitrate in dustfall will be provided in future AQMP reports.</p>	Province	Median (kg/ha/yr)	Newfoundland	28	Nova Scotia	39	Prince Edward Island	99	New Brunswick	56	Quebec	25	Ontario	26
Province	Median (kg/ha/yr)																	
Newfoundland	28																	
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Ontario	26																	
17	SENES 2.2-7	3.5	<i>In addition to nitrates and sulphates, dustfall samples were also analyzed for soluble particulate and total metals (Section 2.5 and Appendix 2). There is no discussion or interpretation of monitoring results for these analytes.</i>	<p>There has been no criteria established Canada wide for either of these parameters. Results for the 2006-2008 AQMP periods show that many of these parameters are at or below analytical detection limits, which makes it difficult to discern any trends in data. These observations will be continued and documented in future AQMP reports.</p>														

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18	SENES 2.2-8	2.5/3.5/ Appendix 2	<i>There is a discrepancy in the sampling dates between what is written in the AQMP report and what appears in the figures and Appendix 2. Section 2.5 of the AQMP report states that monitoring in 2006 to 2007 took place in July and August, while June was added for the 2008 monitoring period. Figure 3.5-1 indicates that 2007 monitoring was in July, August and September while 2006 monitoring was in August and September.</i>	<p>Noted.</p> <p>During the initial year of monitoring (2006) samples were collected during August and September. In 2007 sampling was extended to a three month period between July and September and in 2008 between June and August.</p> <p>Dustfall monitoring at EKATI usually commences at the onset of freshet when the ground becomes snow free. Generally this occurs sometime in June. 2006 was the inaugural year of the dustfall sampling program. During the earlier months of summer in the first year there was some time taken to set up the program in terms of ordering canisters and installing and calibrating equipment. In 2007 the program was in development and administrative procedures were being worked through in June, hence monitoring did not commence until July. Dustfall sampling procedures have now been developed by EKATI and going forward, given the onset of freshet, sampling will commence in June each year.</p>

2006-2008 AIR QUALITY MONITORING PROGRAM (SENES DRAFT PEER REVIEW) – PRELIMINARY COMMENT/RESPONSE TABLE

Tracking Number	Comment ID	AQMP Section	Review Comment	BHP Billiton Response
Continuous Air Monitoring Program				
19	SENES 2.3-1	3.4.2	<p><i>The only data for the Continuous Air Monitoring (CAM) program presented in the 2008 AQMP report, tabular or otherwise, is a summary of monthly averages of the parameters being measured (Table 3.4-2). There is a statement preceding Table 3.4-2 noting that all of the monthly average concentrations shown are within the Northwest Territories Ambient Air Quality Standards (NTAAQS) and the Canadian Ambient Air Quality Objectives (CAAQO), which are presented as Table 3.2-1 and Table 3.2-2 of the AQMP, respectively. It should be noted that none of the NTAAQSs or CAAQOs are intended for comparison to monthly averages for any of the parameters measured. Table 3.2-1 and Table 3.2-2 each show clearly that the standards/objectives are intended for comparison to either 1-hour average concentrations, 24-hour average concentrations or annual average concentrations. The measured maximum 1-hour and 24-hour average concentrations would be expected to be much higher than the monthly averages presented. In short, the data provided in Section 3.4.2 of the AQMS report provides no useful information to assess performance relative to the NTAAQS standards and the CAAQO operational targets. It should also be noted that the CAAQOs include maximum desirable, acceptable and tolerable concentrations for TSP, NOx and SO2 for various averaging periods. There is no comparison of the measured data to these objectives included in the AQMP report.</i></p>	<p>Refer to Appendix D for 2008 Continuous Air Monitoring data presented for hourly and daily averages for each parameter.</p> <p>For 2008 all other hourly and daily average concentrations for selected parameters shown in Appendix D are within the NWT standards for SO₂, TSP and PM_{2.5}.</p> <p>For all parameters the CAAQO standards for Maximum Tolerable Concentrations were met. For SO₂ the hourly and daily averages for all of 2008 were below the CAAQO objectives for the Maximum Desirable Concentrations. For SO₂, TSP and PM_{2.5} the hourly (SO₂) and daily concentrations for each month in 2008 were below the CAAQO Objectives for Maximum Acceptable Concentrations.</p> <p>Exceedances of the Maximum Acceptable Concentration for nitrogen dioxide were observed in three months during 2008 (March, June and November). The CAAQO Maximum Acceptable Guidelines for NO₂ state that concentrations must be at or below 213 PPB and 106 PPB for hourly and daily averages respectively. The following exceedances of this guideline occurred:</p> <ul style="list-style-type: none"> • NO₂: March - 218 PPB (1 hr average) • NO₂: June - 399 PPB (1 hr average) & 153.6 PPB (24 HR average) • NO₂: November - 323 PPB (1 hr average) & 132.4 PPB (24 hr average). <p>CAMB Data will be compared to standards in this manner in future AQMP reports. For additional context on the observations listed above, the following comments were made in the Maxxam analytical report regarding NO₂ data collection for each month of exceedance.</p> <p>March: <i>"The analyzer was working well throughout the month. The flags for NO₂ daily calibration were put on manually this month. The calibration was performed on March 5th. There was a two hour and forty minute pause between the dilution and GPT portions of the NO_x calibration due to the arrival of the bucket truck for BAM repairs. At the time of visit, no faults were displayed on the analyzer. The readings on the DAS matched those of the analyzer. A spike showed on the data on NO₂ at 15:00 on March 6th. The inlet filter was changed before the monthly calibration was started. Data was corrected using daily zero data."</i></p> <p>June: <i>"The analyzer was working well throughout this month. No operational issues were observed. The flags for NO₂ daily calibration were put on manually this month. The inlet filter was changed before the monthly calibration was started. Data was corrected using daily zero data. Ordinarily, when a NO_x daily calibration program is set up, it is the NO₂ and NO_x channels that are setup as the span channels, and it is the way most NO_x analyzer is configured. However, the NO_x analyzer at the site had originally been set up to report NO₂ on the NO channel during the span phase of the calibration program. It means the NO span readings were actually NO₂ span readings. The technicians observed this problem on July 8th, and set the NO₂ back to the NO₂ channel so that it can correctly present NO₂ daily span readings."</i></p> <p>November: <i>"The analyzer was working well throughout this month. No operational issues were observed."</i></p>
20	SENES 2.3-3	2.4	<p><i>While Section 2.4 of the AQMP report indicated that the CAM building was installed at Grizzly Lake in May 2007, there are no data provided in Section 3.4.2 for 2007 nor any explanation for the absence of these data.</i></p>	<p>Prior to 2008 the CAM station was in commissioning. During 2007 multiple set-up phases and calibrations were performed on the continuous air monitoring equipment to ensure that it was in proper working order for commencement of monitoring in 2008.</p>

