AIR QUALITY MONITORING
AT GIANT MINE SITE – YELLOWKNIFE
A BASELINE STUDY
(Volume 2 – 2005)

Prepared for:

Indian and Northern Affairs Canada
Giant Mine Remediation Project
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September 2006

EXECUTIVE SUMMARY

As a part of the Giant Mine Remediation Project (GMRP), an air quality-monitoring program was devised and carried out during the summers of 2004 and 2005 to establish a baseline for the fugitive emissions from the tailings areas and other disturbed areas at the mine site. This report pertains to the sampling program carried out in 2005. (Please refer to *Air Quality Monitoring at Giant Mine Site – Yellowknife, A Baseline Study* for details on the 2004 program.) The 2005 program was carried out from June through September and consisted of ambient air monitoring of TSP at the nearest residential location in the Giant Mine Town site and simultaneous ambient air monitoring of TSP and PM_{10} at four other locations within the property boundary of the Giant Mine site. The sampling was done to determine total and inhalable particulate loading, as well as the concentrations of their inorganic trace element constituents, such as arsenic.

The 2005 suspended particulate monitoring results indicate that the concentrations at the five sampling locations vary considerably with respect to average and maximum TSP and PM_{10} concentrations. The Giant Mine Town Site results were low in comparison to the onsite monitoring locations. The Northwest Pond site had the highest TSP concentrations of the five TSP monitoring locations and the South Pond site had the highest PM_{10} concentrations of the four PM_{10} monitoring locations.

The analyses of inorganic elements indicated that, with the exception of arsenic, iron, and beryllium, all other concentrations were below their applicable AAQC. There was one beryllium exceedance on July 21st, 2005. The iron concentrations were consistently in exceedance of their respective AAQC from July 21st through August 26th, 2005. The arsenic AAQC of 0.3 µg/m^3 was exceeded 4 times at the Northwest Pond, on July 21st and August 8th, 14th and 20th, 2005. In addition, the August 8th and 14th South Pond samples and August 20th sample at the B3 Pit were above the arsenic AAQC. Results also indicate that the arsenic levels were noticeably higher at the South Pond and Northwest Pond than at the other two onsite sampling locations, suggesting contributions from the South Pond and Northwest Pond, respectively. While the highest arsenic concentration, was reported for the South Pond the Northwest Pond had the higher overall average arsenic concentrations and a greater frequency of exceedances.

Overall the 2005 results indicated noticeably higher ambient concentrations of TSP, PM_{10}, arsenic and iron than the 2004 results. In 2004, with the exception of iron content in one of the onsite PM_{10} samples, all other measured concentrations of trace inorganic elements in the ambient air were below the health-based ambient air quality criteria, as defined by the Ontario Ministry of the Environment (MOE). Also, there was only one day in which the measured TSP concentrations at all the sampling locations were exceeded and two days in which the PM_{10} criterion of 50 µg/m^3 was exceeded. In 2005, there were numerous exceedances of TSP, PM_{10},

arsenic and iron. Most arsenic exceedances were at monitoring locations 2 and 3, suggesting contributions from the South Tailings Pond and the Northwest Tailings Pond, respectively.

The 2005 arsenic concentrations in TSP and PM_{10} (measured at all onsite monitoring locations) were highly variant but on average indicate that more than half of the measured ambient arsenic concentration is contained within the course particles.

The higher concentrations reported in 2005 can in large part be attributed to onsite activities. The site entered into a new care and maintenance contract on July 1st, 2005 which resulted in increased road maintenance throughout the property. Specifically, the main roads were graded and additional gravel was added in places. Also, a significant amount of work in the core area of the mine site occurred during August 2005. This work consisted of removing an existing utilidor (wood and insulation) and the associated water and steam lines. Grinders and saws were used to cut the steel pipes. The elevated ambient air suspended particulate as well as the iron concentrations in the suspended particulate correlate well with these onsite activities.

Since arsenic in TSP provides a better measure of the day-to-day fluctuations in ambient arsenic concentrations, TSP sampling is more useful in determining from which source(s) the arsenic is likely to have originated. Since one of the objectives of the sampling program is to assess harmful levels of exposure to arsenic in ambient air, PM_{10} sampling would be a more appropriate measure of exposure, as the TSP sampling may overestimate exposure levels by a factor of at least 2, on average. Therefore, it is recommended that the simultaneous sampling of TSP and PM_{10} at all onsite sampling locations be continued for subsequent monitoring at this site.

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1.0 INTRODUCTION

As a part of the Giant Mine Remediation Project (GMRP), and establishment of baseline conditions, the second round of air quality monitoring was carried out during the summers of 2005. Similar to the 2004 monitoring program, the summer of 2005 monitoring was to establish a baseline for the fugitive particulate emissions pertaining to the tailings areas and other on-site sources such as disturbed areas and travelled routes. The 2005 sampling program consisted of ambient air monitoring of TSP and PM_{10} at the nearest residential location in the Giant Mine Town site and four other locations within the boundary of the Giant Mine site. Similar to 2004, the program consisted of 24-hour sampling on every 6^{th}-day at all five sampling locations. The sampling was used to determine total and inhalable particulate loading, as well as their inorganic trace elements (e.g. metals) content.

This report provides details of the monitoring program, the results and discussion of the findings, comparisons between 2004 and 2005 data, as well as conclusions and recommendations, based on the 2004 and 2005 monitoring programs. Reference is made to the report entitled "*Air Quality Monitoring at Giant Mine Site – Yellowknife, A Baseline Study*" for details on the 2004 program.

1.1 OVERVIEW OF THE GIANT MINE REMEDIATION PROJECT

The Giant Mine, consisting of a mine, mill and roasting operation located within the city limits of Yellowknife on the west shore of Yellowknife Bay on Great Slave Lake, operated between 1948 and 1999. Prior to 1999, ore extracted from an extensive network of underground mine workings and open pits was processed through the mill and roaster facility for gold recovery. The surface facilities at the site are shown on Figure 1.1. They include the South, Central, North and Northwest Tailings Ponds which were developed to contain tailings (gangue material left after recovery of the gold) produced in the mill. Other surface features on the Giant Mine site include the settling and polishing ponds, which continued to be used to remove chemical precipitates produced in the mine water treatment plant, several pits (A1, A2, B1, B2, B3, B4 and C1) and numerous surface structures. Arsenic trioxide, a by-product of the roaster operation, was disposed in shallow vaults and chambers developed in the underground mine workings.

In 1999, Royal Oak Mines, the owner/operator at the time, was forced into receivership. A court appointed interim receiver transferred Giant Mine to the federal Department of Indian Affairs and Northern Development (DIAND). Immediately following this transfer, the mine was sold to Miramar Giant Mine Ltd. (MGML). MGML resumed mining at the site in 2000 and continued to do so until June 2004. All ore extracted from the mine during this period was processed at MGML parent company's Con operation located on the southern edge of the city of Yellowknife. Under a separate agreement with MGML, concluding June 2005, DIAND funds

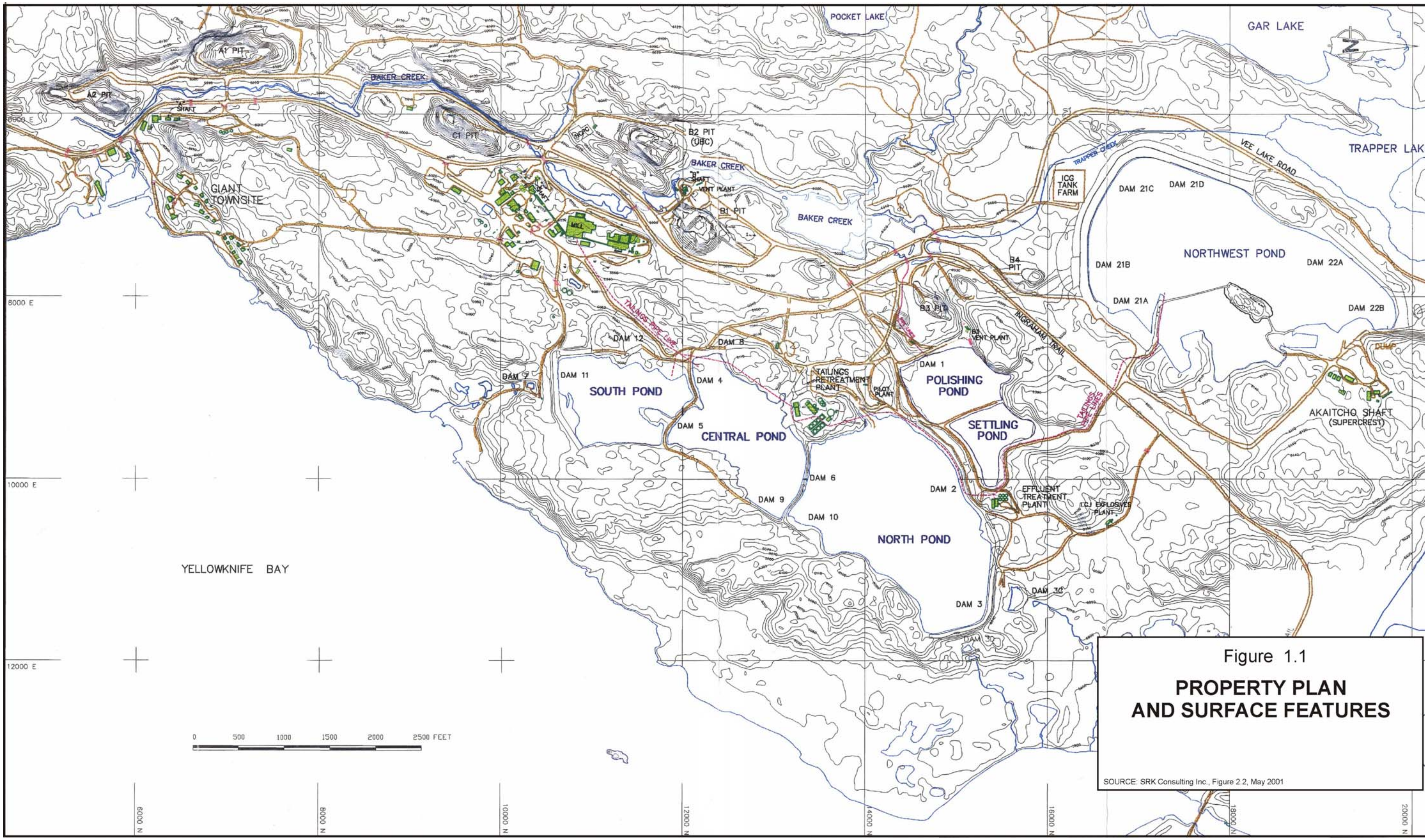


Figure 1.1

PROPERTY PLAN AND SURFACE FEATURES

SOURCE: SRK Consulting Inc., Figure 2.2, May 2001 the ongoing care and maintenance necessary to protect public health and safety as well as to maintain environmental compliance at the mine.

DIAND and the government of the Northwest Territories signed a cooperation agreement respecting the Giant Mine Remediation Project in March 2005. Under this agreement, both parties agree to finalize a site wide Remediation Plan and be co-proponents through the regulatory process for the Plan. Both parties will cooperate and share costs for the implementation of the Remediation Plan. In the interim, the two governments also agreed to share costs for the ongoing care and maintenance of the site until such time that the Remediation Plan is implemented.

1.2 OVERVIEW OF THE STUDY

SENES was retained by DIAND to design and set-up an air quality-monitoring program before the start of the remediation activities at the Giant Mine site. The monitoring program was developed to meet the following objectives:

(1) To establish a baseline for the ambient particulate matter loading and inorganic trace element concentrations (specifically arsenic) at and around the Giant Mine site. These data are intended to augment the database on off-site measurements of particulate matter concentrations, which were historically collected at the community of Ndilo and continue to be collected in the City of Yellowknife. In addition, the on-site data are intended to provide base information for comparison to the effects of future planned remediation activities at the Giant Mine site.

(2) To collect simultaneous samples of particulate matter of less than 10 micron in size (PM_{10}) as well as Total Suspended Particulates (TSP), in order to determine the ratio of concentrations of the two particulate size fractions (i.e., PM_{10}: TSP) and to ensure that sufficient sample is collected for inorganic trace element analysis (PM_{10} sample may not accumulate sufficient mass for trace element analysis). The ratio will be used as a guide to establish the monitoring protocol that is to be implemented during the remediation activities at the Giant Mine site.

The air quality monitoring program was implemented from July through September of 2004 and June through September of 2005. The second objective of the monitoring program, which was to establish the ratio of concentrations of the two particle size fractions, was attained from the 2004 monitoring data. The 2004 results indicated that 75% of the arsenic appears to be associated with the coarse particles in TSP and therefore, to better identify days with high emission levels from the mine site, arsenic concentrations in TSP samples are to be assessed. At the same time, in light of moderate correlation between the two particulate size fractions (TSP and PM_{10}) and the health-related importance of the PM_{10} fraction, it was recommended that the monitoring program be modified to conduct simultaneous monitoring of PM_{10} as well as TSP at all the on-site monitoring locations. This was implemented during the 2005 sampling program.

This report presents the 2005 results, as well as a comparison between the monitoring results for 2004 and 2005.

This report is organized into five sections. Section 2 presents applicable ambient air quality criteria for the subject pollutants. Section 3 provides an overview of the methodology, sampling equipment and implementation of the monitoring program. Section 4 includes a discussion of 2005 results. Section 5 provides a comparison analysis between 2004 and 2005 results, while Section 6 provides the conclusions and recommendations.

2.0 APPLICABLE AIR QUALITY CRITERIA

For the purpose of this study, the ambient air quality criteria set by the Northwest Territories (NWT) Environmental Protection Act (EPA) were used. For pollutants not addressed by the NWT's EPA, criteria from other jurisdictions, such as the Ontario Ministry of the Environment (MOE), were used.

2.1 PARTICULATE MATTER

The term 'particulate matter' describes all airborne solid and liquid particles of microscopic size, with the exception of pure water. The suspended portion of particulate matter generally consists of particles less than 40 to 50 microns (µm) in diameter. These particles can include a broad range of chemical species, such as elemental and organic carbon compounds, sulphates, nitrates and trace metals. Particle diameter (and shape) is reflective of the origin of particulate matter; larger suspended particles often originate from crustal material and smaller particles are largely derived from combustion processes.

Ambient air quality objectives for Canada (and other countries) were initially based on total suspended particulate matter (TSP). In Canada, TSP is a general term which applies to a wide variety of solid or liquid particles of a size and configuration such that they tend to remain suspended in the air and can thus be drawn into the respiratory passages. Other measures of particulate matter are inclusive of a larger range of sizes (for example, Environment Canada uses the term total particulate matter which includes all particles with diameters below 100 microns).

PM_{10}, consists of particles less than or equal to 10 microns in aerodynamic diameter. The PM_{10} fraction poses a health concern because it can accumulate in the respiratory system. Many studies over the past few years have indicated that PM_{10} in the air is associated with various adverse health effects in people who already have compromised respiratory systems due to asthma, chronic pneumonia and cardiovascular problems.

The NWT 24-hour ambient air quality objective for TSP is 120 $\mu g/m^3$. For PM_{10}, neither the NWT nor the Canada-Wide Standard (CWS) setting process has defined an acceptable limit. Consequently, the interim 24-hour objectives/standard adopted by the British Columbia Ministry of Water, Land and Air Protection (WLAP), the Ministry of Environment and Conservation in Newfoundland and Labrador, and the Ontario Ministry of the Environment (MOE) was used for the purpose of this study(no longer listed in ON) (see Table 2.1).

TABLE 2.1
AMBIENT AIR QUALITY CRITERION FOR TSP AND PM_{10}

Pollutant	Averaging Period	Guideline Level	Ambient Air Quality Criterion
TSP	24-Hours	NWT	120 µg/m^3
PM_{10}	24-Hours	B.C., Newfoundland and Labrador, and Ontario	50 µg/m^3

2.2 INORGANIC TRACE ELEMENTS

Suspended particulate matter, and specifically $PM_{10,}$ is a mixture of chemically and physically diverse dusts and droplets, and some of these components may be important in determining the effects of PM_{10} on health. Therefore, with the knowledge of Giant Mine's historic precious metal recovery operation and the presence of some potentially toxic inorganic trace elements (e.g., arsenic) at the site (especially in tailings ponds), it was determined that trace element analysis on the particulate matter samples collected during the three-month monitoring program was appropriate.

In assessing the health risk associated with the inorganic trace element constituents of the suspended particulate matter, the concentrations are compared against regulatory ambient air quality criteria, which in the case of trace elements, are primarily based on health impact. Since no guidelines/objectives were defined by the NWT's EPA or Alberta Environment for 24-hour ambient air inorganic trace element concentrations, the MOE's ambient air criteria, as defined in the *Point of Impingement Standards and Ambient Air Quality Criteria (AAQCs) Guideline* (see Table 2.2), were used as the criteria for determining the relative significance of trace element concentrations in the particulate matter samples from the Giant Mine sampling program.

TABLE 2.2
AMBIENT AIR QUALITY CRITERIA FOR INORGANIC TRACE ELEMENTS (24-HOUR)

Elements	AAQC [(1)] (μg/m^3)
Silver	1
Aluminium	100
Arsenic	0.3 (incl. compounds)
Barium	10 (total water soluble)
Beryllium	0.01 (incl. compounds)
Calcium	n/a
Cadmium	2 (incl. compounds)
Cobalt	0.1
Chromium	1.5 (di, tri and hexa)
Copper	50
Mercury	2
Iron	4 (metallic)
Potassium	n/a
Magnesium	n/a
Manganese	2.5 (compounds)
Molybdenum	120
Sodium	n/a
Nickel	2
Lead	2
Antimony	25 (incl. compounds)
Selenium	10
Tin	10
Strontium	120
Vanadium	2
Tungsten	n/a
Zinc	120
Zirconium	n/a

(1) Ontario Ministry of the Environment's Ambient Air Quality Criteria.

3.0 EQUIPMENT AND METHODOLOGY

3.1 EQUIPMENT

For the 2005 monitoring program, eight (8) AirMetrics Mini-Vols and one Tisch Environmental Hi-Vol sampler were deployed.

The Mini-Vol sampler is a portable sampling device that can be used to sample Total Suspended Particulates (TSP), PM_{10} and Particulate Matter less than 2.5 µm in diameter ($PM_{2.5}$). The samplers use a small diaphragm pump to draw air through a 47 mm filter with pore size of 0.8 µm at a rate of approximately 5 L/min. The sampler can be powered using DC power from rechargeable batteries supplied with the unit, or from AC power, by plugging the charger into an AC source. Details of the Mini-Vol samplers, sampling method are provided in Appendix A.

The High Volume (Hi-Vol) TSP sampler used for this monitoring program was a Volumetric Flow Controlled (VFC) type, equipped with a vacuum motor to pull air through an 8” X 10” filter supported on a wire-mesh at a flow rate of 42 to 45 cfm (~1,200 L/min). The unit was calibrated using a 30” water manometer. Details of sampling procedure are provided in Appendix B.

3.2 METHODOLOGY

3.2.1 Monitoring Locations

After reviewing, the average observed wind data over a five-year period at the Yellowknife Airport, five locations were identified as suitable sites for set-up of the samplers. The predominant winds are from the east as discussed in a subsequent section (see Figure 4.1). The locations chosen for the five monitors are shown on Figure 3.1 and are as follow:

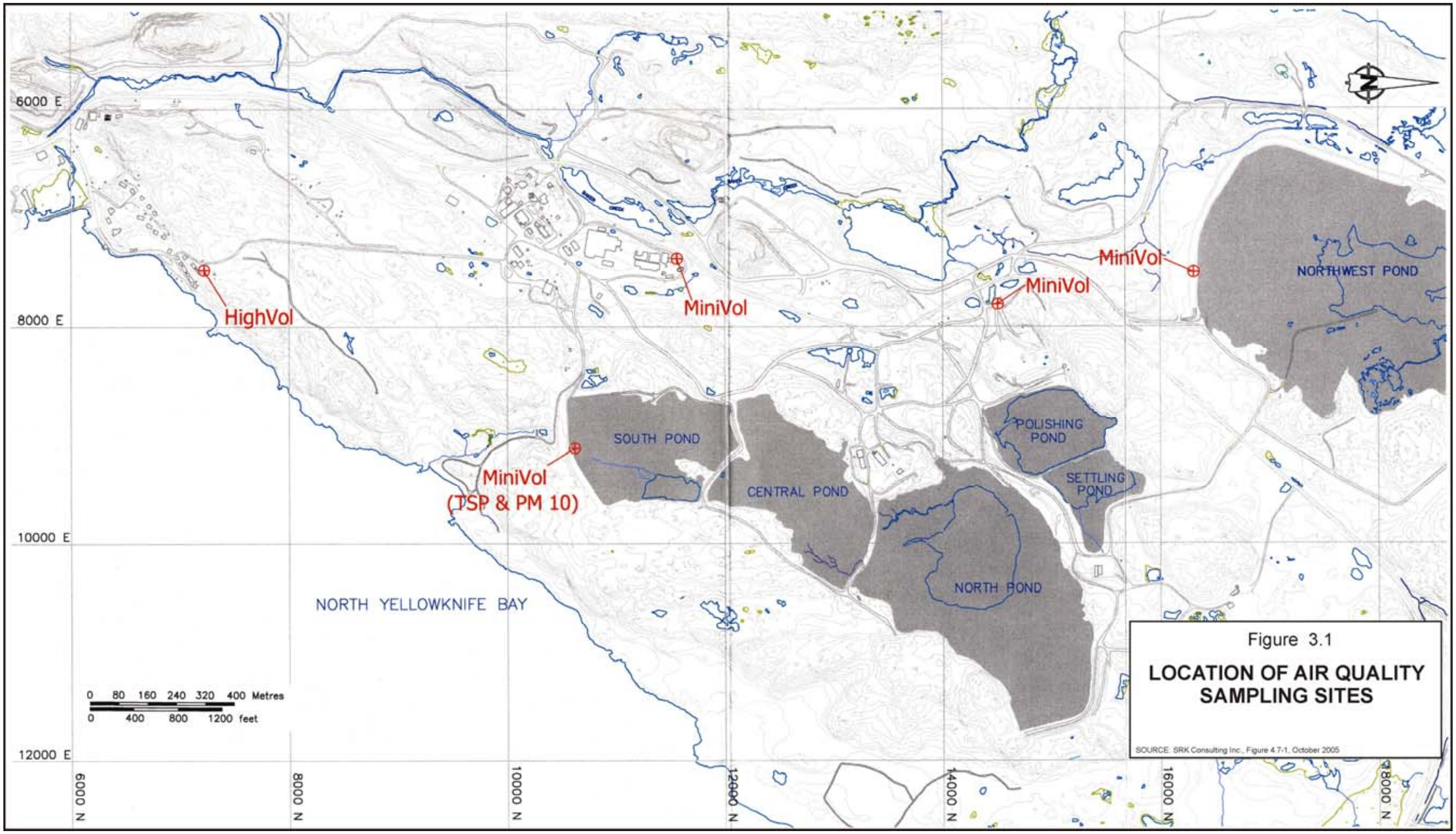


Figure 3.1
LOCATION OF AIR QUALITY SAMPLING SITES

1 *Monitoring Location #1 (Giant Mine Townsite):* The Hi-Vol TSP monitor was located in the Townsite south of the mill/roaster complex. The primary objective for this monitor was to determine ambient levels of total suspended particulate matter and arsenic at the nearest residences to the mine (see Figure 3.2).

FIGURE 3.2
MONITORING LOCATION #1 (GIANT MINE TOWNSITE)

Monitoring Location #2 (South end of South Tailings Pond): Two Mini-Vols were located at the south end of the tailings pond to monitor both TSP and PM_{10} emissions from the tailings (see Figure 3.3), as well as to provide a measure of particulate matter and arsenic concentrations that might be transported towards the residential areas on Latham Island. Two Mini-Vols were used to determine the relationship between PM_{10} and TSP, as per Section 1.2.

FIGURE 3.3
MONITORING LOCATION #2
(SOUTH END OF SOUTH TAILINGS POND)

2 *Monitoring Location #3 (Mill/Roaster Complex):* Two Mini-Vols were located at the north end of the mill/roaster complex, in close proximity to the road (see Figure 3.4), to monitor both TSP and PM_{10} emissions. At this location, the monitors are directly downwind of the prevailing easterly winds from the South Pond and east-northeasterly winds from the Central Pond, as well as downwind of south-southeasterly winds from the mill/roaster complex.

FIGURE 3.4
MONITORING LOCATION #3 (MILL/ROASTER COMPLEX)

3 *Monitoring Location #4 (Junction of Vee Lake Road and Ingraham Trail, B3-Pit):* Two Mini-Vols were located in the vicinity of this road to monitor both TSP and PM_{10} emissions. At this location, the monitors are downwind of the prevailing easterly winds from the Polishing Pond, the Settling Pond and the North Pond. As well, it is a suitable location to monitor emissions from the nearby roads (see Figure 3.5).

FIGURE 3.5
MONITORING LOCATION #4
(JUNCTION OF VEE LAKE ROAD AND INGRAHAM TRAIL, B3-PIT)

4 *Monitoring Location #5 (South of Northwest Pond):* A pair of Mini-Vols was located in on the south side of the Northwest Pond (see Figure 3.6) to monitor both TSP and PM_{10} emissions. This monitoring location was added as per SENES' recommendation in the 2005 monitoring report, for the purpose of better distinguish between the emissions that may originate from the Northwest Pond and those that are emitted from the nearby roads.

FIGURE 3.6
MONITORING LOCATION #5 (SOUTH of NORTHWEST POND)

3.2.2 Monitoring Frequency and Duration

A total of 105 Mini-Vol and 15 Hi-Vol samples were collected during the four months (June to September 2005) of monitoring. The 24-hour sampling was carried out on a 6-day cycle at all the sampling locations (both Hi-Vols and Mini-Vols). The sampling was done at the same time as the Government of Northwest Territories' (GNWT) 6-day ambient air monitoring schedule to allow subsequent comparison of the results, if deemed appropriate. The GNWT sampling is performed on the same day as Environment Canada's National Air Pollution Surveillance (NAPS) Network sampling program.

3.2.3 Analysis

The 47 mm Mini-Vol Quartz filters and the 8" X 10" Hi-Vol Quartz filters were conditioned and pre-weighed inside a humidity-controlled chamber in order to reduce errors due to variation in the humidity that may be adsorbed by the filters. For post-weighing, the filters were placed inside the same humidity controlled chamber as the pre-weighing, until stabilized. The gravimetric results were reported as the difference between the pre-weight and post-weight of the filters.

After the gravimetric analysis, the filters were analyzed for trace elements using acid digestion followed by Inductively Coupled Plasma – Mass Spectroscopy (ICP-MS), in accordance with the U.S. Environmental Protection Agency's (EPA) method SW-6020.

All analyses were conducted at the Enviro-Test Laboratories in Edmonton, Alberta.

3.2.4 QA/QC

The Quality Assurance/Quality Control (QA/QC) program for the sampling study consisted of detailed chain of custody, as well as collection of travel blanks, for each batch of filters shipped to the laboratory for analysis. Analytical QA/QC procedures were also carried out by Enviro-Test Laboratories.

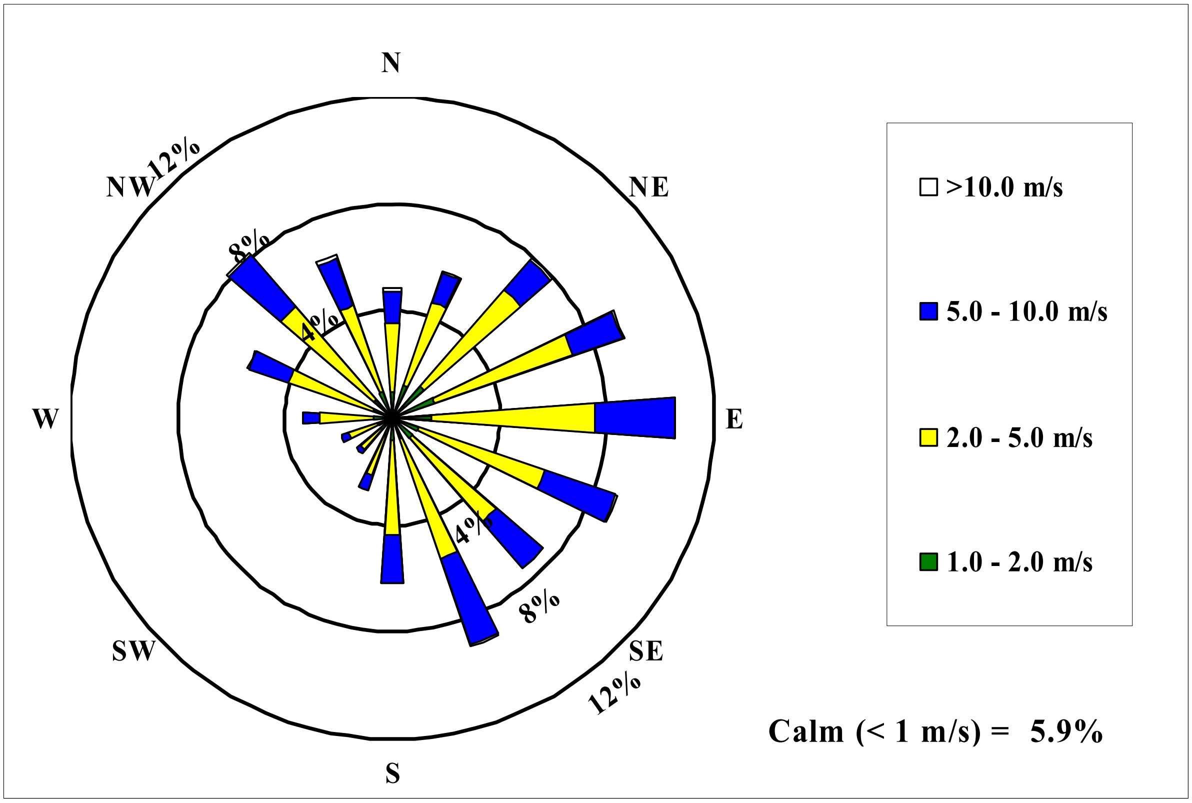
4.0 RESULTS AND DISCUSSION

4.1 METEOROLOGICAL CONSIDERATIONS

In analyzing the impact of the Giant Mine site on the local suspended particulate matter levels and to determine which of the on-site source(s) (e.g., tailings ponds) have the greatest contribution to the ambient air suspended particulate levels, it should be recognized that meteorological conditions play an important role in the generation and dispersion of fugitive dust. Wind contributes to the levels of particulate matter in three ways. First, if sufficiently strong, wind can re-suspend dust. Second, wind disperses any particulate matter suspended in the air. Third, wind enhances evaporation, leading to surface drying and a subsequent increase in the potential for the release of dust particles.

Figure 4.1 illustrates the 5-year (1996 – 2000) average wind speeds and percent frequencies by direction for Yellowknife Airport Meteorological Station.

FIGURE 4.1
WINDROSE FOR YELLOWKNIFE AIRPORT (1996- 2000)



As shown in Figure 4.1, the predominant wind direction has an easterly (from the east) component. Winds out of the northwest and south-southeast occur at a relatively lower frequency, but with a slightly higher speed, than the predominant winds (easterly).

Temperature near the surface controls the buoyant component of turbulence (vertical motion). Heat from the earth's surface warms the air near the ground causing it to rise, reaching a maximum in the early afternoon and a minimum near sunrise. The near-surface temperature also controls how fast the surface dries. If the temperature is low, the moisture on the surface of the ground may remain or freeze, effectively sealing the surface from wind erosion and thereby reducing re-suspension of surface dust.

Precipitation also affects suspended particulate matter and dustfall levels. Most rainfall events are of limited duration, but their effectiveness as dust suppressors lasts considerably longer than the rainfall events themselves. Rain can also wash particulate matter and dust out of the air.

The monthly averages of daily temperature and precipitation for the Yellowknife Airport Meteorological Station, for the months of June, July, August and September 2005 are provided in Table 4.1.

TABLE 4.1
AVERAGE TEMPERATURE AND PRECIPITATION DATA
YELLOWKNIFE AIRPORT (2005)

Temperature:	**June**	**July**	**August**	**September**
Daily Average (°C)	12.5	15.8	13.0	5.9
Standard Deviation	2.8	3.4	3.0	4.9
Daily Maximum (°C)	17.2	19.8	16.9	8.6
Daily Minimum (°C)	7.7	11.7	9.2	3.1
Precipitation:				
Rainfall (mm)	41.2	45.0	61.4	73.4
Snowfall (cm)	0	0	0	7.8
Precipitation (mm)	41.2	45.0	61.4	83.5
Average Snow Depth (cm)	0	0	0	0.3
Median Snow Depth (cm)	0	0	0	0
Snow Depth at Month-end (cm)	0	0	0	4

4.2 TSP AND PM_{10} RESULTS

Gravimetric results for the TSP and PM_{10} fractions are summarized in Table 4.2. The exceedances of ambient air quality criteria are indicated in bold. The 24-hour TSP criterion of 120 µg/m^3 (based on NWT's EPA) was exceeded consistently throughout the month of August at both the South Pond and Northwest Pond locations. The Northwest Pond location also exceeded the 24-hour TSP criterion on July 21st, 2005. The B3 Pit location had one 24-hour TSP exceedance on August 8th, 2005 and the Mill location had one 24-hour TSP exceedance on June 21st, 2005.

The 24-hour PM_{10} standard of 50 µg/m^3 (based on MOE's interim AAQC) was exceeded at the South Pond for four consecutive weeks from June 21st through July 9th and on August 14th. In addition, the 24-hour PM_{10} standard was exceeded at the B3 Pit on July 9th.

TABLE 4.2
RESULTS OF TSP AND PM_{10} MEASUREMENTS

Location	Giant Mine Town Site	South Pond		Mill		B3 Pit		Northwest Pond	
Parameter (µg/m^3)	TSP	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Date	Location #1	Location #2		Location #3		Location #4		Location #5	
21/06/2005	12.62	85.9	**91.5**	**124.7**	no data	76.4	no data	no data	no data
27/06/2005	12.54	96.6	**70.8**	94.4	no data	113.9	no data	no data	no data
03/07/2005	8.90	75.4	**61.1**	81.9	no data	101.0	no data	no data	no data
09/07/2005	11.42	106.8	**79.2**	71.3	45.8	98.6	**62.5**	54.2	no data
15/07/2005	12.20	29.2	28.1	BDL	6.9	5.5	12.5	BDL	BDL
21/07/2005	8.65	16.7	2.8	36.8	4.8	25.0	4.2	**241.7**	19.9
27/07/2005	BDL	no data	no data	no data	no data	no data	no data	no data	no data
02/08/2005	5.88	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.6
08/08/2005	10.56	**184.4**	27.8	6.9	BDL	74.7	BDL	**390.3**	6.1
14/08/2005	4.71	**185.3**	**70.8**	22.2	BDL	59.7	BDL	**144.4**	22.4
20/08/2005	4.02	**169.4**	BDL	38.9	BDL	**176.4**	5.6	**140.3**	BDL
26/08/2005	27.20	**144.4**	19.4	62.5	43.1	94.4	33.3	no data	15.3
01/09/2005	5.11	33.3	19.4	4.2	8.3	12.5	5.6	no data	13.9
07/09/2005	9.75	8.3	9.7	36.1	12.5	12.5	2.8	40.3	27.8
13/09/2005	9.75	18.1	BDL	25.0	15.3	22.2	13.9	no data	BDL
19/09/2005	7.05	1.4	BDL	BDL	2.8	BDL	15.3	6.9	0.4
AAQC Limits (ug/m^3)	TSP = 120, PM_{10} = 50								

Note: All the exceeding days are shown in bold in the table.
BDL – Below Detection Limit
AAQC – Ambient Air Quality Criteria (MOE)

Figure 4.2 depicts the variability in TSP concentrations between the five sampling locations, while Figure 4.3 shows the variability in PM_{10} concentrations between sampling locations #2 through #5 (PM_{10} was not measured at location #1).

Figure 4.2 indicates that TSP concentrations exceeding the ambient air quality objective of 120 µg/m^3 were recorded consistently throughout the month of August at both the South Pond and Northwest Pond locations as well as once on August 20th, 2005 at the B3 Pit location. The Northwest Pond location recorded one additional exceedance on July 21st, 2005 and the Mill location recorded one exceedance of the 24-hour TSP criterion on June 21st, 2005. Figure 4.3 indicates that PM_{10} concentrations exceeding the standard of 50 µg/m^3 (based on MOE's AAQC) were recorded at the South Pond for four consecutive weeks from June 21st through July 9th and on August 14th. In addition, the 24-hour PM_{10} standard was exceeded at the B3 Pit on July 9th. It is noted that the PM_{10} and TSP exceedances do not correspond well.

Table 4.3 summarizes the statistical distribution of the measured TSP and PM_{10} concentrations at all five sites. The data indicate that the results from the five sampling locations varied considerably with respect to average and maximum TSP and PM_{10} concentrations. The Giant Mine Town Site results were low in comparison to the other sampling sites. The Northwest Pond site had the highest TSP concentrations of the five TSP monitoring locations and the South Pond site had the highest PM_{10} concentrations of the four PM_{10} monitoring locations.