2006-2008 AIR QUALITY MONITORING PROGRAM (SENES DRAFT PEER REVIEW) – PRELIMINARY COMMENT/RESPONSE TABLE

Tracking Number	Comment ID	AQMP Section	Review Comment	BHP Billiton Response
21	SENES 2.3-4	2.4	<i>Similar to a previous comment on the HVAS program, it would be prudent to include a brief description of the QA/QC measures taken in the CAM program. As continuous NOx and SO2 analyzers need to be re-zeroed and re-spanned frequently in order to maintain accuracy, it should be noted how regularly analyzers were calibrated and their proper operation assured. Of note, significant operational issues appear to have been associated with the analyzers, with over 15% of SO2 data (analyzer malfunction) and 4% of PM2.5 data (negative concentrations less than -3 µg/m3) invalidated over the sampling period. These operational issues only appear as footnotes to Table 3.4-2.</i>	The Continuous Air Monitoring (CAM) system is calibrated by Maxxam Analytics quarterly. An example of the calibration notes is provided in response to comment 19 above. The CAM building is checked weekly by BHP Billiton staff, analyzers are checked for faults, snow/ice/frost is cleared from the inlets, and filters are changed as needed. A log is kept of all maintenance done on the CAM system.
Snow Core Sampling Program				
22	SENES 2.4-1	Table 3.6-1	<i>In Section 2.6.2 of the AQMP report, it is stated that analysis of the results was not completed on the basis of concentration (mg/L) as there can be variability depending on the depth of the snow pack. Instead, analysis was based on the surface loading rate (mg/m2/day). There is a statistical summary of selected parameters included in the analysis in Table 3.6-1. The statistics in the table for most parameters are based upon concentrations in units of mg/L (where applicable to the parameter). This seems to contradict the previous statement that indicated that the surface loading rate was to be used in the analysis of the results. For example, if the concentration of a certain parameter is low because it was collected in a deep snow pack, but its surface loading rate is comparable to other locations at a similar distance then there is some question as to how useful these summary statistics are when calculated on a concentration basis.</i>	<p>The data presented in Table 3.6-1 of the AQMP is based on surface loading rates (mg/m²/day). The 'unit's' column of Table 3.6-1 lists measurements in mg/L and should read mg/m²/day.</p> <p>However, the column showing the 1998 and 2005 average was presented using the units mg/L. The data in this column has been re-calculated to present average loadings over this time period in replacement of the average concentrations. A revised Table 3.6-1 is presented in Appendix D.</p> <p>After adjusting the results of the 1998 to 2005 averages from mg/L to average loading the conclusions drawn from the table in the AQMP remain the same. "In general, the 2008 results are within the historical range, the average values from many parameters are below the 1998 to 2005 values."</p>
23	SENES 2.4-2	2.6	<i>Snow samples are allowed to melt prior to analysis. Potential issues with this practice have been previously raised by SENES. In particular, nitrates and sulphates may be subject to reaction resulting in degradation of samples. SENES had previously recommended that split frozen and unfrozen samples be analyzed to validate the method used by the site. There is no indication that this recommendation was followed. Likewise, there is no evidence to suggest that melted snow samples are preserved or stored (e.g., maximum storage times) in accordance with generally accepted practice for water samples.</i>	<p>The analysis of frozen and unfrozen samples to validate this method will be built into the 2011 snow core survey design. It should be noted that all samples are analyzed as water and as per the ALS methodology frozen samples will be thawed prior to analysis. The results of this study will guide any revisions to the snow sampling methodology in future.</p> <p>In 2008 work was completed to address potential QA/QC issues potentially associated with the use of zip lock bags for storing and transporting melted snow/water samples in comparison to ALS water bottles. The results indicated that only trace amounts of Kjeldahl Nitrogen, Ortho Phosphate, and Aluminum were found using the zip lock bags. The additional test work described above will supplement this work completed to provide a more thorough assessment of the validity of the snow core sampling methodology.</p>
24	SENES 2.4-3	3.6	<i>The AQMP states that "The higher concentrations of volatile compounds observed at reference sites is likely to be attributed to external sources such as arctic haze or long range transport." This assertion is unsupported. Further, it is unclear why arctic haze and/or long range transport, being air shed issues, would not equally affect the EKATI site. Lower loadings noted in site monitoring data may be due to improper sampling /melting of snow cores resulting in nitrate and sulphate losses (see also comment 2 in this section).</i>	<p>The unfrozen sample method will be validated in 2011 as noted in Item 23 above.</p> <p>With regards to the effects of long range transport and arctic haze on deposition of volatile compounds such as sulphates and nitrates, future monitoring will help establish whether there is a trend developing relating to regional activities or naturally occurring events. Several years of data will be required in order to make a reliable assessment.</p> <p>It should also be noted that although there are cases where nitrate and sulphate concentrations have been observed to be higher with distance from the mine than found at some stations nearby, all concentrations observed were low and close to background levels. Because all concentrations recorded were low and many were below detection limits (0.2 mg/L sulphate and 0.005 mg/L nitrate) some variability is expected among samples.</p>
25	SENES 2.4-4	2.6/3.6	<i>Section 2.6 states that "spatial patterns in snow chemistry data were analyzed based on the distance from the sampling site to the nearest centre of activity (Main Camp or Fox Pit)." Figures 3.6-2 and 3.6-3 are graphed relative to the distance from the mining source. It is not clear what was used as the point of origin of "the mining source" for each sample. Further, there is no differentiation between upwind and downwind samples which would add useful information to the analysis.</i>	The X-axis on Figures 3.6-2 and 3.6-3 could be more explicitly stated as 'Distance from nearest centre of activity (main camp or fox pit)'.

2006-2008 AIR QUALITY MONITORING PROGRAM (SENES DRAFT PEER REVIEW) – PRELIMINARY COMMENT/RESPONSE TABLE

Tracking Number	Comment ID	AQMP Section	Review Comment	BHP Billiton Response																				
26	SENES 2.4-5	3.6	<i>The AQMP report states “the effects of volatile compounds (S and N) are limited to the active mining areas surrounding EKATI.” Figure 3.6-2 does not appear to support this conclusion, with no clear discernable trends apparent for 2008 data. Given the significant scatter in data, regression analysis would provide further insight into the interpretation of these data.</i>	<p>Correlation analysis was performed on ammonia, nitrate and sulphate concentrations against distance from mining source (Appendix G: Figures X, Y, Z). Distance was normally distributed on a ln scale (W= 0.9481, p=0.11). Sulphate was normally distributed on a ln scale (W= 0.9778, p=0.7177), therefore Pearson’s correlation (r) was calculated for Distance vs Sulphate. The trendline is plotted for this weakly significant correlation (Figure Z).</p> <p>Ammonia and nitrate data were non-normal even after transformation (ln, square root, arcsin), therefore the non-parametric Spearman’s correlation (p) was calculated and both relationships were not significant (Figures X and Y).</p> <p>Summary statistics are provided below:</p> <table border="1"> <thead> <tr> <th></th> <th>Test</th> <th>Value</th> <th>P-value</th> <th>N</th> </tr> </thead> <tbody> <tr> <td>Ammonia</td> <td>Spearman</td> <td>-0.003</td> <td>0.986</td> <td>33</td> </tr> <tr> <td>Sulphate</td> <td>Pearson</td> <td>-0.349</td> <td>0.047</td> <td>33</td> </tr> <tr> <td>Nitrate</td> <td>Spearman</td> <td>0.039</td> <td>0.831</td> <td>33</td> </tr> </tbody> </table> <p>The correlation analysis suggests no correlation between distance from mining with Ammonia and Nitrate concentrations. The analysis suggests a marginally significant correlation between Sulphate concentrations and Distance.</p> <p>This analysis suggests that mining activities at EKATI are not having a significant effect on concentrations of volatile compounds S and N in the surrounding study area.</p>		Test	Value	P-value	N	Ammonia	Spearman	-0.003	0.986	33	Sulphate	Pearson	-0.349	0.047	33	Nitrate	Spearman	0.039	0.831	33
	Test	Value	P-value	N																				
Ammonia	Spearman	-0.003	0.986	33																				
Sulphate	Pearson	-0.349	0.047	33																				
Nitrate	Spearman	0.039	0.831	33																				
27	SENES 2.4-6	3.6	<i>There appears to be some inconsistency between Figures 3.6.1 and 3.6.3 for aluminum data. While the size of dots on Figure 3.6.1 are difficult to judge, it appears that eight aluminum samples exceed 0.5 mg/m²/day, while Figure 3.6.3 suggests only 2 samples exceeded this value.</i>	Figure 3.6-3 shows the correct representation of aluminum loadings from snow core samples. Only 2 samples showed values in excess of 0.5 mg/m ² /day.																				
28	SENES 2.4-7	2.6/3.6	<i>With regard to QA/QC measures, there is mention that duplicate samples were collected at three locations, however there is no further discussion regarding comparison between the duplicates. A cursory review of the laboratory data revealed that there were some notable differences in the two samples collected at location AQ-C4. For example, total suspended solids at this location for the two samples were 5.9 mg/L and 15.9 mg/L. It should also be noted that only two duplicates were found in the chain of custody forms (locations AQ-C4 and AQ-114).</i>	<p>At the following sites duplicate samples were taken:</p> <ol style="list-style-type: none"> 1. AQ-02 2. AQ-C4 3. AQ-114 <p>A table has been included in Appendix H that compares analytical results of the duplicate samples collected. As identified in the SENES comments there are two instances where duplicate sample results vary substantially, in particular for TSS and turbidity analysis. However, for most parameters analyzed variability between duplicates is minor.</p> <p>Future AQMP reports will include a QA/QC section for each sub AQMP program describing the results of individual QA/QC assessments.</p>																				
29	SENES 2.4-8	3.6/3.5	<i>The snow sampling program and dustfall monitoring program both monitor deposition rates (mg/m²/d). As dustfall sampling is limited to summer months, some comparison of results between the two programs may provide insight into, or validation of, monitoring programs.</i>	This synergy between the different AQMP programs was recognized to some extent in the 2008 AQMP report by providing a comparative analysis between lichen and dustfall results. Going forward adding a similar analysis to compare snow core and dustfall results will contribute to the AQMP analysis. Future AQMP reports will include a high level comparison of results between the snow sampling and dustfall loading results. GIS will be used to overlay dustfall monitoring stations with snow core sampling sites. Co-located sites (within 1-2 km) will be used in the comparison to provide insight into summer versus winter loading rates and to some extent data validation.																				
30	SENES 2.4-9	3.6	<i>Lastly, the AQMP states that background concentrations are based upon 20 years of precipitation monitoring data at Snare Rapids, but refers to a 10 year period (1998 to 2008).</i>	This is a typographic error. The sentence should read “Background conditions are presented based on 20 years of precipitation monitoring data (1988 to 2008) from Snare Rapids.” The 20 year period remains correct.																				