TABLE 4.3
SUMMARY OF STATISTICS FOR PARTICULATE MATTER

Location	**Giant Mine Town Site**	**South Pond**		**Mill**		**B3 Pit**		**Northwest Pond**	
Parameter (µg/m^3)	**TSP**	**TSP**	**PM_{10}**	**TSP**	**PM_{10}**	**TSP**	**PM_{10}**	**TSP**	**PM_{10}**
Statistical Parameter	**Location #1**	**Location #2**		**Location #3**		**Location #4**		**Location #5**	
Maximum	27	185	92	125	46	176	63	390	28
98th Percentile	23	185	89	161	58	118	45	372	27
95th Percentile	17	185	85	139	51	108	45	346	26
Median	10	81	28	75	13	38	10	140	15
Mean	10	83	44	67	17	50	17	145	14

FIGURE 4.2
VARIABILITY IN TSP CONCENTRATIONS AT ALL LOCATIONS
GIANT MINE, NWT, JUNE – SEPTEMBER 2005

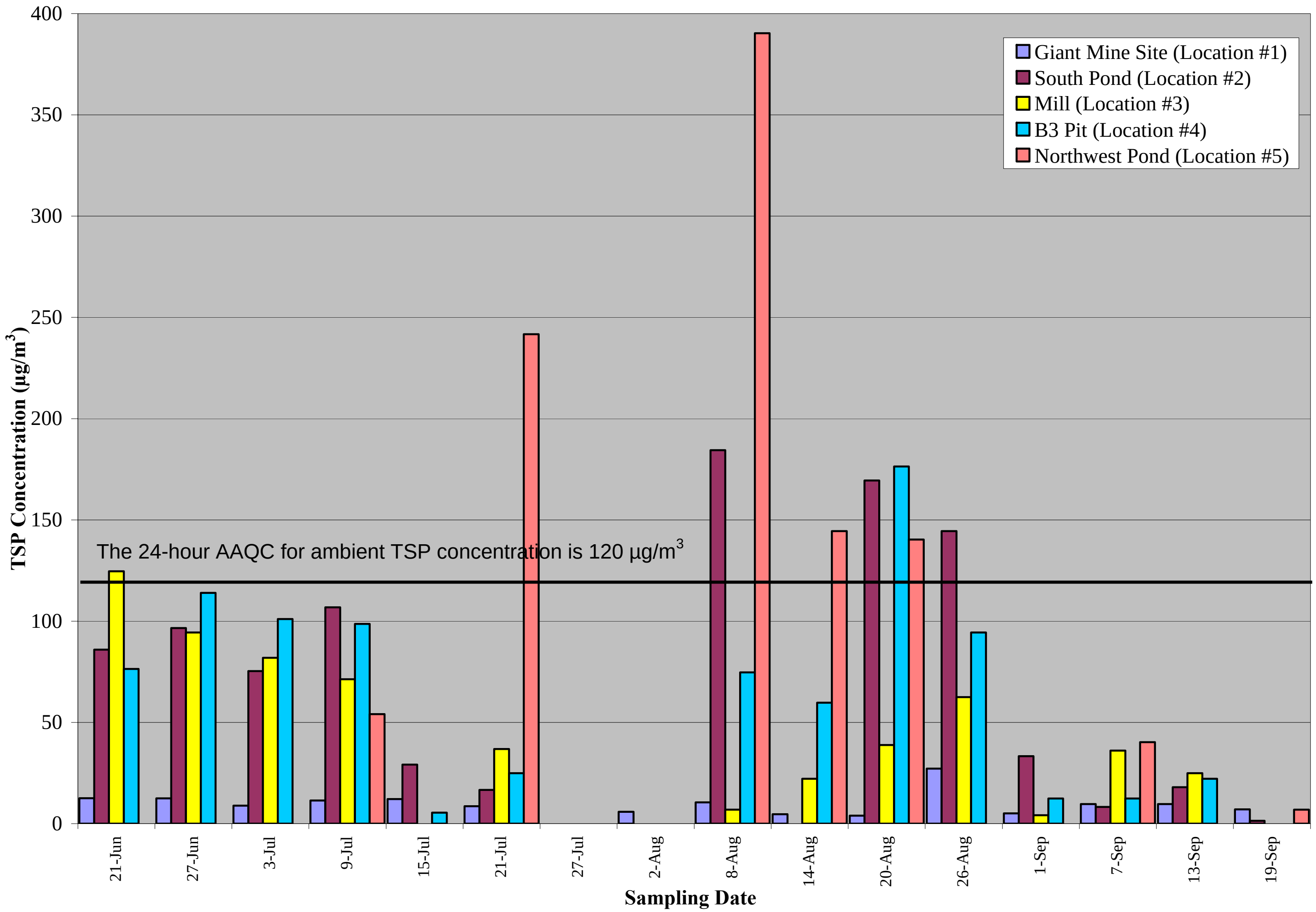
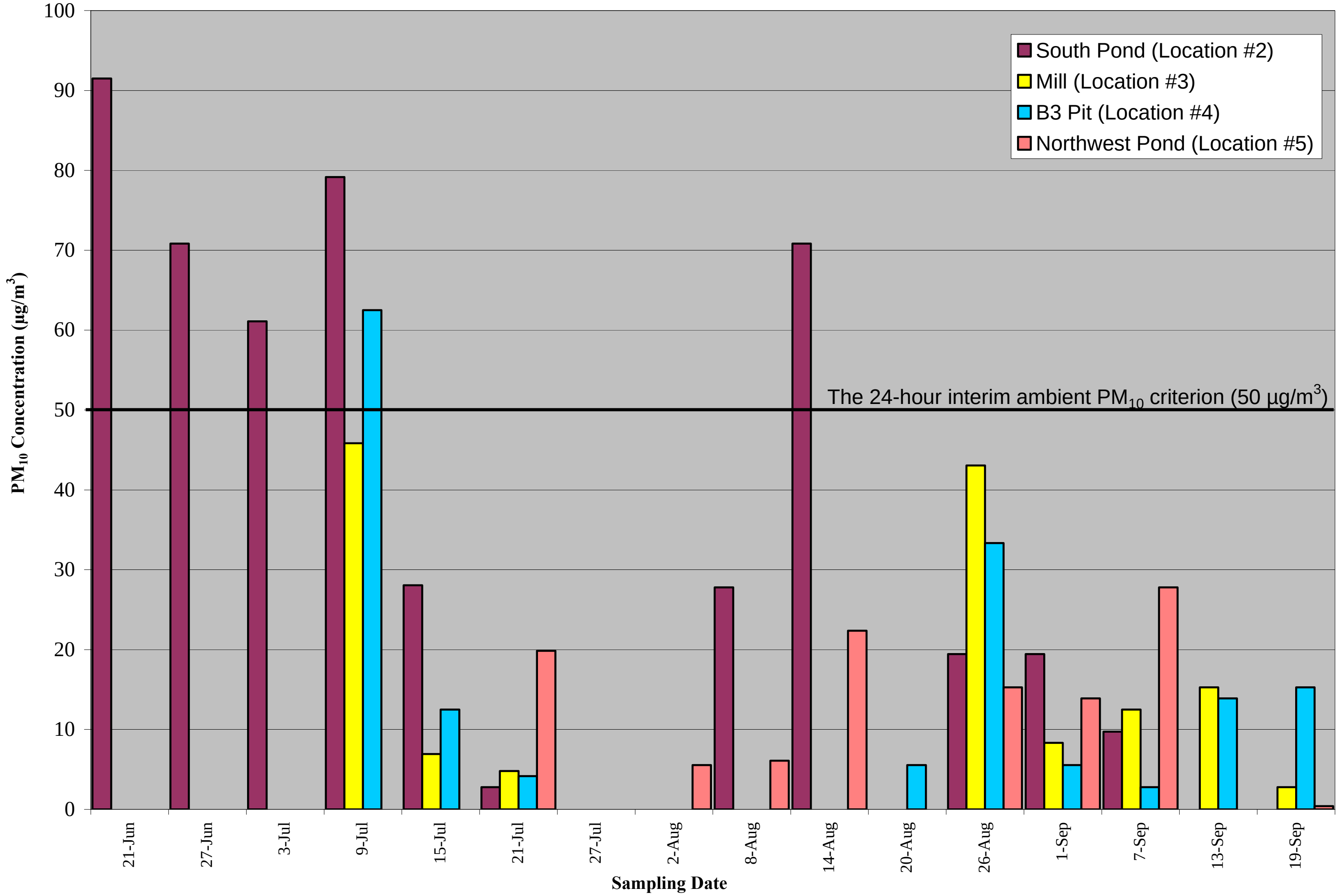


FIGURE 4.3
VARIABILITY IN PM_{10} CONCENTRATIONS AT LOCATIONS 2, 3, 4 & 5
GIANT MINE, NWT, JUNE – SEPTEMBER 2005



4.3 INORGANIC TRACE ELEMENTS

As discussed in Section 3, the particulate samples (both TSP and PM_{10}) were analyzed for inorganic trace element concentrations. The concentrations were given in weight per filter, which were converted into ambient concentrations in µg/m^3, based on the calibrated flow rate of the sampling equipment. The trace element concentrations for all of the 105 Mini-Vol filters and 15 of the Hi-Vol filters are presented in Tables 4.6 and 4.7, respectively (included at the end of this section). The results indicate that, with the exception of beryllium, iron and arsenic all other metal concentrations were below their applicable AAQC. There was one beryllium exceedance on July 21st, 2005. The iron concentrations were consistently in exceedance of their respective AAQC from July 21st through August 26th, 2005.

One of the main concerns with respect to the particulate matter emissions from the tailings areas at the Giant Mine site is the trace element content, specifically arsenic, of the suspended particulate matter. Table 4.4 lists the arsenic concentrations reported at all five sites during the monitoring period of June-September 2005. The results indicate exceedances primarily at the Northwest Pond and South Pond from July 21st through August 20th, with only one exceedance at the B3 Pit during the month of August. The health-based ambient air quality criterion for arsenic of 0.3 µg/m^3 was exceeded 4 times at the Northwest Pond, on July 21st, 2005 and August 8th through August 20th. In addition, the August 8th and 14th South Pond samples and the August 20th sample at the B3 Pit were above the arsenic AAQC.

The data in Table 4.4 indicates that the arsenic levels were noticeably higher at the South Pond and Northwest Pond than at the other two onsite sampling locations, suggesting contributions from the South Pond and Northwest Pond, respectively. While the highest arsenic concentration was reported for the South Pond, the Northwest Pond had the higher overall average arsenic concentrations and a greater frequency of exceedances. The B3 Pit arsenic concentrations (maximums and averages) were noticeably lower than the Northwest and South Pond locations, the Mill arsenic concentrations were noticeably lower than the B3 Pit location, and the Giant Mine Town Site arsenic concentrations were an order of magnitude lower than the Mill location. This demonstrates that the arsenic concentrations varied greatly by sample location, and for certain locations by sample date.

TABLE 4.4
ARSENIC CONCENTRATIONS IN PARTICULATE MATTER

Location	Giant Mine Town Site	South Pond		Mill		B3 Pit		Northwest Pond	
Parameter ($\mu g/m^3$)	AS in TSP	As in TSP	As in PM_{10}	As in TSP	As in PM_{10}	As in TSP	As in PM_{10}	As in TSP	As in PM_{10}
Date	Location #1	Location #2		Location #3		Location #4		Location #5	
21/06/2005	0.018	0.105	0.005	0.007	no data	0.008	no data	no data	no data
27/06/2005	0.008	0.005	0.003	0.049	no data	0.017	no data	no data	no data
03/07/2005	0.003	0.005	0.003	0.003	no data	0.013	no data	no data	no data
09/07/2005	0.004	0.005	0.003	0.004	0.003	0.007	0.003	0.003	no data
15/07/2005	0.006	0.003	0.004	0.014	0.003	0.009	0.003	0.003	0.003
21/07/2005	0.004	0.057	0.018	0.018	0.006	0.040	0.003	**0.633**	0.004
27/07/2005	0.003	no data	no data	no data	no data	no data	no data	no data	no data
02/08/2005	0.003	0.003	0.003	0.004	0.003	0.010	0.005	0.014	0.003
08/08/2005	0.002	**0.851**	0.146	0.107	0.026	0.188	0.065	**0.536**	0.163
14/08/2005	0.048	**0.515**	**0.335**	0.104	0.033	0.289	0.167	**0.594**	0.221
20/08/2005	0.005	0.165	0.032	0.138	0.008	**0.482**	0.139	**0.533**	0.059
26/08/2005	0.002	0.294	0.022	0.044	0.024	0.119	0.019	no data	0.003
01/09/2005	0.014	0.017	0.003	0.003	0.003	0.003	0.003	no data	0.003
07/09/2005	0.001	0.013	0.003	0.008	0.003	0.013	0.003	0.036	0.003
13/09/2005	0.001	0.125	0.088	0.026	0.036	0.036	0.003	no data	0.056
19/09/2005	0.001	0.026	0.061	0.003	0.014	0.028	0.032	0.029	0.032
Summary Statistics									
Maximum	0.048	0.851	0.335	0.138	0.036	0.482	0.167	0.633	0.221
98th Percentile	0.039	0.757	0.282	0.129	0.036	0.428	0.161	0.627	0.210
95th Percentile	0.026	0.616	0.203	0.116	0.035	0.347	0.151	0.618	0.192
Median	0.004	0.026	0.005	0.014	0.007	0.017	0.004	0.036	0.004
Mean	0.008	0.146	0.049	0.036	0.014	0.084	0.037	0.265	0.050

Note: exceedances are shown in Bold.

Figures 4.4 through 4.9 show the trends and correlations in arsenic levels in both TSP and PM_{10} at locations 2 through 5. The figures show that arsenic levels in the two particulate matter size fractions (i.e., TSP & PM_{10}) tracked each other quite well at the Northwest Pond and B3 Pit locations, while only moderately at the South Pond and Mill sampling locations. Overall, peak arsenic concentrations in PM_{10} generally corresponded with peak arsenic concentrations in TSP. The figures indicate that at all locations a large percentage of the arsenic was present in the large particles (TSP) that are less likely to be of concern for human health.

FIGURE 4.4
VARIABILITY IN ARSENIC CONCENTRATIONS AT ALL TSP SAMPLING LOCATIONS

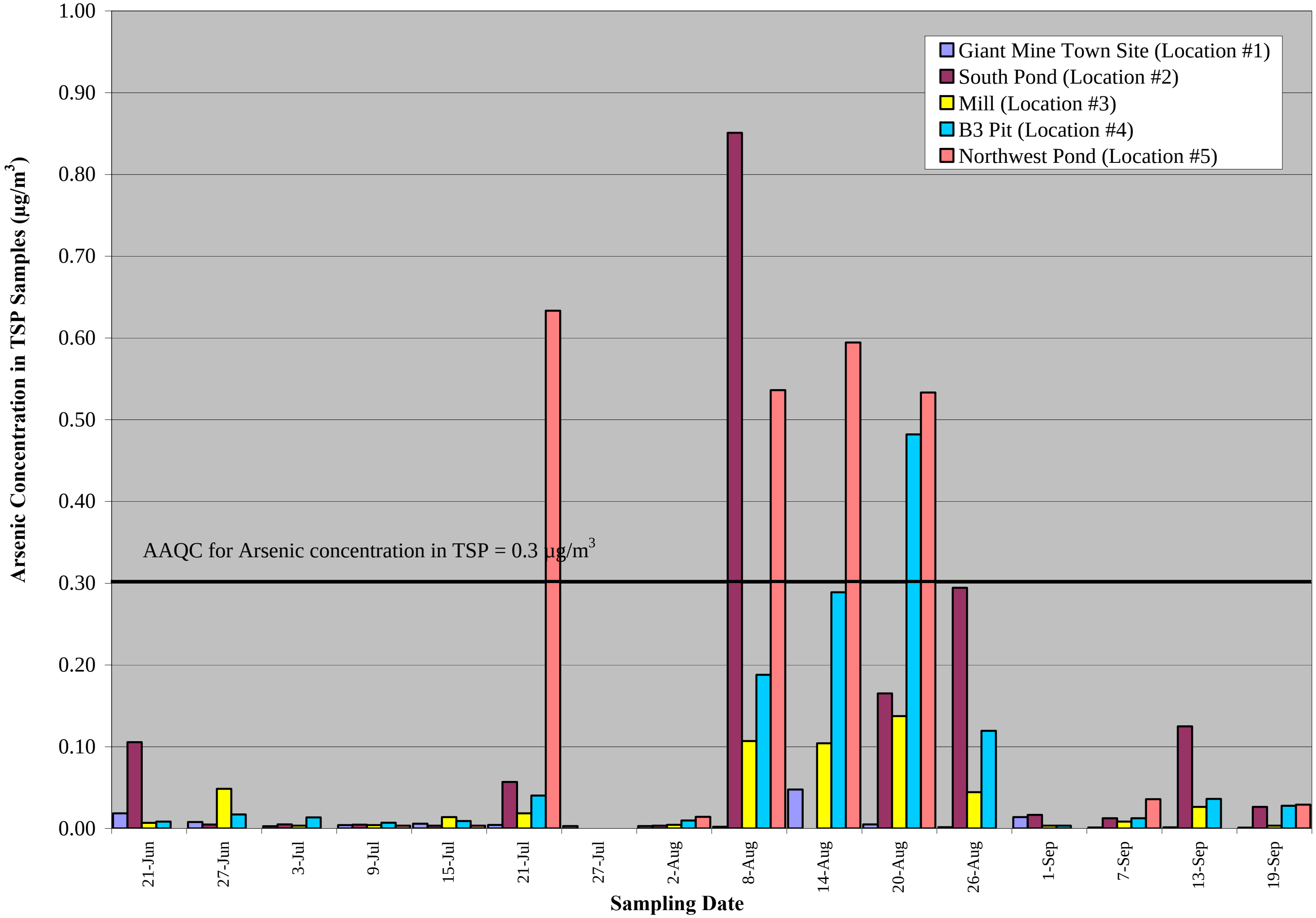


FIGURE 4.5
VARIABILITY IN ARSENIC CONCENTRATIONS AT PM_{10} SAMPLING LOCATIONS

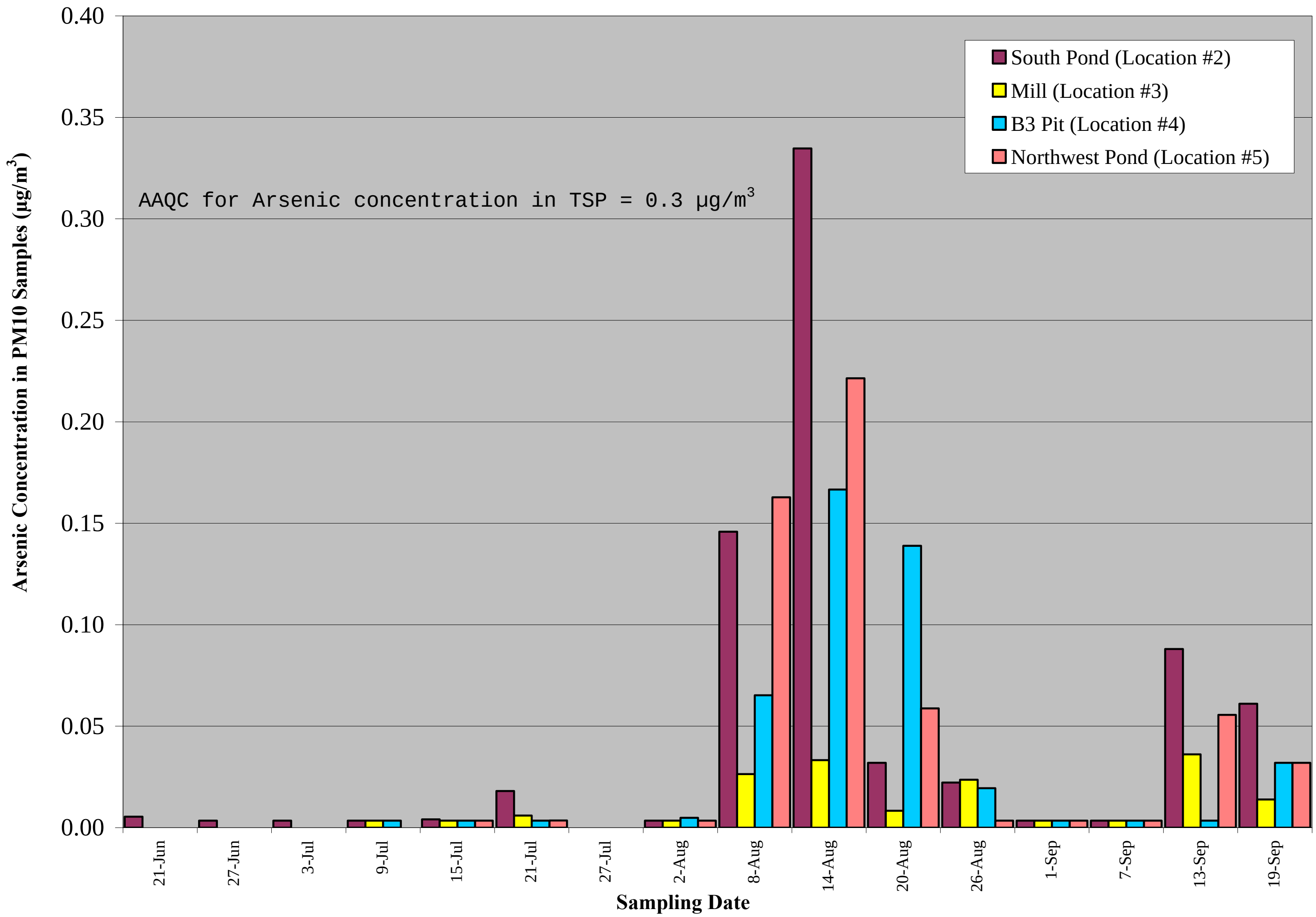


FIGURE 4.6
VARIABILITY IN ARSENIC CONCENTRATIONS AT SOUTH POND FOR TSP AND PM_{10} SAMPLES

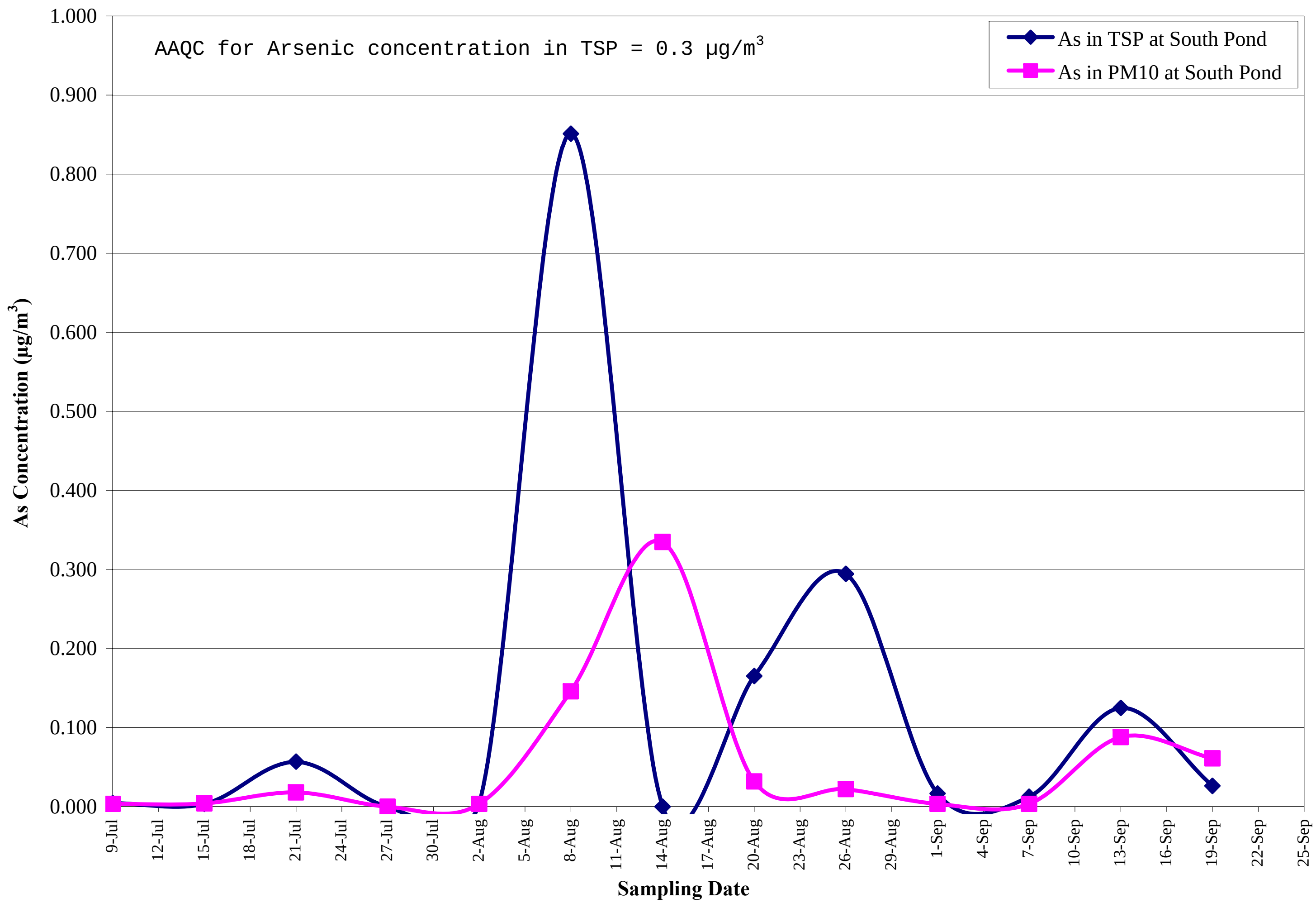


FIGURE 4.7
VARIABILITY IN ARSENIC CONCENTRATIONS AT MILL FOR TSP AND PM_{10} SAMPLES

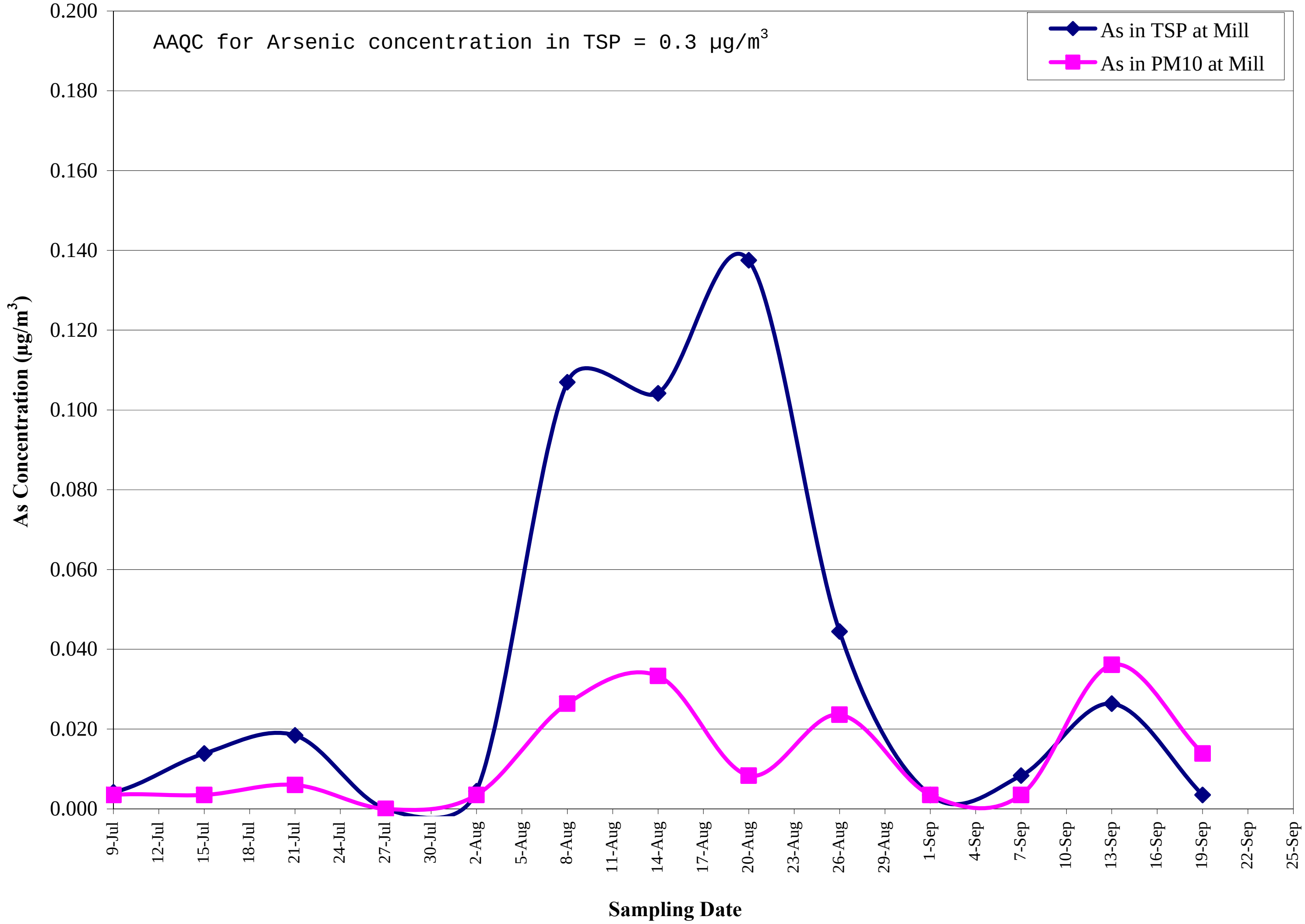


FIGURE 4.8
VARIABILITY IN ARSENIC CONCENTRATIONS AT B3 PIT FOR TSP AND PM_{10} SAMPLES

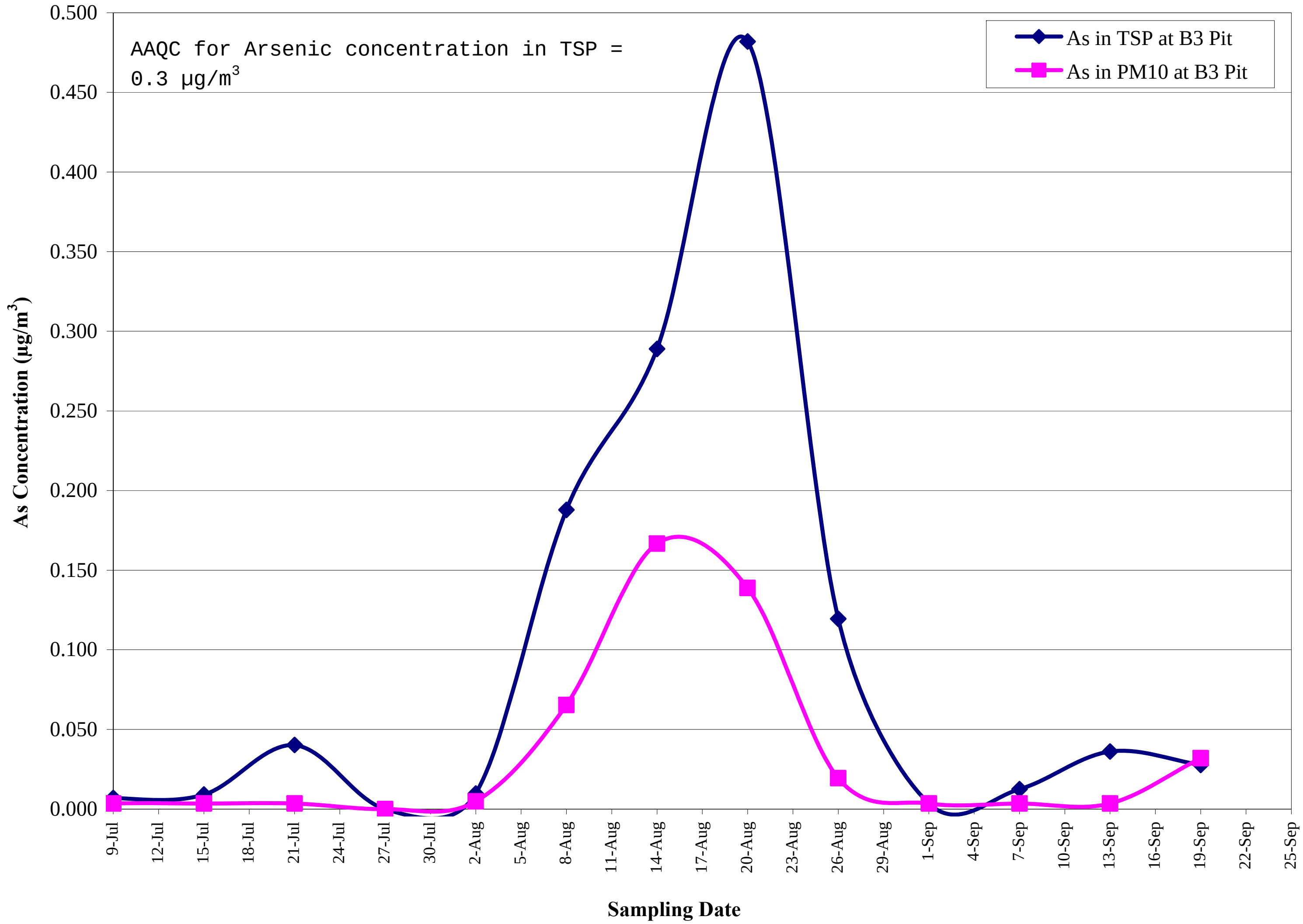
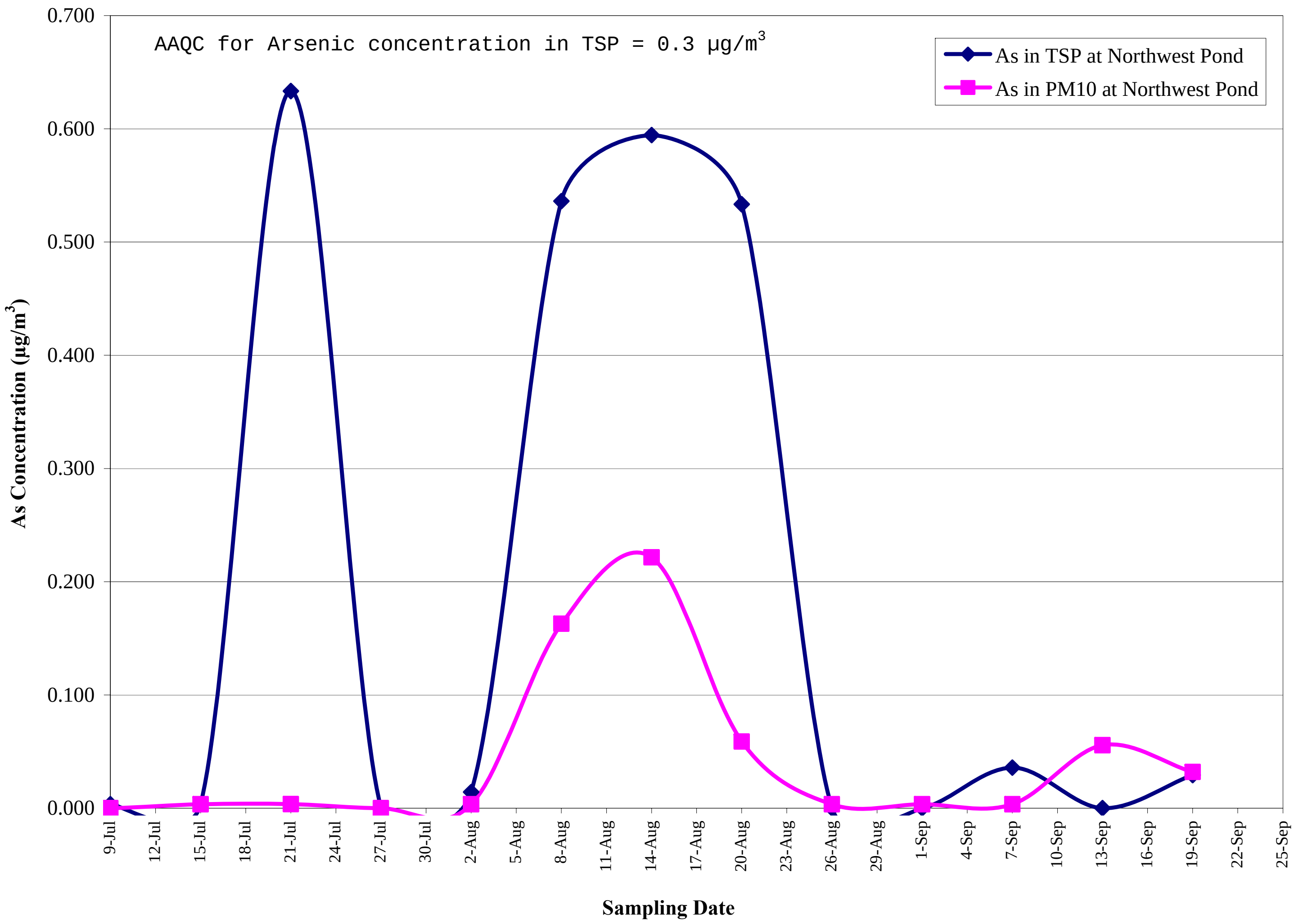


FIGURE 4.9
VARIABILITY IN ARSENIC CONCENTRATIONS AT NORTHWEST POND FOR TSP AND PM_{10} SAMPLES



4.4 INTERPRETATION OF RESULTS

Table 4.5 summarizes the days on which the particulate matter (TSP and PM_{10}) and/or arsenic and/or iron concentrations were reported to be above their respective AAQC. The table clearly shows that all arsenic exceedances, both in TSP and PM_{10}, corresponded with days that the concentrations of TSP and/or PM_{10} were also exceeding their respective AAQC. However, at monitoring location 2 (south end of South Pond) there were days in which the TSP and/or PM_{10} concentrations were in exceedance and the arsenic concentrations were not.