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Tracking Number	Comment ID	AQMP Section	Review Comment	BHP Billiton Response
Greenhouse Gas Emissions Inventory				
31	SENES 2.5-1	2.2/3.3	<i>There is a discrepancy between the information in Table 3.3-1 of the AQMP report and the GHG Management Plan. The report identifies blasting emissions as being calculated using diesel consumption, while the GHG Management Plan identifies ANFO as the basis of the blasting emissions calculation. When using the emission factors appearing in Appendix A with the associated fuel volumes in Table 3.3-1, the resulting GHG emissions do not match with the annual emissions in Table 3.3-2 of the AQMP report. Interestingly, when the diesel fuel volume assigned to blasting in Table 3.3-1 is removed from the calculation, the resulting GHG emissions do match. This raises a concern that the GHG emissions totals in Table 3.3-2 are not complete as they appear to only include diesel fuel used as a fuel source, Jet A1 fuel and Waste Oil. Appendix A identifies other sources of GHGs, such as blasting, gasoline and biomass consumption in the waste incinerator which do not appear to be accounted for in Table 3.3-2.</i>	BHP Billiton is assessing this comment.
32	SENES 2.5-2	2.2-3.3	<i>The source document for the emission factors – Environment Canada’s National Inventory Report 1990 – 2005: Greenhouse Gas Sources and Sinks in Canada, Annex 12 [EC, 2005], was reviewed in order to ensure that the factors being applied were appropriate. The emission factors for diesel fuel were found in Table A12-7 of the reference document, under the entry for Heavy-Duty Diesel Vehicles with Advance Control. The information in Table 3.3-1 of the AQMP report identifies that only approximately 27% of the diesel fuel consumed at the site is consumed by motive sources, while over 50% is consumed by power generators. It is incorrect to apply emission factors for mobile equipment to stationary sources such as generators. Considering that diesel fuel consumption is already tracked by the type of equipment it is consumed by, it is recommended that emission factors suitable to each equipment grouping be applied. While it is not anticipated that this will make a significant difference to the overall CO2e emissions estimates, it would be a more technically sound approach. This practice has been previously questioned by SENES.</i>	BHP Billiton is assessing this comment.

References

Environment Canada. 2004. *2004 Canadian acid deposition science assessment*. N.p.: Environment Canada, Meterological Service of Canada. http://www.msccmc.ec.gc.ca/saib/acid/assessment2004/assessment_2004_e.pdf (accessed November, 2008).

Appendix A – HVAS Sampling Procedure ENVR-SOP-AIR-01



High Volume Air Sampler Operation

Owner: Environmental Compliance Team Leader	Approver: Chief Environmental Officer	Issue Number: 1	Creation Date: 25 November 2002
			Revision Date: 8 May 2007

Objective

The purpose of this procedure is to explain the process of HiVol TSP sampler operation to all involved BHP Billiton Diamonds Inc. employees and contractors to ensure that samples are collected in a consistent manner in accordance with the EKATI Diamond Mine Air Quality Program.

Scope

This procedure applies to Technicians and Summer Students of the Environment Department required to operate the two HiVol TSP samplers located on the roof of the Grizzly Lake Pumphouse and east of the LLCF at Cell B at the base of the meteorology station respectively. Sampling takes place every 6 days from approx. May to Oct., depending on the weather conditions. Sampling involves preparation, loading and starting up the samplers, retrieving filters after 24 hours, lab procedures and data entry.

Introduction

EKAT Diamond Mine established an air quality management and monitoring plan to monitor possible effects of emissions and fugitive dust to soil, water, vegetation, animals and worker health and safety. The monitoring plan consists of four (4) elements;

- 1) mass balance emission calculations.
- 2) high volume air sampling.
- 3) snow surveys and.
- 4) vegetation studies.

This procedure will focus on the operation of the High Volume air samplers.

Definitions

HiVol TSP sampler High Volume Total Suspended Particle (Air) Sampler, namely the Tisch Environmental Model TE-5170 Series equipped with a mass flow controller. The equipment functions by drawing a known volume of air through a pre-weighed rectangular glass fiber filter at a known flow rate for a 24-hour period. Samples are weighed after the 24-hour period and the concentration of TSP determined gravimetrically. The sampler is operated every six days to avoid sampling bias.

Filter Binderless glass fiber filters measuring 20.0 by 25.4 cm (Graseby Model # G810)

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Filter Paper Cartridge

The Filter Paper Cartridge provides a rigid frame for the filter, as well, the removable cover protects the filter from contamination during transport.

Preparation

Hazards

- Working on roof tops, snow and ice may be slippery.
- Sampler shelter doors or roof may slam in wind and may pinch fingers/hands.
- Very high windchills may be encountered.
- Difficult terrain walking up tundra to Cell B station TSP-3.

Tools

- 2 Filter Paper Cartridges loaded with prepared filters
- Clipboard
- Pencil
- 2 Data Sheets
- 2 Circular charts
- Spare flow recorder pens
- Spare timer stops
- Screwdriver or multitool
- Watch
- PPE

Requirements

- Sound knowledge and familiarity with the sampling procedure
- Driver's Licence Class 2
- Basic understanding of the science and math involved
- Attention to detail
- No fear of heights, to a smaller extent

Tasks

1. Equipment Preparation

- Filters used for the collection of TSP are batch prepared and stored individually in sequentially numbered envelopes.
- Filters are heated in a Fisher Scientific 737F Isotemp drying oven at 105°C for 24 hours. The filters are then

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transferred to a Plas Labs #863-CG dessicator and cooled to room temperature. The filters are then weighed individually using a Mettler Toledo AG204 analytical balance and placed into manila envelopes. The weight of the filter to four decimal places is recorded on the envelope. The filters are stored and used as required. Filters must never be touched with bare hands, only with tweezers and must be treated quite carefully.

- Pre-weighed filters are then positioned on the Graseby G3000 Filter Paper Cartridge, rougher side facing up, and secured hand-tight, knurled part of the retaining nut facing upwards. The filters must not be damaged, even the slightest rip or hole make them useless and a new filter must be installed. The cover is snapped on to prevent damage and contamination during transport.
- Blank data sheets are found in Section 7 of the High Volume Air Sampling binder. Two are required for each sampling round, one for each location. Filter number and filter weight as indicated on the envelope are entered on the data sheets as they are placed into the cartridge. Even numbered filters go to Grizzly Lake ,TSP-2, odd numbered filters go to Cell B, TSP-3. Destination and sampling personnel must be entered on the data sheet. It is important that the next brush change and calibration due at field at the top of the data sheet is filled in. The number may be taken from the previous data sheet or the calibration sheets in section 4 and 5 in the HiVol binder. This allows instant recognition of the need to service and calibrate the sampler motors.
- The sampling must take place every 6 days during the snow free season. The sampling schedule calendar should be consulted to ensure proper timing. During periods of possible heavy snowfall the sampling should be suspended to avoid sampler motor damage.
- Sampling is generally started at TSP-2 on top of the Grizzly Lake pumphouse. Upon arrival the sampler is inspected for damages visually, the motor is turned on manually without a filter cartridge loaded for 2 to 5 minutes to warm it up and check for proper function. The On/Off switch is reached by opening the main housing door, then opening the mechanical timer housing. The switch is located at the 6 o'clock position

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2. Starting the Sampling

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below the timer disk and is moved right/left to switch On/Off.

- After the warm-up period the motor is shut off, and the filter cartridge placed and secured to the Graseby G10470 Filter Holder, located on top of the sampler underneath the tip-up roof. A chain and S-hook are provided to secure the roof in the open (and closed) position while fastening the cartridge using the four plastic wing nuts. These should be evenly and only finger-tight tightened. It is crucial that the filter cartridge cover is removed before closing the roof and securing it with the S-hook. The removed cover is brought back to the office.
- A TE-106 circular chart is labeled with location, TSP-2 or 3 and the date and inserted into the TE-5009 continuous flow recorder. The chart will fit two ways and care must be taken to insert it so that the pen is at the correct time setting, am or pm. The chart has to be placed underneath the two small metal retainers. The pen should be tested and replaced if necessary. It is then lowered onto the chart by moving the lifter arm. The pen should now sit at the correct present time, if not the chart may be turned for adjustments by inserting a screwdriver into the slot of the axis. The recorder is not yet closed.
- The TE-5007 Flow Controller/7-Day Mechanical timer is checked and set to the correct present time, as displayed by the end of the indicator hand. To correct it, it may be manually turned only in the direction indicated on the timer disk. A stop-clip is now attached onto the rim of the disk and well hand-tightened. The pointed part of the clip indicates the shut-off time, it should be set for 24 hours **and 30 minutes extra** run time. Care must be taken not to confuse am and pm to avoid only 12 hours of run time.
- The fields Month, Day, Year and the present time (in military 24 hour time) are filled out on the data sheet as well as the hour meter reading. This hour reading is compared to the hours previously entered in the Next Brush Change and Calibration due field. If the sampler has reached (or will be reaching during the sampling) the hours indicated the motors will have to be removed at the end of the sampling event for service/calibration.
- The sampler is now turned on manually as done

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previously. The flow recorder is lightly tapped and the stabilized pen reading on the circular chart is read and written into the field provided on the data sheet. The reading is taken in CFM, the distance between two lines equals 2 CFM. The min/max reading should be in the 45 to 55 CFM range, if it deviates significantly it may indicate a problem such as cartridge cover not removed or tear in filter paper.

- Once everything checks out all the covers and doors are shut securely, the cover is taken along, and the next TSP, generally TSP-3, is visited to repeat the above procedure.
- Upon completion of the set-up the airport technician at 880-2220 is called. He/ she will be able to supply the required weather information in the units necessary. Temperature must be accurate to one decimal point. The airport technician takes hourly readings on the hour, the time nearest to the actual start-up event must be chosen for the weather data. This could mean that two different weather data set are required. Example: one sampler was started at 1520h (nearest to the 1500h weather obs.), the other one at 1540h (nearest to the 1600h weather obs.)

3. Ending the Sampling

- After 24 hours have passed the samplers will be shut down, manually or automatically, and the used filter cartridges returned to the office. A reasonable effort should be made to arrive at the site precisely at the same time they were set the previous day. If the samplers are found still running upon arrival, the Start Sampling Hr. Meter entry is compared to the actual hour meter reading. If at least 24 hours have passed according to these numbers (not watch time) the sampler motor is shut down manually. If not enough time has passed a little wait may be necessary, if the sampler stopped already on its own this step can be omitted.
- Any clips on the edge of the yellow timer disk, stop or others, must be removed and placed at the bottom of the timer housing. Date, time of shutdown in 24 hour time and hour meter reading are entered on the data sheet. The meter hours are compared to the Brush Change and Calibration due at entry. If the meter is in need of service the motors must be removed, serviced and calibrated before the next sampling event five days later. For calibration refer to Section 6. Calibration below.

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- The circular chart is removed and the last pen reading (before it dropped down to zero) is written into the field on the data sheet.
- The roof of the sampler is opened and secured, the cartridge cover is snapped back on and the cartridge removed by loosening the four plastic wing nuts. The sampler roof as well as all the cover and doors are closed securely and rechecked before leaving.
- The same procedure applies to the second sampler. During transport the filter cartridges containing the used filters should be handled carefully and kept horizontal to avoid particles from falling off.
- Upon completion of the shut-down the airport technician at 880-2220 is called. He/she will be able to supply the required weather information in the units necessary. Temperature must be accurate to one decimal point. The airport technician takes hourly readings on the hour, the time nearest to the actual shut-down event must be chosen for the weather data. This could mean that two different weather data sets may be required. Example: one sampler was stopped at 1520h (nearest to the 1500h weather obs.), the other one at 1540h (nearest to the 1600h weather obs.)

4. Lab Procedures

- Upon returning to the Environment Laboratory the paper filters are removed from the cartridge by taking first the cover and then the frame off. The filters are then folded into quarters using tweezers, lying on the open cartridge base. The contaminated side is always folded in to avoid loss of particles.
- The filter are then placed in a single layer in a preheated pan. The pan must be labeled to identify the filters and the date of the sampling. The filters are placed inside the drying oven and dried at 105° C for 24 hours.
- After 24 hours the pan is removed from the oven and placed in the dessicator until it reaches room temperature, about two hours. The filters should not be left in the dessicator longer than necessary. The dessicator door must be closed during cooling and dry (blue or purple) dessicant must be present in the same compartment.
- The cooled filters are removed and weighed individually

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using a Mettler Toledo AG204 analytical balance. A pedestal has to be put on the scale plate to accommodate the filters, a small beaker works well. The scale must be reset to zero prior to filter placement. The weight in grams up to four decimal points is written on the data sheet.

- The used filters are returned to their original envelopes and stored in the used filter container in the air quality cabinet. The empty filter cartridges and the clipboard are stored at the same location.
- At this time the supply of prepared filters should be checked and restocked if required.

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5.

**Calculation
and Data
Entry**

- The necessary calculations are now performed on the data sheets in the following steps.
- The atmospheric pressure is converted from mb to kPa by using the measurement conversion program and entered on the data sheet.
- Run time hours are calculated and entered (two decimal places) by subtracting the meter hours at start-up from the meter hours at shut-down. If the above procedures were followed carefully this number should never be less than 24.00, or slightly above.
- Average Pressure is calculated and entered by adding the converted pressures at start-up and shut-down and dividing the sum by two.
- Average Temperature is calculated and entered in the same manner.
- Average circular chart is calculated and entered by taking a chart pen reading every three hours (i.e. at 0900h, 1200h, 1500h, 1800h and so on) for a total of eight readings. The sum of these readings is divided by eight to obtain an average.
- These calculations are performed twice, one for each data sheet for each location
- The circular charts are stapled to the data sheet. Each data entry field of the data sheet should now be filled out. Open spaces indicate a neglect that should be rectified at this time.
- Further manual calculation is cumbersome, complicated and prone to mistakes. Instead the data are entered from the data sheets into the HiVol Excel spreadsheet located at "S:\Environment\Data\Air Quality\Hi-Vol\Import\HiVol Data.xls". The TSP value will be calculated automatically once all the data are transferred.

6.

**Calibration
and Brush
Change**

- Calibration of the sampler unit is a complex operation that should only be attempted by trained technicians, never casual students.
- Calibration is required under the following conditions: after three months or 400 sampling hours, after motor maintenance and upon initial installation. Brush changes are required every 400 running hours. If it is recognized

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during sampling that any of these conditions apply a technician should be notified immediately to perform the task.

- Changing the brushes of the electric motors require the removal of the sampler motors and returning them to the environment lab. A partial disassembly needs to be performed to exchange these parts. The exact procedure is covered in the Maintenance and Calibration SWP and can be found in the Operations Manual for Graseby Tisch Environmental TE-5170 Series.
- Calibration of the unit is performed using the Graseby G2835 (Vari-Flo) calibration kit, located in the air quality cabinet. The exact procedure is covered in the Maintenance and Calibration SWP and can be found on Pg. 10-22 in the Operations Manual for Tisch Environmental Model TE-5170 Series. However, the result are not calculated manually but the readings are first entered into the calibration worksheet. Upon return to the office the numbers are transferred into the Excel spreadsheet found at S:\Environment\Data\Air Quality\Hi-Vol\Calibration\Air monit calib worksheet – Calculation Sheet. The spreadsheet formulas will automatically calculate the rather complex computations and determine the correlation coefficient r which must be 0.990 or larger for the calibration to be acceptable. The displayed values slope m and intercept b are entered into the appropriate columns in the HiVol Excel spreadsheet located at "S:\Environment\Data\Air Quality\Hi-Vol\Import\HiVol Data.xls". If r is smaller than 0.990 the calibration must be performed again after a thorough check of the sampler and its components. There are no further adjustments possible to affect the calibration performance. This procedure must be performed twice, once for each TSP sampler serviced. It is advisable that brush changes and calibration are done for both samplers at the same time.