In general, for most of the monitoring stations, a better correlation was observed between the iron and TSP exceedances than iron and PM_{10} exceedances, suggesting that similar to arsenic, iron is associated mainly with larger suspended particulate fractions. For monitoring locations 3 and 4, the iron exceedances (AAQC of 4 $\mu g/m^3$) did not correlate well with the TSP exceedances, nor with PM_{10} at monitoring location 4 (there were no exceedances for PM10 / iron at monitoring location 3).

All arsenic and iron exceedances were reported between July 21st and August 20th, 2005 indicating that perhaps the high concentrations of arsenic and iron could be attributed to a specific onsite activity that occurred during this time period.

TABLE 4.5
SUMMARY OF SIGNIFICANT DATES FOR ELEVATED OR EXCEEDED PM_{10} AND As CONCENTRATIONS

Parameter ($\mu g/m^3$)	TSP				PM_{10}				Arsenic in TSP				Arsenic in PM_{10}				Iron in TSP				Iron in PM_{10}			
Location	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**
21/6/2005		x			x																			
27/6/2005					x																			
3/7/2005					x																			
9/7/2005					x		x																	
15/7/2005																								
21/07/2005				x								x								x				
2/8/2005																							x	
8/8/2005	x			x					x			x					x		x	x	x			
14/8/2005	x			x	x				x			x	x				x		x	x	x		x	x
20/8/2005	x		x	x							x	x					x	x	x	x			x	
26/8/2005	x																x		x					
1/9/2005																								
7/9/2005																								
13/9/2005																								
19/9/2005																								

Note: Location #1 (Giant Mine Town Site) was not included because there were no exceedances reported at this location.

The potential sources of some of the AAQC exceedances of TSP/PM_{10} and arsenic observed during the 2005 sampling program are discussed below.

JUNE 21ST – JULY 9TH, 2005

This period of the sampling program was characterized by moderate daytime temperatures (11 to 18 ^{0}C) and low periods of calm winds (0% to 13% on individual days). There was little or no precipitation during this sampling period, such that surface conditions were relatively dry.

Figures 4.10 (a) through (d) indicate that the predominant wind direction varied greatly over the four sampling days. On June 21st the winds were primarily from the northeast. On June 27th, the winds were primarily from the west and west-southwest direction. On July 3rd, the winds were primarily from the east and south-southeast. On July 9th, the winds were primarily from the east-northeast, northeast, and east directions.

FIGURE 4.10
WINDROSES FOR THE DAYS WITH ELEVATED OR EXCEEDED PM_{10} /As / Fe CONCENTRATIONS

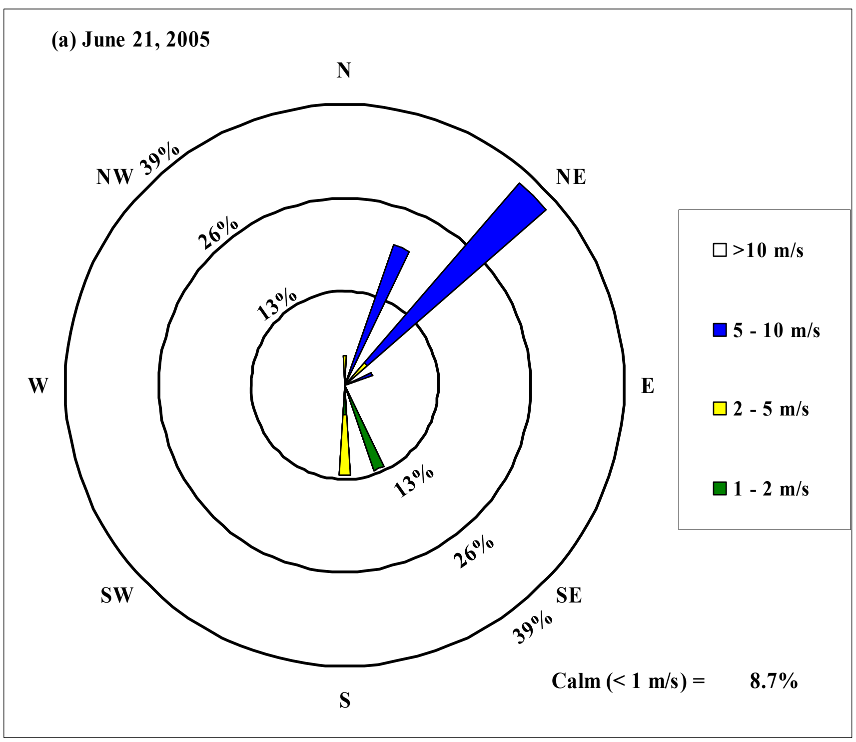
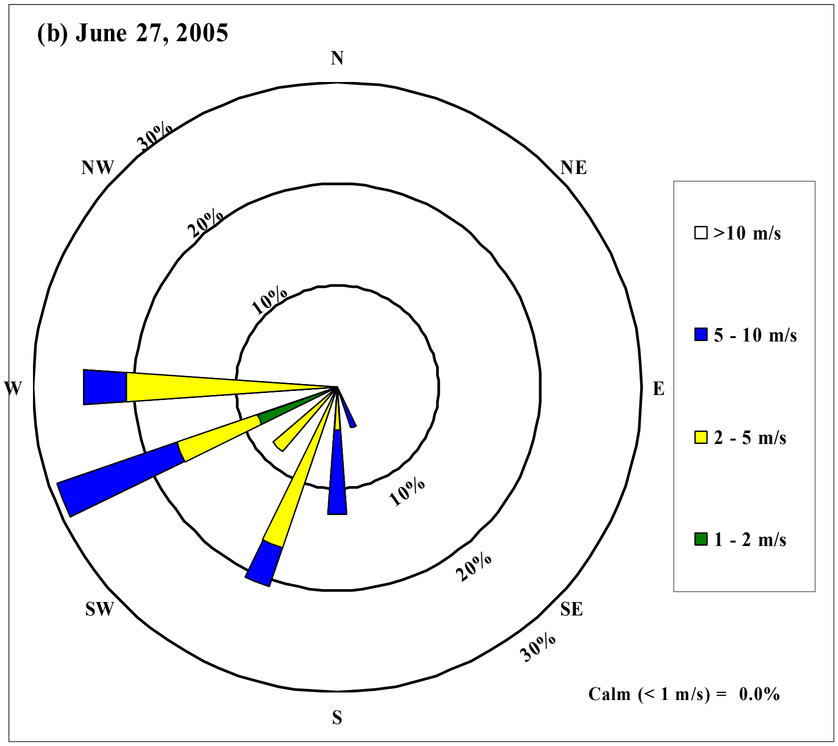


FIGURE 4.10 (Cont'd)
WINDROSES FOR THE DAYS WITH ELEVATED OR EXCEEDED PM_{10} /As / Fe CONCENTRATIONS



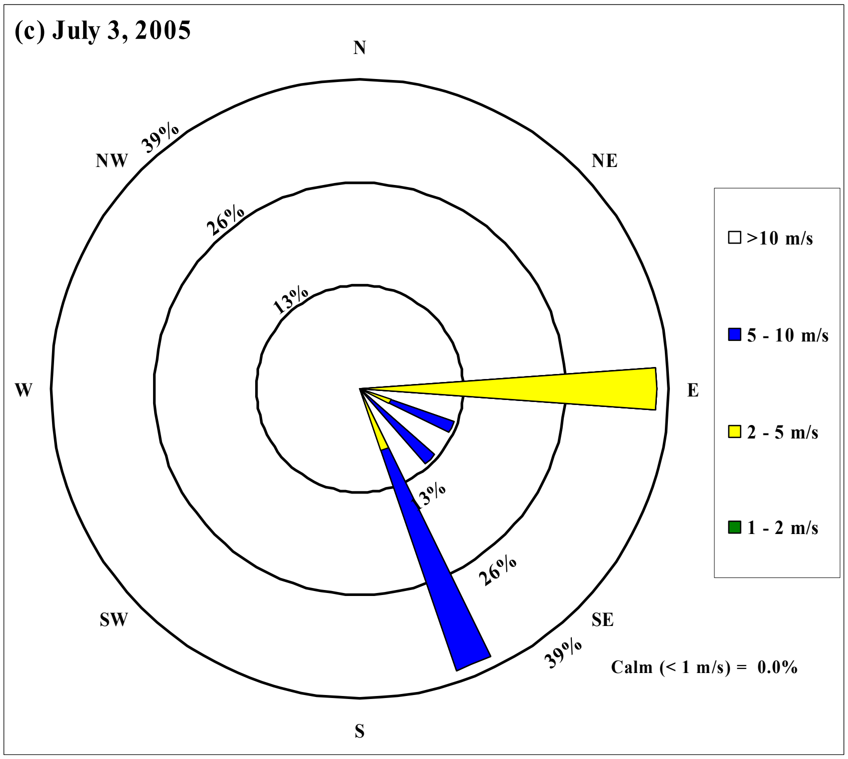
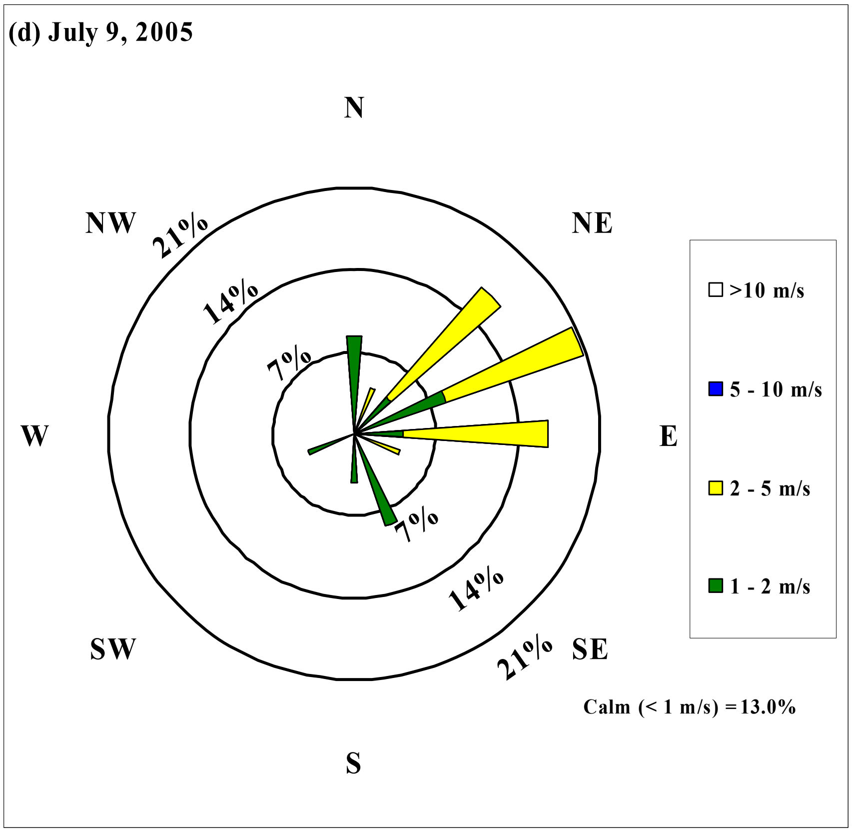


FIGURE 4.10 (Cont'd)
WINDROSES FOR THE DAYS WITH ELEVATED OR EXCEEDED PM_{10} /As / Fe CONCENTRATIONS



The PM_{10} ambient air quality objective of 50 µg/m^3 was exceeded on four consecutive sampling dates at the South Pond location. Given the variation observed in the wind directions in these four exceedance days (see Figure 4.10), contributions from sources in the close vicinity of the monitoring station, such as the South Tailing Pond and nearby onsite road are suspected. During this time there was also one PM_{10} exceedance at the B3 Pit location which may be attributed to the increased onsite road maintenance, which began in early July, 2005. The TSP AAQC was exceeded once at the Mill location on June 21st. Based on the wind data (see Figure 4.10 (a)), contributions from nearby road network as well as the Central and North ponds are suspected.

July 21st – August 26th, 2005

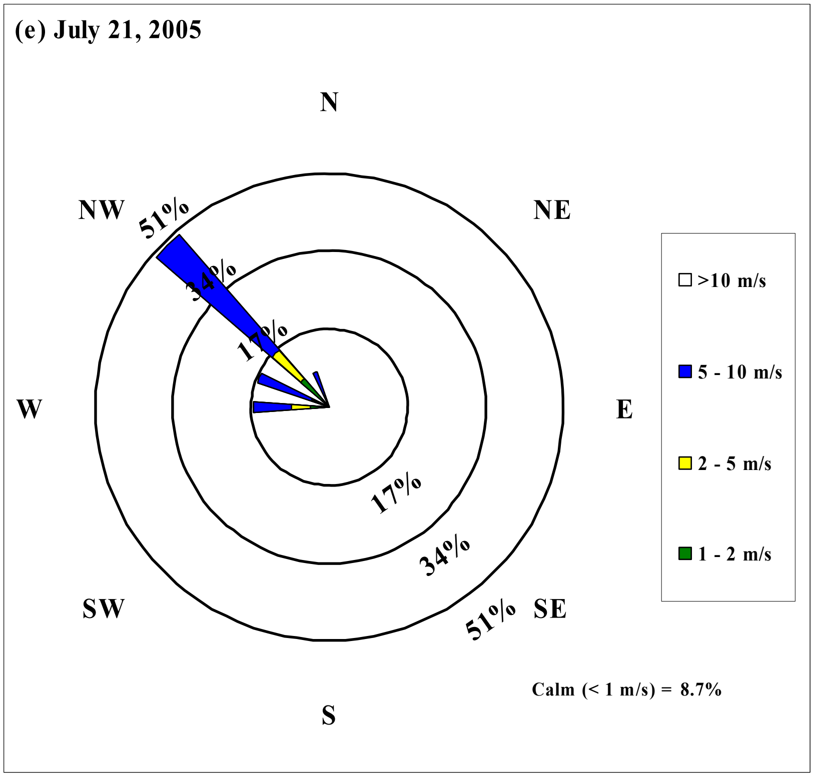
This period of the sampling program was characterized by moderate daytime temperatures (8 to 18 ^{0}C) and low periods of calm winds (0% to 8.7% on individual days). There was some precipitation during the sampling periods, such that surface conditions were not extremely dry.

Figures 4.10 (e) through (j) indicate that the predominant winds were from northwest on July 21st, north-northeast on August 2nd, north to north-northwest on August 8th, north on August 14th, and southeast on August 20th and 26th.

During this time period there were consistent exceedances of respective AAQCs of TSP, arsenic, and iron at monitoring locations 2 (south of South Pond) and 3 (south of Northwest Pond). There was only one PM_{10} exceedance, which occurred at the South Pond on August 14th, 2005.

Given the wind regime for this time period (mainly northerly winds) both the South Pond and Northwest Pond are suspected sources of suspended particulate for monitoring locations 3 and 4. Based on site reconnaissance information, these high concentrations can also be attributed to activities that occurred onsite during the month of August. As a result of a new care and maintenance contract that began July 1st, 2005, there was an increase in road maintenance throughout the property. This included grading of the main roads and applying additional gravel in certain places. There was also a significant amount of work performed in the core area of the mine site (C-Dry, C-Shaft, MEG shop, C-boiler areas) during the month of August. The work consisted of removing an existing utilidor (wood and insulation) and the associated water and steam lines. The pipes were cut with grinders and saws. These activities would have resulted in TSP and PM_{10} emissions, which is reflected in the increase in TSP and PM_{10} concentrations measured. Cutting of steel pipes may have contributed to the elevated iron concentrations in some of the TSP and PM_{10} samples.