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Documents and Records

[Operations Manual For Tisch Environmental Model TE-5170 Series Total Suspended Particulate MFC High Volume Air Sampler](#)

High Volume Air Sampling Binder, in Environment Library

Air Quality Monitoring Plan in OEMP

[Field Data Sheet](#)

[Field Data Sheet, Example and Instructions](#)

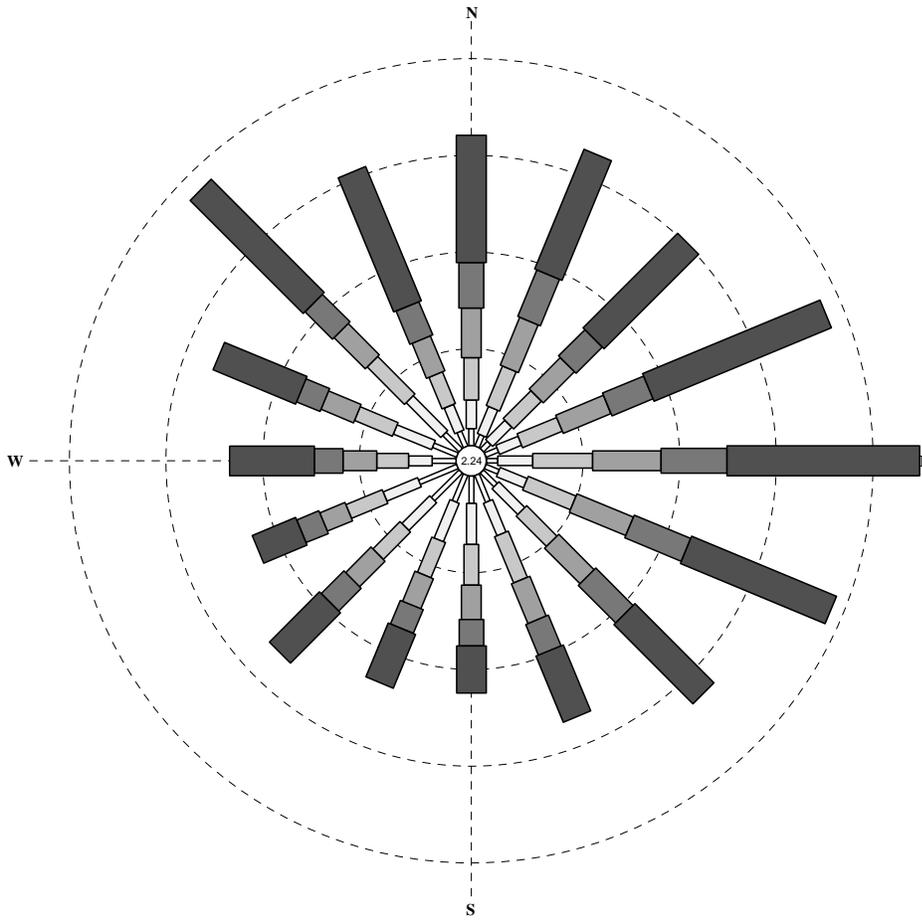
[HiVol Sampler Calibration Worksheet](#)

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Appendix B – Summer Wind Rose 2000-2008

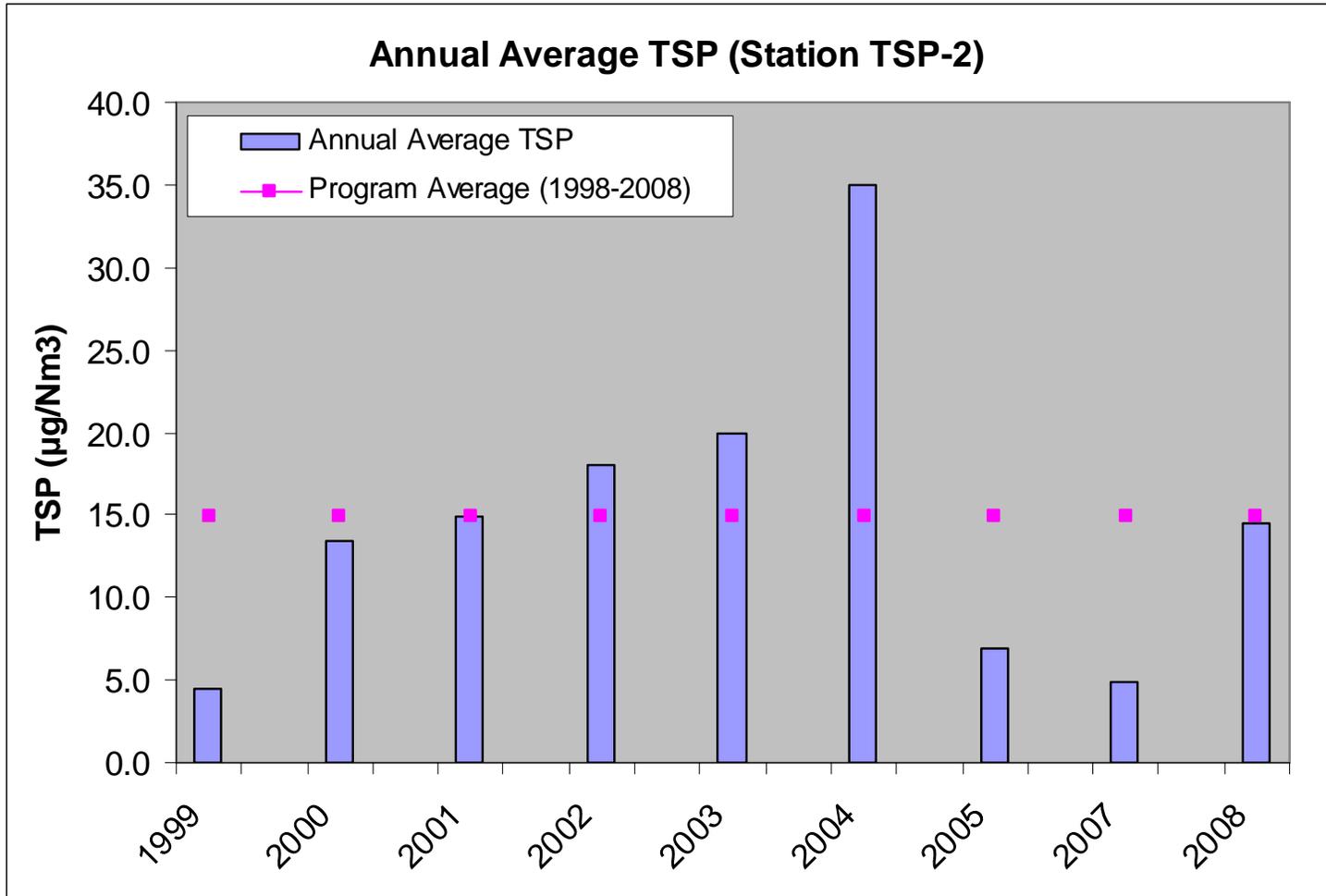
KOALA METEOROLOGICAL STATION
SUMMER 2000 - 2008



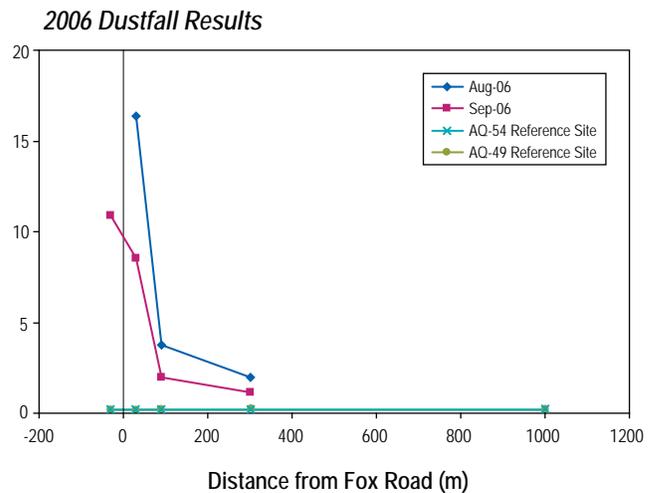
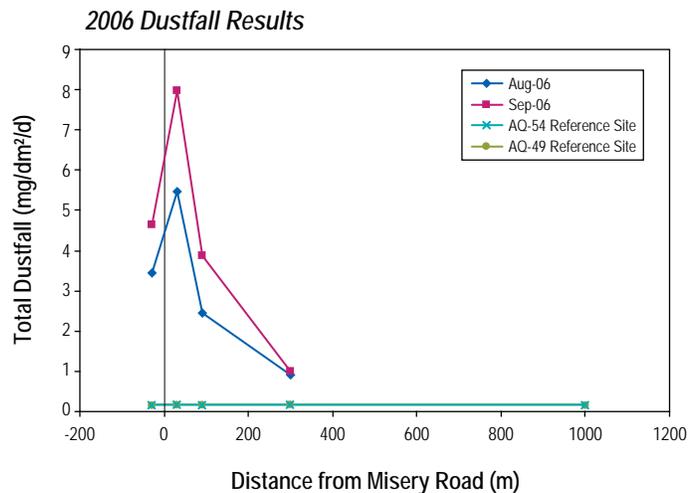
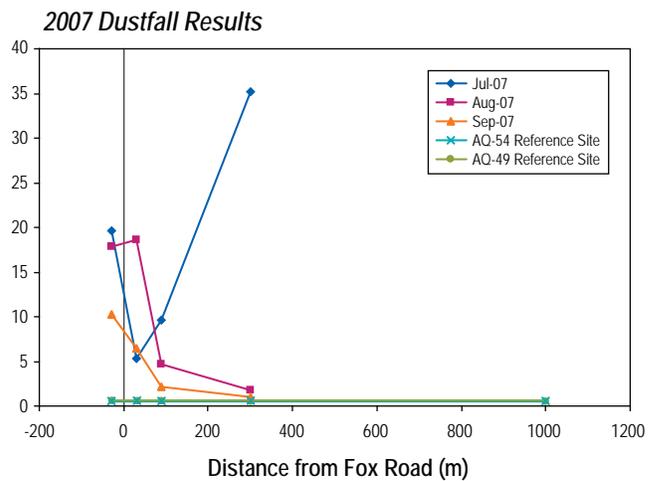
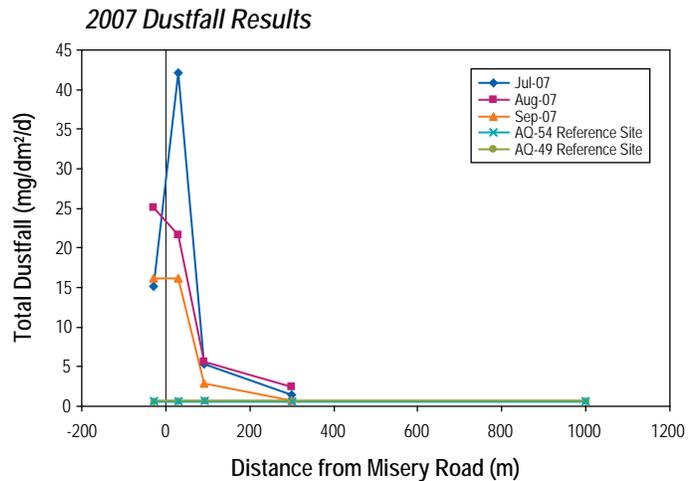
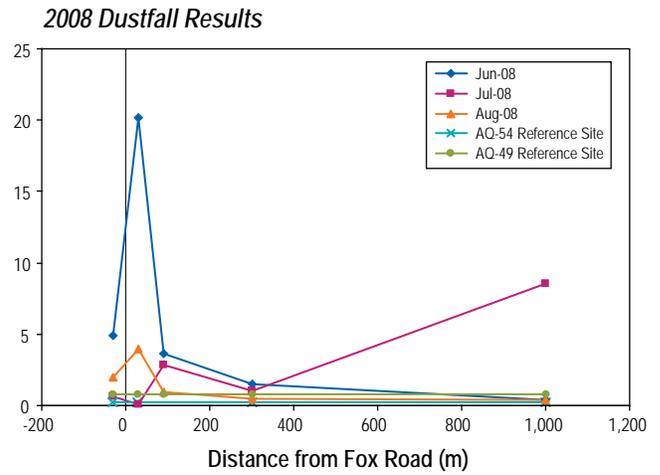
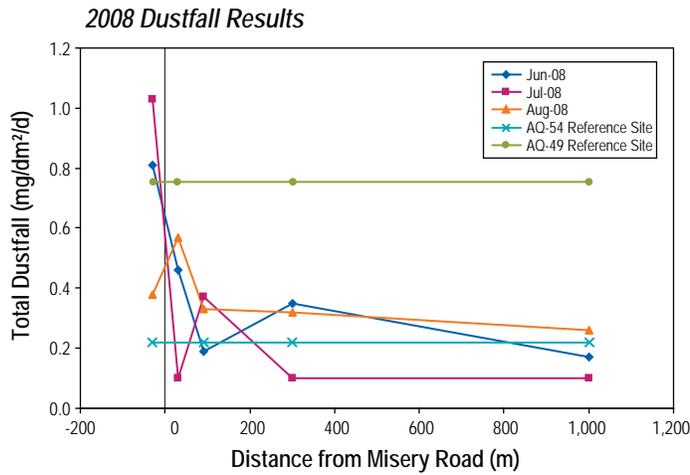
Wind Speed (Meters Per Second)

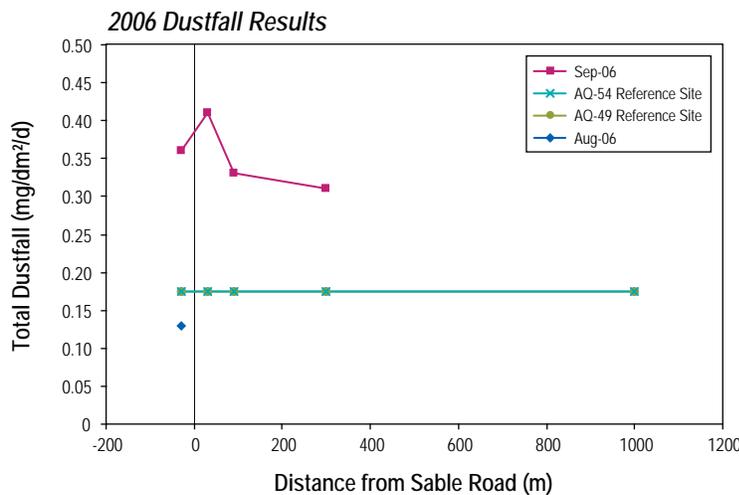
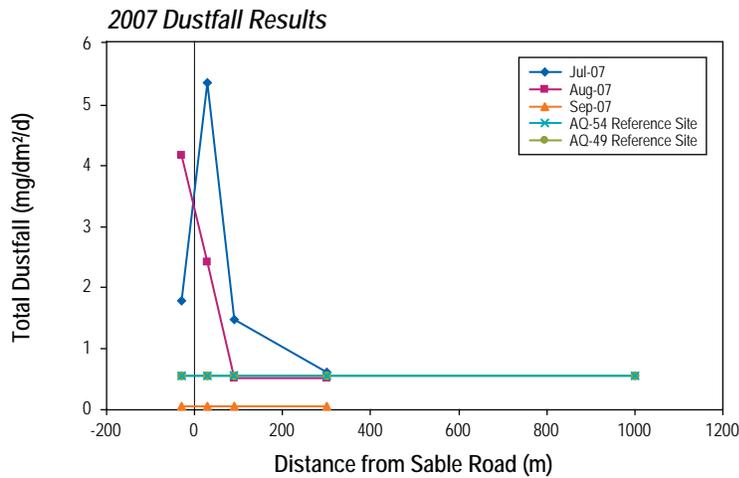
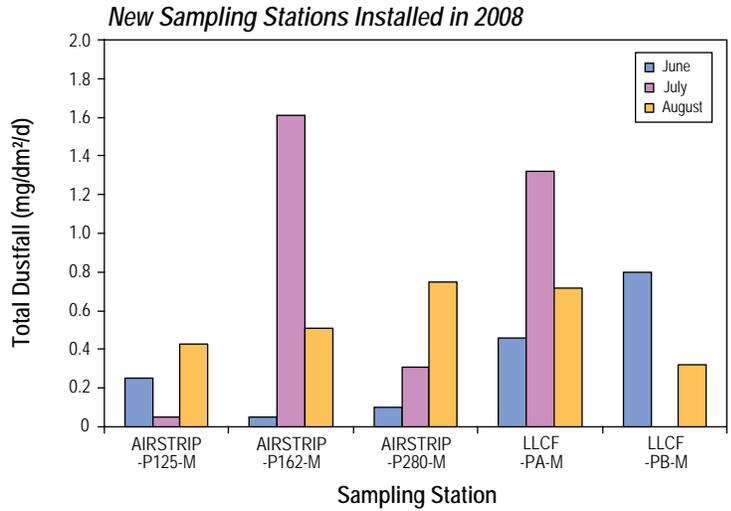
Calms included at center.
Rings drawn at 2% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