FIGURE 4.10 (Cont'd)
WINDROSES FOR THE DAYS WITH ELEVATED OR EXCEEDED PM_{10} /As /Fe CONCENTRATIONS



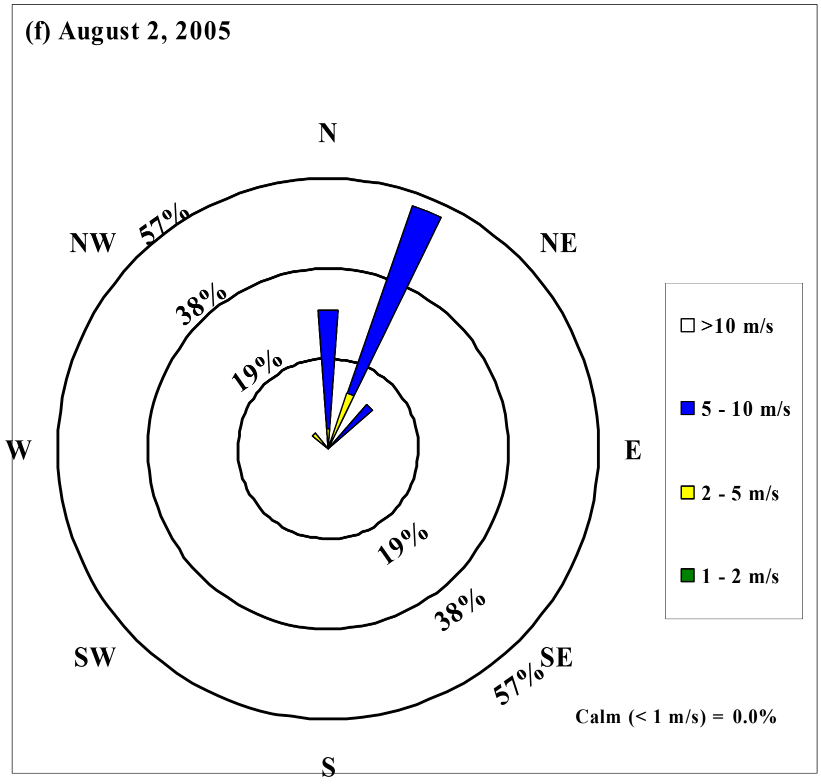
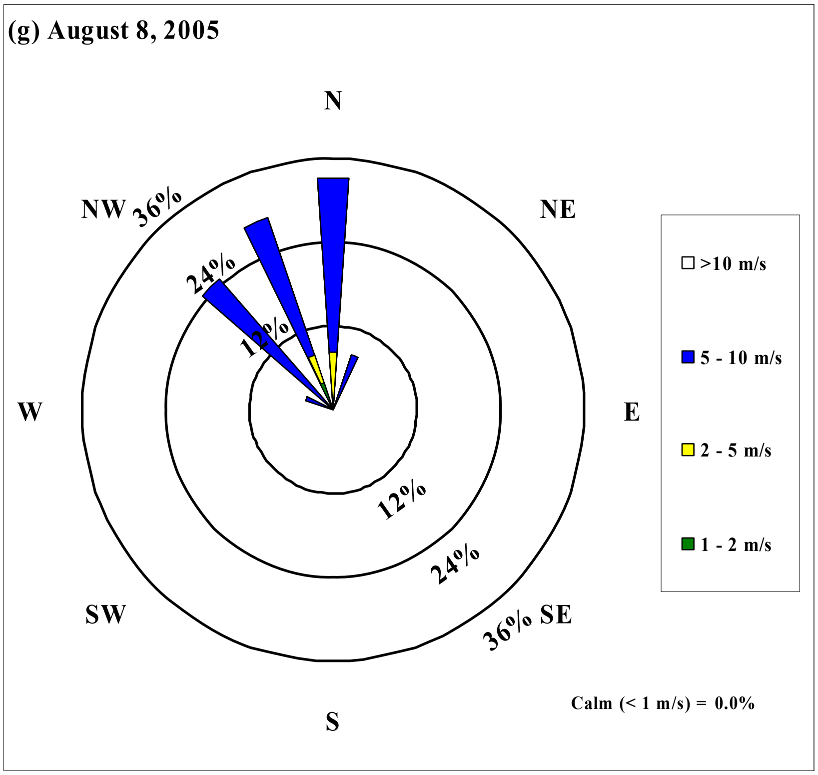


FIGURE 4.10 (Cont'd)
WINDROSES FOR THE DAYS WITH ELEVATED OR EXCEEDED PM_{10} /As / Fe CONCENTRATIONS



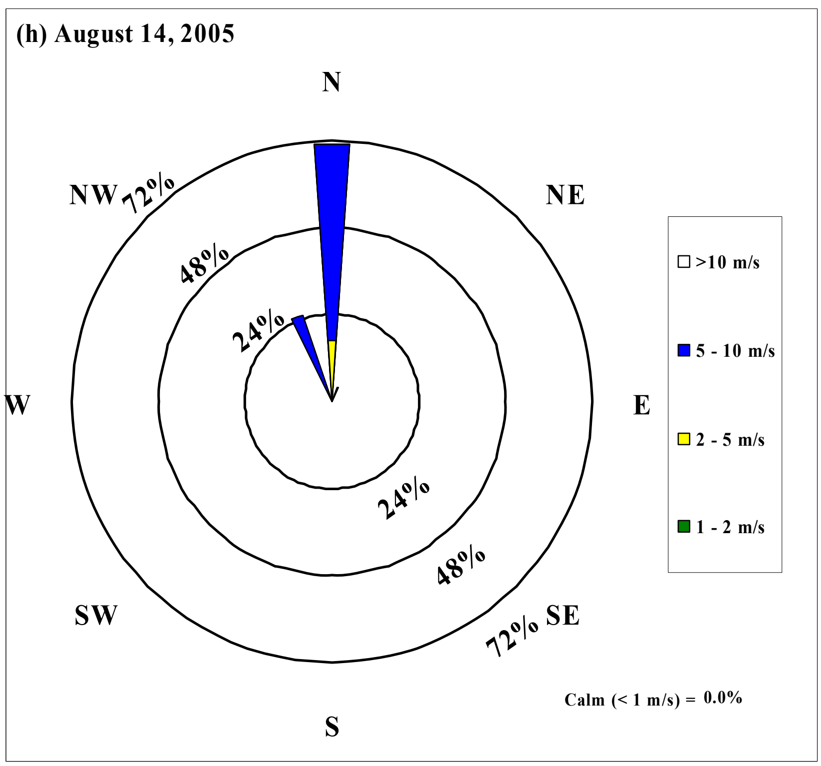
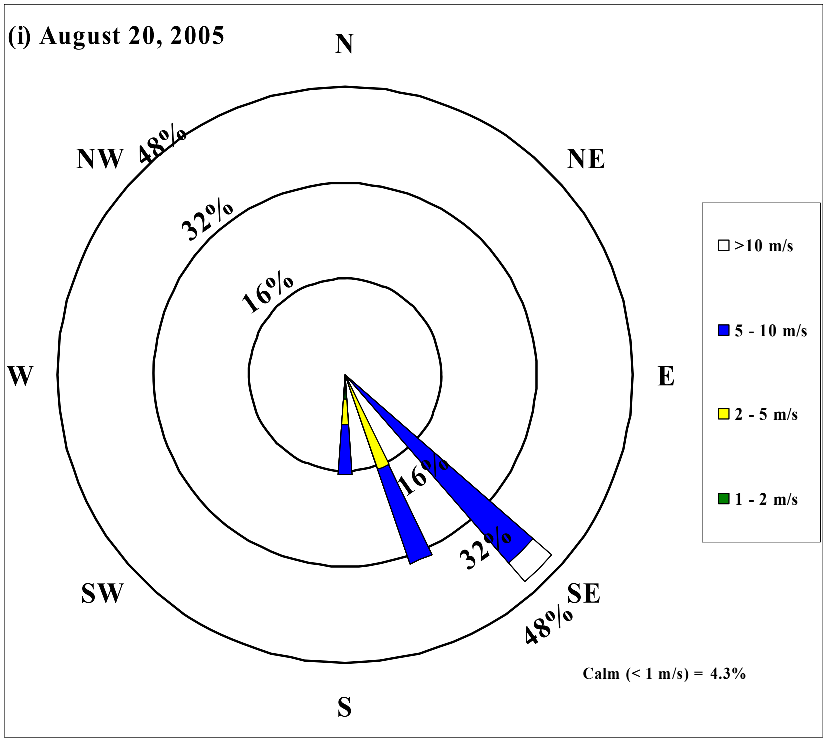
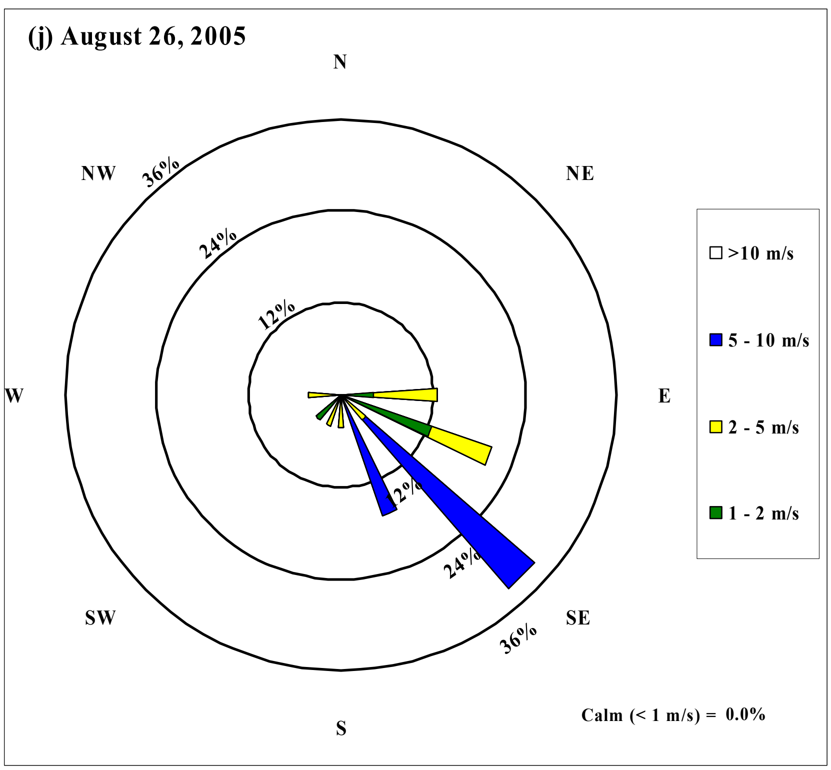


FIGURE 4.10 (Cont'd)
WINDROSES FOR THE DAYS WITH ELEVATED OR EXCEEDED PM_{10} /As / Fe CONCENTRATIONS





4.5 COMPARISON OF 2004 AND 2005 MONITORING RESULTS

In 2005 there was a significant increase in the quantity of samples collected, as one onsite sampling location was added (the Northwest Pond) and at all onsite sampling locations both TSP and PM_{10} samples were collected (in 2004, PM_{10} samples were collected at only one sampling location (the South Pond)).

Overall the 2005 results indicate noticeably higher ambient concentrations of TSP, PM_{10}, arsenic and iron than the 2004 results. In 2004, with the exception of iron content in one of the onsite PM_{10} samples, all other measured concentrations of trace inorganic elements in the ambient air were below the health-based ambient air quality criteria, as defined by the Ontario Ministry of the Environment (MOE). Also, there was only one day in which the measured TSP concentrations at all the sampling locations were exceeded and two days in which the PM_{10} criterion of 50 $\mu g/m^3$ was exceeded. In 2005, there were numerous exceedances of TSP, PM_{10}, arsenic and iron (see Tables 4.2 and 4.4). Most arsenic exceedances were at monitoring locations 2 and 3, suggesting contributions from the South Tailings Pond and the Northwest Tailings Pond, respectively.

The 2004 monitoring data at location #2 suggested that 75% of the ambient arsenic is contained within the coarse particles, and only 25% on average is present in the inhalable PM_{10} fraction. The 2005 arsenic concentrations in TSP and PM_{10} (measured at all onsite monitoring locations) are highly variant but on average indicate that more than half of the measured ambient arsenic concentration is contained within the course particles (see Table 4.4).

The higher concentrations reported in 2005 can in large part be attributed to onsite activities. The site entered into a new care and maintenance contract on July 1st, 2005 which resulted in increased road maintenance through the property. Specifically, the main roads were graded and additional gravel was added in places. In addition, a significant amount of work in the core area of the mine site occurred during August 2005. This work consisted of removing an existing utilidor (wood and insulation) and the associated water and steam lines. Grinders and saws were used to cut the steel pipes. The monitoring results, specifically, the elevated ambient suspended particulate as well as iron concentrations, correlate well with these onsite activities.

From the perspective of the monitoring program and detecting arsenic emissions from the Giant Mine site, the 2005 data supports the conclusions of the 2004 monitoring program, in that:

- TSP provides a better measure of peaks in fugitive dust emissions from the mine site because more arsenic is present in the TSP than in the PM_{10} samples; and,
- PM_{10} samples provide a better measure of arsenic exposure for health protection.

Since arsenic in TSP provides a better measure of the day-to-day fluctuations in ambient arsenic concentrations, TSP sampling is more useful in determining from which sources the arsenic is likely to have originated. Since one of the objectives of the sampling program is also to assess harmful levels of exposure to arsenic in ambient air, PM_{10} sampling would be a more appropriate measure of exposure, as the TSP sampling may overestimate exposure levels by a factor of at least 2, on average.

TABLE 4.6
AMBIENT AIR METAL CONCENTRATIONS AT THE ON-SITE MONITORING LOCATIONS (Mini-Vol samplers)

Filter ID	Start Date	Location	Sampling Duration (hrs)	Ag	Al	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Mo	Na	Ni	Pb	Sb	Se	Sn	Sr	V	W	Zn	Zr	Comment
QTZ-111	21/06/2005	South Pond - TSP	25.6	0.0326	1.30	0.1055	0.0247	0.0033	1.30	0.0007	0.0033	0.0326	0.0326	3.91	0.0033	1.30	0.9115	0.0391	0.0130	3.91	0.0065	0.0130	0.0033	0.0065	0.0326	0.0065	0.0065	0.0326	0.3255	0.3255	
QTZ-112	21/06/2005	South Pond - PM10	15.3	0.0545	2.18	0.0054	0.0196	0.0054	2.18	0.0011	0.0054	0.0545	0.0545	2.18	0.0054	2.18	0.5447	0.0218	0.0218	6.54	0.0109	0.0218	0.0054	0.0109	0.0545	0.0109	0.0109	0.0545	0.5447	0.5447	
QTZ-113	21/06/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.0083	0.0167	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.8333	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	Batteries not fully charged though indicator said otherwise
QTZ-114	21/06/2005	Mill -TSP	12.3	0.0678	2.71	0.0068	0.0271	0.0068	2.71	0.0014	0.0068	0.0678	0.0678	2.71	0.0068	2.71	0.6775	0.0271	0.0271	8.13	0.0136	0.0271	0.0068	0.0136	0.0678	0.0136	0.0136	0.0678	0.6775	0.6775	
QTZ-115	27/06/2005	South Pond - TSP	17.6	0.0473	1.89	0.0047	0.0189	0.0047	1.89	0.0009	0.0047	0.0473	0.0473	1.89	0.0047	1.89	0.4735	0.0189	0.0189	5.68	0.0095	0.0189	0.0047	0.0095	0.0473	0.0095	0.0095	0.0473	0.4735	0.4735	
QTZ-116	27/06/2005	South Pond - PM10	24.0	0.0347	1.39	0.0035	0.0139	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
QTZ-118	27/06/2005	B3 Pit -TSP	19.6	0.0425	1.70	0.0170	0.0187	0.0043	1.70	0.0009	0.0043	0.0425	0.0425	1.70	0.0043	3.40	1.1905	0.0170	0.0170	10.20	0.0085	0.0170	0.0043	0.0085	0.0425	0.0085	0.0085	0.0425	0.4252	0.4252	
QTZ-117	27/06/2005	Mill -TSP	24.0	0.0347	1.39	0.0486	0.0139	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	5.56	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
QTZ-119	03/07/2005	South Pond - TSP	16.8	0.0496	1.98	0.0050	0.0218	0.0050	1.98	0.0010	0.0050	0.0496	0.0496	1.98	0.0050	1.98	0.4960	0.0198	0.0198	7.94	0.0099	0.0198	0.0050	0.0099	0.0496	0.0099	0.0099	0.0496	0.4960	0.4960	Batteries changed out due to continuing problems
QTZ-120	03/07/2005	South Pond - PM10	24.0	0.0347	1.39	0.0035	0.0111	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
QTZ-121	03/07/2005	B3 Pit -TSP	19.8	0.0421	1.68	0.0135	0.0168	0.0042	1.68	0.0008	0.0042	0.0421	0.0421	1.68	0.0042	1.68	0.8418	0.0168	0.0168	5.05	0.0084	0.0168	0.0042	0.0084	0.0421	0.0084	0.0084	0.0421	0.4209	0.4209	
QTZ-122	03/07/2005	Mill -TSP	24.0	0.0347	1.39	0.0035	0.0111	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
QTZ-124	09/07/2005	South Pond - TSP	18.1	0.0460	1.84	0.0046	0.0129	0.0046	1.84	0.0009	0.0046	0.0460	0.0460	1.84	0.0046	1.84	0.4604	0.0184	0.0184	5.52	0.0092	0.0184	0.0046	0.0092	0.0460	0.0092	0.0092	0.0460	0.4604	0.4604	
QTZ-123	09/07/2005	South Pond - PM10	24.0	0.0347	1.39	0.0035	0.0097	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	New samplers arrived
QTZ-125	09/07/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.0069	0.0097	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
QTZ-126	09/07/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.0035	0.0111	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
QTZ-127	09/07/2005	Mill-TSP	20.1	0.0415	1.66	0.0041	0.0116	0.0041	1.66	0.0008	0.0041	0.0415	0.0415	1.66	0.0041	1.66	0.4146	0.0166	0.0166	4.98	0.0083	0.0166	0.0041	0.0083	0.0415	0.0083	0.0083	0.0415	0.4146	0.4146	
QTZ-128	09/07/2005	Mill-PM10	24.0	0.0347	1.39	0.0035	0.0083	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
QTZ-129	09/07/2005	NW Pond-TSP	24.0	0.0347	1.39	0.0035	0.0139	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
QTZ-130	09/07/2005	NW Pond-PM10																													Sampler was programmed incorrectly?
QTZ-132	15/07/2005	South Pond - TSP	24.0	0.0347	1.39	0.0035	0.0444	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
QTZ-131	15/07/2005	South Pond - PM10	20.2	0.0413	1.65	0.0041	0.0611	0.0041	1.65	0.0008	0.0041	0.0413	0.0413	1.65	0.0041	1.65	0.8251	0.0165	0.0165	6.60	0.0083	0.0165	0.0041	0.0083	0.0413	0.0165	0.0083	0.0413	0.4125	0.4125	
QTZ-134	15/07/2005	B3 Pit -TSP	18.3	0.0455	1.82	0.0091	0.0583	0.0046	1.82	0.0009	0.0046	0.0455	0.0455	1.82	0.0046	1.82	0.4554	0.0182	0.0182	5.46	0.0091	0.0182	0.0046	0.0091	0.0455	0.0091	0.0091	0.0455	0.4554	0.4554	
QTZ-133	15/07/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.0035	0.0528	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	5.56	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2385	15/07/2005	Mill-TSP	24.0	0.0347	1.39	0.0139	0.0167	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.8333	0.0139	0.1806	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2384	15/07/2005	Mill-PM10	24.0	0.0347	1.39	0.0035	0.0097	0.0035	2.78	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.9722	0.0139	0.1111	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0278	0.0069	0.0347	0.3472	0.3472	
G2387	15/07/2005	NW Pond-TSP	24.0	0.0347	1.39	0.0035	0.0125	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.9722	0.0139	0.6528	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0139	0.0069	0.0347	0.3472	0.3472	
G2386	15/07/2005	NW Pond-PM10	24.0	0.0347	1.39	0.0035	0.0125	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	4.17	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2389	21/07/2005	South Pond - TSP	24.0	0.0347	1.39	0.0569	0.0750	0.0035	5.56	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	1.2500	0.0833	0.0139	12.50	0.0069	0.0139	0.0035	0.0069	0.0347	0.0139	0.0069	0.0347	0.3472	0.3472	
G2388	21/07/2005	South Pond - PM10	24.0	0.0347	1.39	0.0181	0.0903	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.9722	0.0139	0.0139	13.89	0.0069	0.0139	0.0035	0.0069	0.0347	0.0139	0.0069	0.0347	0.3472	0.3472	
G2391	21/07/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.0403	0.0917	0.0035	5.56	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	1.5278	0.0139	0.0139	13.89	0.0069	0.0139	0.0035	0.0069	0.0347	0.0278	0.0069	0.0347	0.3472	0.3472	
G2390	21/07/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.0035	0.0597	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.8333	0.0139	0.0139	9.72	0.0069	0.0139	0.0035	0.0069	0.0347	0.0139	0.0069	0.0347	0.3472	0.3472	
G2393	21/07/2005	Mill-TSP	18.1	0.0460	1.84	0.0184	0.1400	0.0046	9.21	0.0009	0.0046	0.0460	0.0460	1.84	0.0046	1.84	2.3941	0.0368	0.0184	18.42	0.0092	0.0184	0.0046	0.0092	0.0460	0.0368	0.0092	0.0460	0.4604	0.4604	
G2392	21/07/2005	Mill-PM10	13.9	0.0600	2.40	0.0060	0.1391	0.0060	7.19	0.0012	0.0060	0.0600	0.0600	2.40	0.0060	2.40	1.1990	0.0240	0.0240	21.58	0.0120	0.0240	0.0060	0.0120	0.0600	0.0240	0.0120	0.0600	0.5995	0.5995	
G2395	21/07/2005	NW Pond-TSP	4.0	0.2083	8.33	**0.6333**	0.5333	**0.0208**	41.67	0.0042	0.0208	0.2083	0.2083	**8.33**	0.0208	8.33	9.1667	0.2500	0.0833	75.00	0.0417	0.0833	0.0208	0.0417	0.2083	0.1667	0.0417	0.2083	2.0833	2.0833	
G2394	21/07/2005	NW Pond-PM10	23.5	0.0355	1.42	0.0035	0.0780	0.0035	4.26	0.0007	0.0035	0.0355	0.0355	1.42	0.0035	1.42	0.8511	0.0142	0.0142	11.35	0.0071	0.0142	0.0035	0.0071	0.0355	0.0142	0.0071	0.0355	0.3546	0.3546	