Appendix C – TSP-2 Annual Average



Appendix D – Figure 3.5.1 revised with new annual average dustfall at AQ-49





2006-2008 Total Dustfall Measured at Sable Road, LLCF, Airstrip and Background Monitoring Stations

FIGURE 3.5-2



Appendix E – 2008 Continuous Air Monitoring Data

Location	Month	SO2 (ppb)		NO2 (ppb)		NO (ppb)		NOx (ppb)		TSP (µg/Nm3)		PM2.5 (µg/Nm3)	
		1 Hr	24 Hr	1 Hr	24 Hr	1 Hr	24 Hr	1 Hr	24 Hr	1 Hr	24 Hr	1 Hr	24 Hr
Maximum Values		1 Hr	24 Hr	1 Hr	24 Hr	1 Hr	24 Hr	1 Hr	24 Hr	1 Hr	24 Hr	1 Hr	24 Hr
Grizzly Lake	January	10	3.1	30	16.7	124	10.7	150	23.1	38	25.3	22	14
	February	2	0	37	23.3	39	7	70	27	83	24	12	4
	March	0	0	218	18.3	278	32.4	319	46.4	994	104.8	42	8.0
	April	10	2.4	77	56	56	14	104	65	86	16	37	10.7
	May	3	0.47	121	69.2	120	44.2	236	110.1	108	24.7	22	10.0
	June	9	3.0	399	153.6	361	137.9	525	268.5	361	45	14	7.6
	July	10	5.3	84	55.5	79	49.3	131	93.2	735	61.3	108	18.9
	August	3	1.3	119	55.1	73	27.2	192	84	237	22.3	24	12.6
	September	-	-	-	-	-	-	-	-	-	-	-	-
Polar Explosives	October	3	0.7	48	30.2	209	58.2	248	82.3	128	20.7	15	6.6
	November	5	1.9	323	132.4	73	55.4	370	167.7	156	18.4	50	3.5
	December	3	0.9	117	82	147	51.2	225	102	107	22.6	11	3.4

Canadian Ambient Air Quality Objectives – Maximum Acceptable Concentration

Parameter	Unit	Maximum Desirable Concentration		Maximum Acceptable Concentration		Maximum Tolerable Concentration	
		1 Hour	24 Hour	1 Hour	24 Hour	1 Hour	24 Hour
SO2	µg/m ³ (PPB)	450 (172)	150 (57)	900 (344)	300 (114)	-	800 (306)
NO2	µg/m ³ (PPB)	-	-	400 (213)	200 (106)	1000 (532)	300 (160)
NO	µg/m ³ (PPB)	-	-	-	-	-	-
NOx	µg/m ³ (PPB)	-	-	-	-	-	-
TSP	µg/m ³	-	-	-	120	-	400
PM2.5	µg/m ³	-	-	-	30	-	-

Northwest Territories Ambient Air Quality Standards

Air Contaminant	Average Period	Standards ($\mu\text{g}/\text{m}^3$)¹	Standard (ppb)²
Sulphur Dioxide	1-hour	450	172
	24-hour	150	57
	Annual	30	11
Ground Level Ozone	8-hour	127	65
Total Suspended Particulate	24-hour	120	
	Annual	60	
Fine Particulate (PM _{2.5})	24-hour	30	

NA = Not Available.

1: Micrograms per cubic metre.

2: Parts per billion by volume.

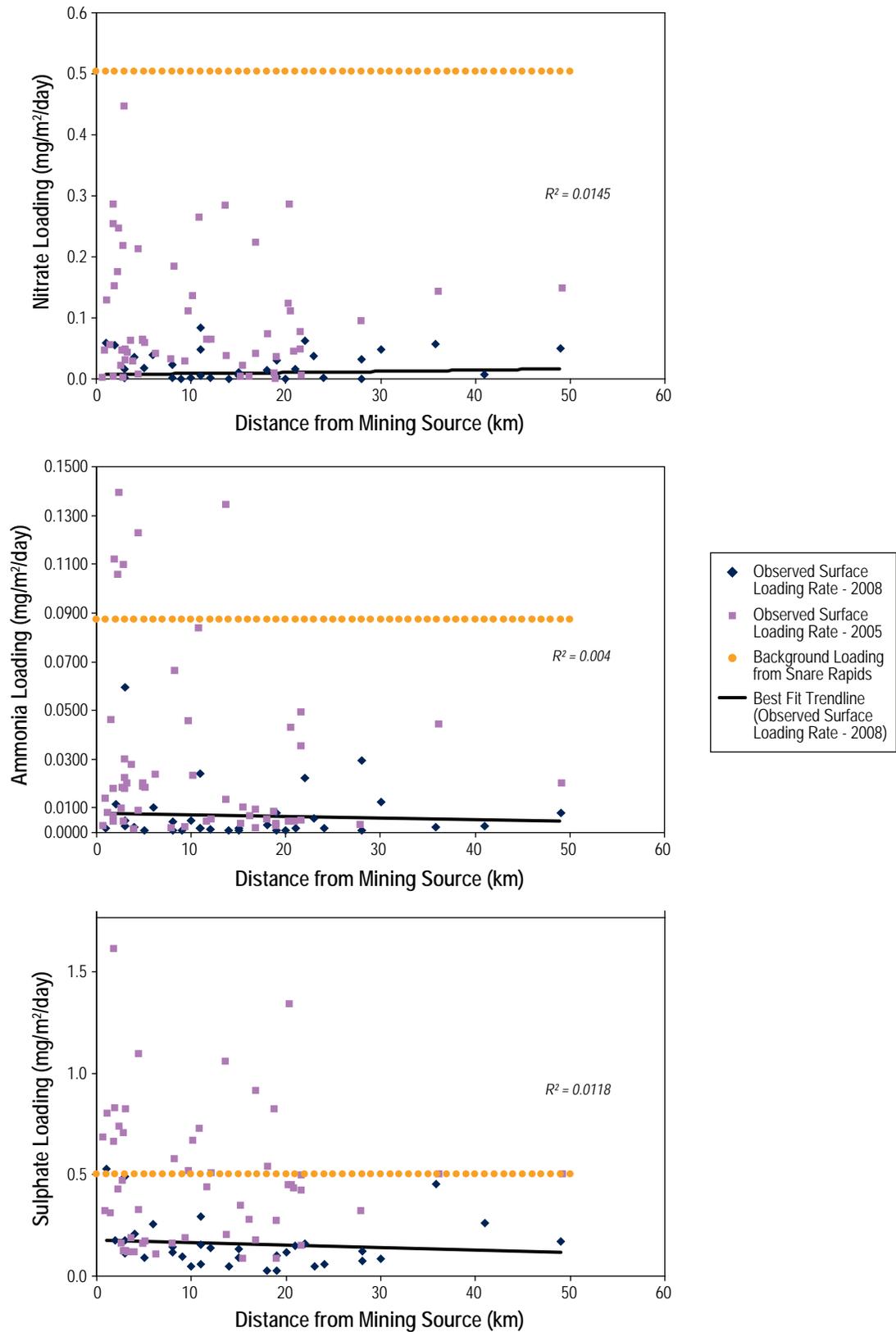
Appendix F – Table 3.6-1 revised to present 1998 to 2005 Average as loadings

Table 3.6-1. Summary of Chemical Analyses for Selected Parameters from 2008 Snow Sampling