TABLE 4.6 (Cont'd)
AMBIENT AIR METAL CONCENTRATIONS AT THE ON-SITE MONITORING LOCATIONS (Mini-Vol samplers)

Filter ID	Start Date	Location	Sampling Duration (hrs)	Ag	Al	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Mo	Na	Ni	Pb	Sb	Se	Sn	Sr	V	W	Zn	Zr	Comment
G2534	02/08/2005	South Pond - TSP	24.0	0.0347	1.39	0.0035	0.1028	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	12.50	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2533	02/08/2005	South Pond - PM10	24.0	0.0347	1.39	0.0035	0.0667	0.0035	5.56	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.9722	0.0139	0.0139	15.28	0.0069	0.0139	0.0035	0.0069	0.0347	0.0278	0.0069	0.0347	0.3472	0.3472	
G2536	02/08/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.0097	0.1014	0.0035	5.56	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.9722	0.0139	0.0139	12.50	0.0069	0.0139	0.0035	0.0069	0.0347	0.0139	0.0069	0.0347	0.3472	0.3472	
G2535	02/08/2005	B3 Pit -PM10	17.2	0.0484	1.94	0.0048	0.1570	0.0048	7.75	0.0010	0.0048	0.0484	0.0484	**7.75**	0.0048	1.94	1.1628	0.3488	0.0194	21.32	0.0097	0.0194	0.0048	0.0097	0.0484	0.0388	0.0097	0.0484	0.4845	0.4845	
G2538	02/08/2005	Mill-TSP	18.8	0.0443	1.77	0.0044	0.1365	0.0044	7.09	0.0009	0.0044	0.0443	0.0443	1.77	0.0044	1.77	1.0638	0.0177	0.0177	15.96	0.0089	0.0177	0.0044	0.0089	0.0443	0.0177	0.0089	0.0443	0.4433	0.4433	
G2537	02/08/2005	Mill-PM10	24.0	0.0347	1.39	0.0035	0.1000	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.6944	0.0139	0.0139	13.89	0.0069	0.0139	0.0035	0.0069	0.0347	0.0139	0.0069	0.0347	0.3472	0.3472	
G2542	02/08/2005	NW Pond-TSP	21.1	0.0395	1.58	0.0142	0.1122	0.0039	6.32	0.0008	0.0039	0.0395	0.0395	1.58	0.0039	1.58	1.1058	0.0158	0.0158	15.80	0.0158	0.0158	0.0039	0.0079	0.0395	0.0316	0.0079	0.0395	0.3949	0.3949	
G2541	02/08/2005	NW Pond-PM10	24.0	0.0347	1.39	0.0035	0.0861	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	12.50	0.0069	0.0139	0.0035	0.0069	0.0347	0.0139	0.0069	0.0347	0.3472	0.3472	
G2584	08/08/2005	South Pond - TSP	14.1	0.0591	2.36	**0.8511**	0.0059	0.0059	9.46	0.0012	0.0189	0.0591	0.0591	**18.91**	0.0059	2.3641	5.4374	0.2128	0.0236	2.36	0.0236	0.0946	0.0402	0.0118	0.0591	0.0118	0.0118	0.0591	0.5910	0.5910	Need to complete battery check
G2583	08/08/2005	South Pond - PM10	24.0	0.0347	1.39	0.1458	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	**4.17**	0.0035	1.3889	0.9722	0.0278	0.0139	1.39	0.0069	0.0139	0.0083	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2586	08/08/2005	B3 Pit -TSP	16.5	0.0505	2.02	0.1879	0.0051	0.0051	2.02	0.0010	0.0051	0.0505	0.0505	**4.04**	0.0051	2.0202	0.5051	0.0202	0.0202	2.02	0.0101	0.0202	0.0051	0.0101	0.0505	0.0101	0.0101	0.0505	0.5051	0.5051	
G2585	08/08/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.0653	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2588	08/08/2005	Mill-TSP	24.0	0.0347	1.39	0.1069	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2587	08/08/2005	Mill-PM10	24.0	0.0347	1.39	0.0264	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2590	08/08/2005	NW Pond-TSP	24.0	0.0347	1.39	**0.5361**	0.0035	0.0035	5.56	0.0007	0.0069	0.0347	0.0347	**11.11**	0.0035	1.3889	2.5000	0.1111	0.0139	1.39	0.0139	0.0694	0.0181	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2589	08/08/2005	NW Pond-PM10	21.9	0.0381	1.52	0.1629	0.0038	0.0038	1.52	0.0008	0.0038	0.0381	0.0381	3.04	0.0038	1.5221	0.7610	0.0152	0.0152	1.52	0.0076	0.0152	0.0091	0.0076	0.0381	0.0076	0.0076	0.0381	0.3805	0.3805	
G2592	14/08/2005	South Pond - TSP	24.0	0.0347	27.78	**0.5153**	0.0035	0.0035	11.67	0.0007	0.0085	0.0347	0.0347	**13.19**	0.0035	1.3889	5.4028	0.2278	0.0139	1.39	0.0139	0.0389	0.0375	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	1708 ok
G2591	14/08/2005	South Pond - PM10	24.0	0.0347	1.39	**0.3347**	0.0097	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	**8.33**	0.0035	1.3889	2.7778	0.0833	0.0139	1.39	0.0069	0.0417	0.0236	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	Battery 1714 ok
G2594	14/08/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.2889	0.0083	0.0035	2.78	0.0007	0.0035	0.0347	0.0347	**6.94**	0.0035	1.3889	1.5278	0.0556	0.0139	1.39	0.0069	0.0417	0.0236	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	2542 ok
G2593	14/08/2005	B3 Pit -PM10	15.2	0.0548	2.19	0.1667	0.0055	0.0055	2.19	0.0011	0.0055	0.0548	0.0548	**4.39**	0.0055	2.1930	0.5482	0.0219	0.0219	2.19	0.0110	0.0219	0.0132	0.0110	0.0548	0.0110	0.0110	0.0548	0.5482	0.5482	1713 short
G2596	14/08/2005	Mill-TSP	24.0	0.0347	1.39	0.1042	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0069	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	2536 ok
G2595	14/08/2005	Mill-PM10	24.0	0.0347	1.39	0.0333	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	2537 ok
G2598	14/08/2005	NW Pond-TSP	24.0	0.0347	1.39	**0.5944**	0.0083	0.0035	5.56	0.0007	0.0097	0.0347	0.0347	**12.50**	0.0035	1.3889	3.3333	0.1250	0.0139	1.39	0.0069	0.0833	0.0472	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	1705 ok
G2597	14/08/2005	NW Pond-PM10	14.9	0.0559	2.24	0.2215	0.0056	0.0056	2.24	0.0011	0.0056	0.0559	0.0559	**6.71**	0.0056	2.2371	1.3423	0.0447	0.0224	2.24	0.0224	0.0224	0.0157	0.0112	0.0559	0.0112	0.0112	0.0559	0.5593	0.5593	1706 short
G2600	20/08/2005	South Pond - TSP	24.0	0.0347	1.39	0.1653	0.0035	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	**5.56**	0.0035	1.3889	1.9444	0.0833	0.0139	1.39	0.0069	0.0139	0.0139	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2599	20/08/2005	South Pond - PM10	24.0	0.0347	1.39	0.0319	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2602	20/08/2005	B3 Pit -TSP	24.0	0.0347	2.78	**0.4819**	0.0035	0.0035	8.33	0.0007	0.0083	0.0347	0.0347	**12.50**	0.0035	1.3889	4.0278	0.1389	0.0139	1.39	0.0139	0.0417	0.0278	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2601	20/08/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.1389	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	**4.17**	0.0035	1.3889	0.9722	0.0278	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	2543 ok
G2604	20/08/2005	Mill-TSP	24.0	0.0347	1.39	0.1375	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	**4.17**	0.0035	1.3889	1.3889	0.0417	0.0139	1.39	0.0069	0.0139	0.0069	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2603	20/08/2005	Mill-PM10	24.0	0.0347	1.39	0.0083	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2606	20/08/2005	NW Pond-TSP	24.0	0.0347	1.39	**0.5333**	0.0035	0.0035	6.94	0.0007	0.0083	0.0347	0.0347	**12.50**	0.0035	1.3889	3.6111	0.1389	0.0139	1.39	0.0139	0.0556	0.0444	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2605	20/08/2005	NW Pond-PM10	8.5	0.0980	3.92	0.0588	0.0098	0.0098	3.92	0.0020	0.0098	0.0980	0.0980	3.92	0.0098	3.9216	0.9804	0.0392	0.0392	3.92	0.0196	0.0392	0.0098	0.0196	0.0980	0.0196	0.0196	0.0980	0.9804	0.9804	1712 short
G2608	26/08/2005	South Pond - TSP	24.0	0.0347	1.39	0.2944	0.0035	0.0035	8.33	0.0007	0.0035	0.0347	0.0347	**9.72**	0.0035	1.3889	3.7500	0.1528	0.0139	1.39	0.0139	0.0139	0.0486	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2607	26/08/2005	South Pond - PM10	24.0	0.0347	1.39	0.0222	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	Batteries ok
G2610	26/08/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.1194	0.0069	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	**4.17**	0.0035	1.3889	2.0833	0.0556	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2609	26/08/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.0194	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2612	26/08/2005	Mill-TSP	24.0	0.0347	1.39	0.0444	0.0035	0.0035	1.39	0.0007	0.0736	0.0347	0.0347	1.39	0.0035	1.3889	1.1111	0.0278	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2611	26/08/2005	Mill-PM10	24.0	0.0347	1.39	0.0236	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2613	26/08/2005																														Blank
G2614	26/08/2005	NW Pond-PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	Sampler 3728 was used for PM10; 3729 was taken out - timer is to be replaced

TABLE 4.6 (Cont'd)
AMBIENT AIR METAL CONCENTRATIONS AT THE ON-SITE MONITORING LOCATIONS (Mini-Vol samplers)

Filter ID	Start Date	Location	Sampling Duration (hrs)	Ag	Al	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K	Mg	Mn	Mo	Na	Ni	Pb	Sb	Se	Sn	Sr	V	W	Zn	Zr	Comment
G2616	01/09/2005	South Pond - TSP	24.0	0.0347	1.39	0.0167	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.8333	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2615	01/09/2005	South Pond - PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	Batteries ok
G2618	01/09/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2617	01/09/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2620	01/09/2005	Mill-TSP	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2619	01/09/2005	Mill-PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2621	01/09/2005	NW Pond-PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2623	07/09/2005	South Pond - TSP	24.0	0.0347	1.39	0.0125	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347		0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2622	07/09/2005	South Pond - PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2625	07/09/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.0125	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2624	07/09/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2627	07/09/2005	Mill-TSP	24.0	0.0347	1.39	0.0083	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2626	07/09/2005	Mill-PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2629	07/09/2005	NW Pond-TSP	14.9	0.0559	2.24	0.0358	0.0056	0.0056	2.24	0.0011	0.0056	0.0559	0.0559	2.24	0.0056	2.2371	0.5593	0.0224	0.0224	2.24	0.0112	0.0224	0.0056	0.0112	0.0559	0.0112	0.0112	0.0559	0.5593	0.5593	
G2628	07/09/2005	NW Pond-PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.3889	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2631	13/09/2005	South Pond - TSP	24.0	0.0347	1.39	0.1250	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2630	13/09/2005	South Pond - PM10	23.1	0.0361	1.44	0.0880	0.0036	0.0036	1.44	0.0007	0.0036	0.0361	0.0361	1.44	0.0036	1.44	0.3608	0.0144	0.0144	1.44	0.0072	0.0144	0.0036	0.0072	0.0361	0.0072	0.0072	0.0361	0.3608	0.3608	
G2633	13/09/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.0361	0.0083	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	1.1111	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0278	0.0069	0.0347	0.3472	0.3472	
G2632	13/09/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2635	13/09/2005	Mill-TSP	24.0	0.0347	1.39	0.0264	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2634	13/09/2005	Mill-PM10	24.0	0.0347	1.39	0.0361	0.0083	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	1.1111	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0278	0.0069	0.0347	0.3472	0.3472	
G2637	13/09/2005	NW Pond-TSP																													Battery 1711
G2636	13/09/2005	NW Pond-PM10	24.0	0.0347	1.39	0.0556	0.0069	0.0035	2.78	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.8333	0.0139	0.0139	1.39	0.0278	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2639	19/09/2005	South Pond - TSP	24.0	0.0347	1.39	0.0264	0.0035	0.0035	4.17	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0139	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2638	19/09/2005	South Pond - PM10	24.0	0.0347	1.39	0.0611	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2641	19/09/2005	B3 Pit -TSP	24.0	0.0347	1.39	0.0278	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2640	19/09/2005	B3 Pit -PM10	24.0	0.0347	1.39	0.0319	0.0083	0.0035	2.78	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.9722	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2643	19/09/2005	Mill-TSP	24.0	0.0347	1.39	0.0035	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2642	19/09/2005	Mill-PM10	24.0	0.0347	1.39	0.0139	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2645	19/09/2005	NW Pond-TSP	24.0	0.0347	1.39	0.0292	0.0035	0.0035	6.94	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0139	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	
G2644	19/09/2005	NW Pond-PM10	24.0	0.0347	1.39	0.0319	0.0035	0.0035	1.39	0.0007	0.0035	0.0347	0.0347	1.39	0.0035	1.39	0.3472	0.0139	0.0139	1.39	0.0069	0.0139	0.0035	0.0069	0.0347	0.0069	0.0069	0.0347	0.3472	0.3472	

Note: Exceedances are indicated in bold.

TABLE 4.7
AMBIENT AIR METAL CONCENTRATIONS FOR SAMPLES COLLECTED AT THE GIANT MINE TOWNSITE (Hi-Vol samplers)

Sample ID	H1834	H1835	H1836	H1837	H1838	H1839	H1840	H1841	H2396	H2397	H2401	H2400	H2402	H2403	H2404	Max	Limit
Sampling Start Date	21/06/2005	27/06/2005	03/07/2005	09/07/2005	15/07/2005	21/07/2005	27/07/2005	02/08/2005	08/08/2005	14/08/2005	20/08/2005	26/08/2005	01/09/2005	07/09/2005	13/09/2005		
Duration of Sampling (hrs)	20.71	20.56	20.60	24.16	20.01	23.70	23.73	26.22	23.89	23.89	23.79	23.91	23.82	23.77	23.83		
Ag	0.0002	0.0002	0.0002	0.0001	0.0005	0.0004	0.0004	0.0007	0.0002	0.0002	0.0010	0.0002	0.0010	0.0007	0.0002	0.0010	1
Al	0.1259	0.3170	0.1125	0.1679	0.1593	0.1345	0.0916	0.0387	0.2304	0.0909	0.0548	0.3756	0.0608	0.1158	0.0869	0.3756	100
As	0.0185	0.0080	0.0028	0.0041	0.0059	0.0043	0.0030	0.0020	0.0477	0.0050	0.0016	0.0140	0.0013	0.0013	0.0011	0.0477	0.3
Ba	0.0067	0.0088	0.0095	0.0074	0.0096	0.0076	0.0077	0.0068	0.0096	0.0097	0.0090	0.0106	0.0095	0.0112	0.0133	0.0133	10
Be	0.00002	0.00002	0.00002	0.00001	0.00002	0.00002	0.00002	0.00001	0.00002	0.00002	0.00004	0.00004	0.00004	0.0001	0.0001	0.0001	0.01
Ca	0.4267	0.7116	0.4008	0.4856	0.5502	0.4095	0.3418	0.2541	0.7579	0.3638	0.2740	0.7391	0.2919	0.4327	0.7040	0.7579	n/a
Cd	0.000003	0.000004	0.000004	0.000003	0.0001	0.0000	0.0001	0.0001	0.0001	0.00005	0.00002	0.0005	0.00002	0.00002	0.00002	0.0005	2
Co	0.0003	0.0003	0.0001	0.0002	0.0002	0.0001	0.0001	0.0000	0.0008	0.0001	0.0001	0.0004	0.0000	0.0001	0.0001	0.0008	0.1
Cr	0.0027	0.0042	0.0032	0.0032	0.0038	0.0029	0.0026	0.0024	0.0041	0.0024	0.0015	0.0026	0.0019	0.0021	0.0025	0.0042	1.5
Cu	0.0727	0.0399	0.0619	0.0557	0.0601	0.0393	0.0543	0.0586	0.0542	0.0776	0.0414	0.0666	0.0604	0.0658	0.0636	0.0776	50
Fe	0.4267	0.5495	0.1477	0.2818	0.2896	0.2384	0.1587	0.0884	0.9823	0.1637	0.0792	0.6543	0.0669	0.1767	0.1304	0.9823	4
Hg	0.00002	0.00002	0.00002	0.00001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.00002	0.00002	0.00002	0.00002	0.0001	0.0001	2
K	0.0350	0.0070	0.0070	0.00600	0.0652	0.0306	0.0549	0.0718	0.0485	0.0424	0.0426	0.1212	0.0608	0.0731	0.0435	0.1212	n/a
Mg	0.1413	0.2973	0.1125	0.1643	0.1607	0.1302	0.0830	0.0464	0.2692	0.0764	0.0633	0.3574	0.0632	0.1115	0.2590	0.3574	2.5
Mn	0.0048	0.0090	0.0028	0.0050	0.0049	0.0039	0.0023	0.0014	0.0099	0.0025	0.0013	0.0105	0.0013	0.0034	0.0025	0.0105	120
Mo	0.0002	0.0003	0.0002	0.0002	0.0005	0.0004	0.0004	0.0003	0.0002	0.0004	0.0003	0.0003	0.0003	0.0003	0.0004	0.0005	n/a
Na	0.8043	1.1132	1.0126	0.8454	1.0786	0.9107	0.8790	0.7237	0.9034	0.8852	0.8342	0.8542	0.8088	0.9324	1.0169	1.1132	2
Ni	0.0020	0.0022	0.0018	0.0022	0.0028	0.0017	0.0014	0.0011	0.0020	0.0007	0.0009	0.0016	0.0009	0.0009	0.0010	0.0028	2
Pb	0.0027	0.0025	0.0027	0.0058	0.0034	0.0010	0.0018	0.0008	0.0063	0.0013	0.0006	0.0018	0.0005	0.0010	0.0012	0.0063	2
Sb	0.0005	0.0001	0.00002	0.00001	0.0002	0.0002	0.0002	0.0002	0.0052	0.0004	0.0000	0.0006	0.00003	0.0001	0.0001	0.0052	25
Se	0.00003	0.00004	0.00004	0.00003	0.00004	0.00003	0.00003	0.00003	0.00003	0.00003	0.0001	0.0002	0.00003	0.0002	0.0002	0.0002	10
Sn	0.0002	0.0002	0.00018	0.00015	0.0006	0.0002	0.0002	0.0001	0.00015	0.0002	0.0002	0.0002	0.00015	0.0002	0.0002	0.0006	10
Sr	0.0010	0.0015	0.0011	0.0012	0.0010	0.0004	0.0004	0.0004	0.0009	0.0006	0.0007	0.0023	0.0007	0.0011	0.0012	0.0023	120
V	0.0001	0.0009	0.0001	0.0004	0.0005	0.0004	0.0003	0.0001	0.0008	0.0003	0.0001	0.0011	0.00003	0.0002	0.0001	0.0011	2
W	0.0002	0.0002	0.0002	0.0001	0.0002	0.0002	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.00015	0.0002	0.0002	0.0002	n/a
Zn	0.0371	0.0324	0.0295	0.0264	0.0304	0.0147	0.0140	0.0122	0.0273	0.0212	0.0195	0.0279	0.0207	0.0219	0.0322	0.0371	120
Zr	0.0017	0.0018	0.0018	0.0015	0.0018	0.0015	0.0015	0.0014	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0022	0.0022	n/a