Parameter	Units	# of Samples	# Below Detection Limit	Average	Median	Standard Deviation	Minimum	Maximum	1998 to 2005 Average
Alkalinity	mg/m ² /day	33	30	0.662	0.517	0.597	0.133	3.393	n/a
Ammonia	mg/m ² /day	33	13	0.007	0.002	0.012	0.001	0.059	0.053
Anion Sum	meq/L	33	31	0.029	0.026	0.019	0.007	0.108	n/a
Bicarbonate-Alkalinity CaCO ₃	mg/m ² /day	33	33	1.000	1.000	0.000	1.000	1.000	n/a
Cation Sum	meq/L	33	22	0.101	0.032	0.227	0.007	1.194	n/a
Conductivity	µS/cm	33	5	6.387	4.200	7.431	2.000	42.300	4.981
Fluoride	mg/m ² /day	33	33	0.005	0.005	0.002	0.001	0.010	n/a
Nitrate	mg/m ² /day	33	13	0.023	0.015	0.024	0.000	0.084	0.081
pH	log	33	0	5.478	5.360	0.353	5.050	6.580	5.413
Sulphate	mg/m ² /day	33	17	0.158	0.124	0.125	0.028	0.528	0.412
Total Organic Carbon	mg/m ² /day	33	3	1.422	0.991	1.288	0.168	4.853	n/a
Total Suspended-Solids	mg/m ² /day	33	4	9.695	5.513	12.229	0.602	63.455	26.42
Turbidity	NTU	33	1	7.112	4.020	8.199	1.500	41.400	9.554
Total Metals									
Aluminum	mg/m ² /day	33	1	0.217	0.070	0.359	0.012	1.910	0.340
Arsenic	mg/m ² /day	33	5	0.000	0.000	0.000	0.000	0.000	n/a
Barium	mg/m ² /day	33	2	0.006	0.002	0.014	0.000	0.080	0.010
Beryllium	mg/m ² /day	33	33	0.000	0.000	0.000	0.000	0.000	n/a
Boron	mg/m ² /day	33	17	0.001	0.001	0.001	0.001	0.003	n/a
Cadmium	mg/m ² /day	33	25	0.000	0.000	0.000	0.000	0.000	n/a
Calcium	mg/m ² /day	33	3	0.253	0.120	0.438	0.014	2.161	0.376
Chromium	mg/m ² /day	33	2	0.001	0.000	0.004	0.000	0.019	0.002
Cobalt	mg/m ² /day	33	15	0.001	0.000	0.002	0.000	0.007	n/a

Parameter	Units	# of Samples	# Below Detection Limit	Average	Median	Standard Deviation	Minimum	Maximum	1998 to 2005 Average
Copper	mg/m ² /day	33	8	0.001	0.000	0.001	0.000	0.005	0.006
Iron	mg/m ² /day	33	2	0.265	0.063	0.643	0.009	3.462	0.484
Magnesium	mg/m ² /day	33	2	0.568	0.123	1.576	0.014	8.419	0.440
Manganese	mg/m ² /day	33	2	0.010	0.005	0.014	0.000	0.070	0.053
Mercury	mg/m ² /day	33	33	0.000	0.000	0.000	0.000	0.000	n/a
Molybdenum	mg/m ² /day	33	2	0.013	0.005	0.021	0.000	0.088	n/a
Nickel	mg/m ² /day	33	1	0.005	0.001	0.013	0.000	0.072	0.053
Phosphate	mg/m ² /day	33	2	0.016	0.009	0.019	0.001	0.076	0.038
Potassium	mg/m ² /day	33	5	0.201	0.107	0.276	0.007	1.301	0.268
Silicon	mg/m ² /day	33	1	0.730	0.126	1.995	0.010	10.555	n/a
Sodium	mg/m ² /day	33	2	0.091	0.048	0.154	0.013	0.896	0.123
Strontium	mg/m ² /day	33	2	0.006	0.002	0.014	0.000	0.068	0.053
Uranium	mg/m ² /day	33	5	0.000	0.000	0.000	0.000	0.000	n/a
Vanadium	mg/m ² /day	33	2	0.001	0.000	0.002	0.000	0.009	0.053
Zinc	mg/m ² /day	33	23	0.007	0.003	0.010	0.001	0.036	0.053

Appendix G – Figure 3.6-2 Revised with Trend Lines



Note: Background loading rate based on the daily average loading from 20 years of winter data (October to May) at Snare Rapids (1988 to 2008).

Appendix H – Comparison of analytical results between duplicate snow core samples

Parameter	Station Name Collect Date/Time	AQ-C4	AQ-C4	AQ-114	AQ-114	AQ-02	AQ-02
		11/04/2008	11/04/2008	18/04/2008	18/04/2008	21/04/2008	21/04/2008
Alkalinity-Total	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Anion Sum	meq/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cation Sum	meq/L	<0.1	<0.1	<0.1	<0.1	0.2	0.1
Carbonate-Alkalinity CaCO3	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Dissolved Chloride	mg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Conductivity	uS/cm	4.3	3.7	3.3	4.8	3	3.4
Fluoride	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Hardness	mg/L	1.15	1.26	1.84	2.1	3.54	3.54
Bicarbonate-Alaklinity CaCO3	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Ion Balance	%	0	0	84.9	88.2	89.3	86.9
Ammonia-N	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0077
Nitrite-N	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0022	<0.0010
Nitrate-N	mg/L	<0.0050	<0.0050	0.009	<0.0050	0.0454	0.0469
Hydroxide-Alaklinity CaCO3	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
pH	pH	5.27	5.46	5.49	5.51	5.49	5.49
Orthophosphate	mg/L	0.0089	<0.0010	0.0244	0.0081	0.0049	0.0105
Total Phosphate	mg/L	0.0337	0.0194	0.0411	0.0214	0.0183	0.0642
Sulphate	mg/L	<0.50	<0.50	0.23	0.23	0.27	0.24
Total Silver	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Total Aluminum	mg/L	0.142	0.0882	0.119	0.0958	0.479	0.207
Total Arsenic	mg/L	0.000043	0.000032	0.000054	0.000066	0.000067	0.000051
Total Boron	mg/L	0.0012	<0.0010	<0.0010	0.0014	<0.0010	0.0011
Total Barium	mg/L	0.00356	0.00308	0.00376	0.00527	0.01	0.0103
Total Beryllium	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Total Calcium	mg/L	0.258	0.31	0.177	0.346	0.339	0.755
Total Cadmium	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000074
Total Cobalt	mg/L	0.00011	0.00014	0.00016	0.00013	0.00035	0.00021
Total Chromium	mg/L	0.00028	0.00027	0.00085	0.00046	0.00182	0.00101
Total Copper	mg/L	0.0014	<0.0010	0.0004	0.00061	0.00074	0.00082
Tot-Diss-Solids	mg/L	4.2	4.7	4.3	5	4.1	6.3

Parameter	Station Name Collect Date/Time	AQ-C4	AQ-C4	AQ-114	AQ-114	AQ-02	AQ-02
		11/04/2008	11/04/2008	18/04/2008	18/04/2008	21/04/2008	21/04/2008
Total Iron	mg/L	0.085	0.057	0.142	0.11	0.481	0.242
Total Mercury	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Total Potassium	mg/L	0.363	0.163	0.203	0.369	0.311	0.333
Tot-Kjeldahl-N	mg/L	0.11	0.11	0.061	<0.050	<0.050	0.143
Total Magnesium	mg/L	0.121	0.117	0.339	0.299	0.653	0.403
Total Manganese	mg/L	0.017	0.02	0.0132	0.0374	0.00971	0.0276
Total Molybdenum	mg/L	0.0203	0.0172	0.00555	0.0071	0.00179	0.00813
Total Sodium	mg/L	0.094	0.066	0.091	0.097	0.126	0.088
Total Nickel	mg/L	0.00104	0.00056	0.00225	0.00183	0.00397	0.00217
Total Organic Carbon	mg/L	3.52	3.85	2.94	3.44	1.3	3.8
Total Lead	mg/L	0.000331	0.000309	0.000184	0.000253	0.00039	0.000305
Total Antimony	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Total Selenium	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Total Silicon	mg/L	0.079	0.076	0.4	0.25	1.16	0.407
Total Strontium	mg/L	0.00204	0.00117	0.00155	0.00159	0.00345	0.00404
Tot-Suspended-Solids	mg/L	15.9	5.9	15.3	15.3	12.7	19.3
Turbidity	NTU	3.94	2.19	3.68	2.92	3.28	6.83
Total Vanadium	mg/L	0.000125	0.00013	0.000272	0.000243	0.00104	0.000579
Total Zinc	mg/L	0.0165	<0.0080	<0.0050	<0.0040	0.0167	0.0324
Total Uranium	mg/L	0.000023	0.000015	0.000014	0.000014	0.000052	0.00003