Note: All values are in µg/m^3

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

As a part of the Giant Mine Remediation Project (GMRP), an air quality-monitoring program was devised and carried out during the summers of 2004 and 2005 to establish a baseline for the fugitive emissions from the tailings areas and other disturbed areas at the mine site. This report pertains to the sampling program carried out in 2005. The 2005 program was carried out from June through September and consisted of ambient air monitoring of TSP at the nearest residential location in the Giant Mine Town site and simultaneous ambient air monitoring of TSP and PM_{10} at four other locations within the property boundary of the Giant Mine site. The sampling was done to determine total and inhalable particulate loading, as well as the concentrations of inorganic trace element constituents, such as arsenic.

The 2005 suspended particulate monitoring results indicate that the concentrations at the five sampling locations vary considerably with respect to average and maximum TSP and PM_{10} concentrations. The Giant Mine Town Site results were low in comparison to the onsite monitoring locations. The Northwest Pond site had the highest TSP concentrations of the five TSP monitoring locations and the South Pond site had the highest PM_{10} concentrations of the four PM_{10} monitoring locations.

The analyses of inorganic elements indicated that, with the exception of arsenic, iron, and beryllium, all other concentrations were below their applicable AAQC. There was one beryllium exceedance on July 21st, 2005. The iron concentrations were consistently in exceedance of the AAQC from July 21st through August 26th, 2005. The arsenic AAQC of 0.3 µg/m^3 was exceeded 4 times at the Northwest Pond, on July 21st and August 8th, 14th and 20th, 2005. In addition, the August 8th and 14th South Pond samples and August 20th sample at the B3 Pit were above the arsenic AAQC. Results also indicate that the arsenic levels were noticeably higher at the South Pond and Northwest Pond than at the other two onsite sampling locations, suggesting contributions from the South Pond and Northwest Pond, respectively. While the highest arsenic concentration, was reported for the South Pond the Northwest Pond had the higher overall average arsenic concentrations and a greater frequency of exceedances.

Overall the 2005 results indicated noticeably higher ambient concentrations of TSP, PM_{10}, arsenic and iron than the 2004 results. There were numerous exceedances of TSP, PM_{10}, arsenic and iron. Most of the arsenic exceedances occurred at the monitoring locations 2 (south of the South Pond) and 3 (south of Northwest Pond), suggesting contributions from the South Tailings Pond and the Northwest Tailings Pond, respectively.

The 2005 arsenic concentrations in TSP and PM_{10} (measured at all onsite monitoring locations) were highly variant but on average indicate that more than half of the measured ambient arsenic concentration is contained within the course particles.

The higher concentrations reported in 2005 can in large part be attributed to onsite activities. The site entered into a new care and maintenance contract on July 1st, 2005 which resulted in increased road maintenance throughout the property. Specifically, the main roads were graded and additional gravel was added in places. In addition, a significant amount of work in the core area of the mine site occurred during August 2005. This work consisted of removing an existing utilidor (wood and insulation) and the associated water and steam lines. Grinders and saws were used to cut the steel pipes. The elevated ambient air suspended particulate as well as the iron concentrations in the suspended particulate correlate well with these onsite activities.

5.2 RECOMMENDATIONS

Based on the 2005 monitoring results, it is recommended that the ambient air-monitoring program be continued for the period prior to as well as during the remediation activities at the Giant Mine site. Since arsenic in TSP provides a better measure of the day-to-day fluctuations in ambient arsenic concentrations, TSP sampling is more useful in determining from which source(s) the arsenic is likely to have originated. Since one of the objectives of the sampling program is to assess harmful levels of exposure to arsenic in ambient air, PM_{10} sampling would be a more appropriate measure of exposure, as the TSP sampling may overestimate exposure levels by a factor of at least 2, on average. Therefore, it is recommended that the simultaneous sampling of TSP and PM_{10} at all onsite sampling locations be continued for subsequent monitoring at this site.

The following improvements to the monitoring program are recommended:

- When assessing the contributions of different onsite sources to the ambient air suspended particulate levels, it is useful to have site reconnaissance information for each sampling day. Therefore, it is recommended that a site activity log be prepared by onsite personnel, which would record date, time and duration of all onsite activities, including those that at first may seem not to contribute to ambient suspended particulate levels (e.g. fire training).

- The 2005 monitoring data had numerous failed samplings, which were mainly attributed to equipment malfunction. Since the sampling is carried out from midnight to midnight, it may be beneficial to check-up on the samplers, early on the sampling days to ensure that the units are working properly. More frequent maintenance of the sampling equipment may also improve equipment reliability.

- Similar to 2004, there were a few cases in which the concentrations of PM_{10} were higher than TSP. The concentrations reported for these samples were quite low, and thus the higher PM_{10} concentrations are most likely attributed to analytical errors. Nevertheless, it would be helpful to regularly clean and re-grease the impactors for the PM_{10} Mini-Vol samplers to ensure proper split of the suspended particulates that is drawn in through the sampling head.

6.0 REFERENCES

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APPENDIX A

MINI-VOL AIR SAMPLING PROCEDURE

APPENDIX A MINI-VOL AIR SAMPLING PROCEDURE

The AirMetrics Mini-Vol is a portable sampling device that can be used to sample Total Suspended Particulates (TSP), Particulate Matter less than 10 µm (PM_{10}, also known as inhalable particulates) and Particulate Matter less than 2.5 µm ($PM_{2.5}$, also known as respirable particulates). The sampler can be powered using DC power from the rechargeable batteries supplied with the unit, or AC power, by plugging the charger into an AC source.

The pieces of equipment required are:

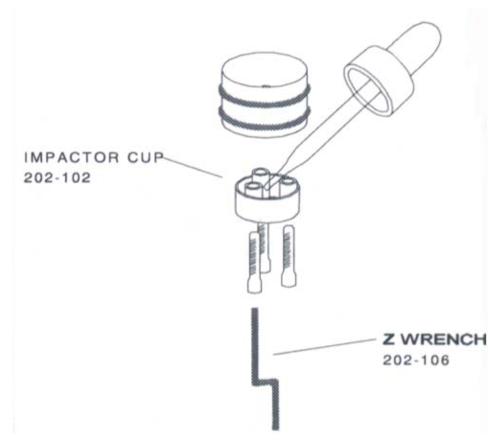
- 1 Mini-Vol pump module
- 2 battery packs
- 1 battery charger/transformer
- 1 tube of impactor grease
- hexane solvent
- 47 mm filters
- 1 field calibration kit including calibration orifice and flow measurement device (magnahelic or manometer)
- 1 tripod (for indoor or sampling in a protected area)
- 2 filter holder assemblies
- 2 PM_{10} impactor assemblies
- 2 $PM_{2.5}$ impactor assemblies
- 2 multi-impactor adaptors
- 2 rain hats
- 1 mounting cradle
- 1 mounting bracket and hoisting pole assembly (for mounting unit on high poles)

In order to successfully implement a sampling programme, the following steps should be followed:

1. Purchase 47 mm filters. The filter media chosen depends on the type of post-sampling analyses to be completed. For example, if only the particulate concentrations are required, choose glass fibre filters. If particulate sulphate concentrations or metals components are required, quartz, Teflon membrane or Teflon-coated glass fibre filters are more appropriate.
2. Send the filters to an accredited laboratory for numbering, conditioning and pre-weighing, OR
   - Label each filter with a unique identification number, place them in a desiccator and allow it to equilibrate for a minimum of 24 hours. After desiccation, immediately weigh the filters on a scale accurate to 1 µg and record the weight. Place the filters in a storage case (e.g. petri-slides). Filters should be handled with forceps to prevent contamination.
3. Charge the battery (ies) for a minimum of 18 hours prior to sampling. Check to ensure that the pump and programmer/timer work prior to transport to the field.

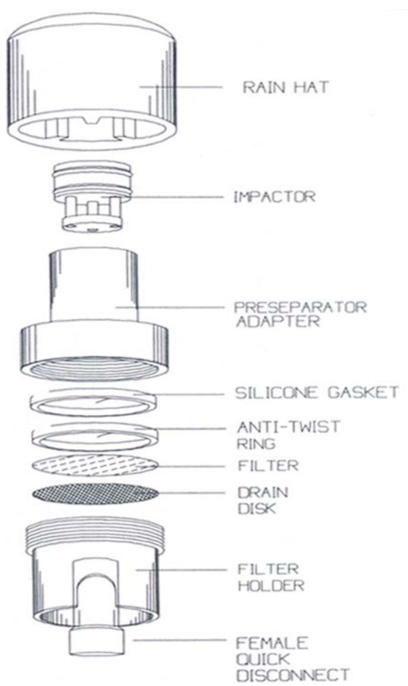
4. Prepare the sampler for initial use. Ensure that the filter holder assemblies, impactor discs and rain hats are free of dust and debris. Clean all parts with hexane to remove any grease and/or debris. Make up a suspension of 1" of impactor grease to 100 mL of hexane. Shake well until all grease is dissolved and a uniform suspension results. Use a dropper to thoroughly coat the impactor discs (both PM_{10} and $PM_{2.5}$ assemblies) with a small amount of the suspension as shown in Figure 1.

Figure 1
REGREASING $PM_{2.5}$ IMPACTOR



5. Allow the hexane to evaporate, leaving a fine film of impactor grease on the discs. All actions involving solvent use should be completed in a fume hood or a well-ventilated area. The PM_{10} and $PM_{2.5}$ impactor assemblies and discs should be cleaned with hexane solvent and recoated with impaction grease solution after every seventh use, or sooner if noticeable build-up of particulate occurs.

Figure 2
PM_{10} PRESEPARATOR AND FILTER HOLDER ASSEMBLY



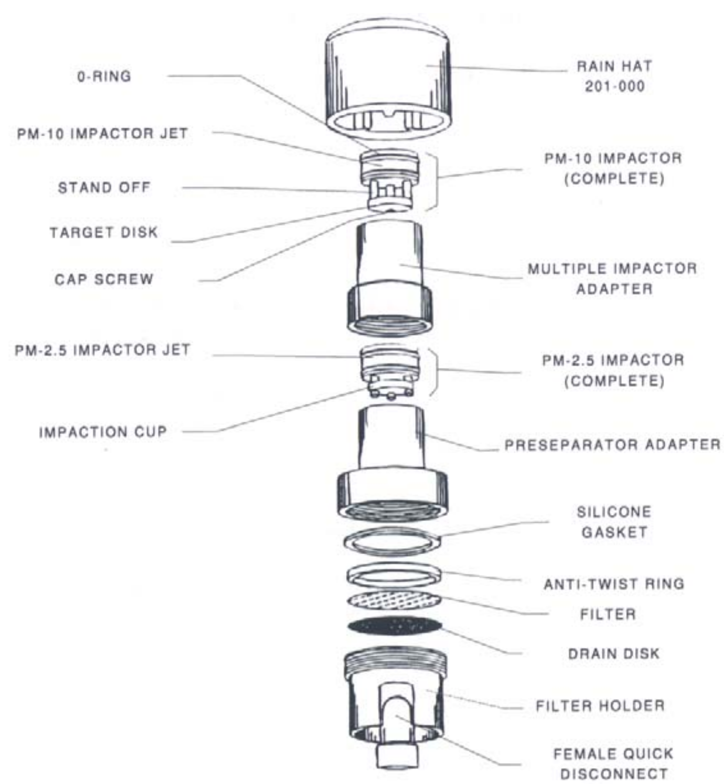
6. Assemble the filter holder and impactor assemblies. Unscrew the filter holder assembly and remove the drain disc filter support screen assembly. Use a narrow, flat edge (such as a flat head screwdriver) to pop the filter support ring off, and place a preweighed, numbered filter on the support screen rough side up. Place the support ring back on, taking care not to twist or damage the filter. Place the support assembly back into the bottom portion of the filter holder.

   - If TSP sampling is desired, screw the filter holder assembly together and place a rain hat over the top of the assembly.
   - If PM_{10} sampling is desired, slide the PM_{10} impactor assembly (the one with the larger funnel hole) into the top portion of the filter holder assembly, such that the top of the

impactor is flush with the top of the holder assembly. This impactor causes all particles greater than 10 µm to impact on and stick to the disc at the bottom. Only particle 10 µm and less flow through to the filter. Screw the holder assembly together and place a rain hat over the top of the filter holder assembly. See Figure 2 for further detail.

- If $PM_{2.5}$ sampling is desired, slide the $PM_{2.5}$ impactor assembly (the one with the smaller funnel hole) into the top portion of the filter holder assembly, such that the top of the impactor is flush with the top of the holder assembly. This impactor causes all particles greater than 2.5 µm to impact on and stick to the disc at the bottom. Screw the holder assembly together. Next, slide the PM_{10} impactor assembly into the second impactor holder (i.e. the one that does not have a filter holder). Ensure that the impactor assembly is flush with the top of the impactor holder. Slide the bottom of this holder over the top of the filter holder assembly, containing the $PM_{2.5}$ impactor assembly. Place a rain hat over the top of the holder containing the PM_{10} impactor assembly. This configuration works by first removing particles greater than 10 µm (i.e. they impact and stick to the PM_{10} impactor disc). Only particles 10 µm and less flow through to the second impactor assembly, where particles greater than 2.5 µm impact and stick to the $PM_{2.5}$ impactor disc. Only particles 2.5 µm and less flow through to the filter. See Figure 3 for details.

Figure 3
$PM_{2.5}$ PRESEPARATOR AND FILTER HOLDER ASSEMBLY



- Flow meter reading from the centre of the ball. Record the displayed flow and the corresponding pressure drop reading on the magnahelic, manometer, etc.
- Adjust the flow knob to decrease the flow slightly. Record the corresponding indicated flow on the flow meter and pressure drop on the magnahelic. Continue to do this for a minimum of five calibration points such that flows between approximately 4 and 7 L/min are sampled.

- Measure and record the ambient temperature and atmospheric pressure using a thermometer and a barometer (not included with the calibration kit). (NOTE: ambient pressure and temperature may be obtained from a nearby weather office if a measuring device is unavailable).
- For each calibration point, use the equation provided with the calibration orifice to calculate the actual flow rate from the indicated flow rate, magnahelic pressure drop, ambient temperature and pressure. Plot a graph of indicated flow rate versus actual flow rate and draw a line of best fit. From the graph, determine the indicated flow that corresponds to an actual flow of 5 L/min. Re-set the flow meter to the indicated flow that provides an actual flow of 5 L/min. (NOTE: THIS IS EXTREMELY IMPORTANT WHEN SAMPLING FOR PM_{10} OR $PM_{2.5}$ AS THE IMPACTOR DISCS ARE DESIGNED TO PROVIDE THE CORRECT SIZE CUTPOINT AT PRECISELY 5 L/MIN).
- Record the indicated flow rate. Turn the unit off and remove the calibration orifice and blank filter holder assembly.

7. Remove the pre-prepared filter holder assembly containing the pre-weighed filter from the protective plastic bag and attach it to the Mini-Vol using the Quick Connect fitting attached to the unit.
8. Program the timer to turn the unit on at the appropriate time as described on Page 8 of the Users Manual, or manually turn the unit on to begin sampling. Slide the pump and timer assembly back into the casing, and re-attach the carrying handle.
9. Record the filter number, battery number, sampler ID (if using more than one) and elapsed time meter reading.
10. Place the sampler in the monitoring location. The unit should be upright, in an unobstructed area at least 30 cm away from any obstacle to air flow. For ambient monitoring, place the sampler away from interferences such as buildings, chimneys, trees, etc. Equipment security should also be taken into consideration when locating sampling sites to prevent theft or vandalism.
11. Allow the unit to remain in the sampling location undisturbed for the appropriate duration. A sample duration of 24-hours is appropriate for ambient samples.
12. If an additional sample is desired, repeat Steps 3 – 7 above with the second filter holder assembly and spare battery included with the Mini-Vol.
13. After sampling has been completed, return to the site and retrieve the unit from the sampling location. Place the unit on a firm level surface. (NOTE: THE FILTERS SHOULD BE REMOVED FROM THE UNIT SHORTLY AFTER SAMPLING TO PREVENT CONTAMINATION AND/OR LOSS OF VOLATILES, ETC.)

14. Remove the carrying handle and lift the pump and timer assembly out of the casing, taking care not to pull any tubing or wires loose.
15. Check the sampler faceplate for any errors such as low battery or low flow, which causes the power to shut off and terminates sampling. Record the elapsed time.
16. Turn the unit on and record the ending flow rate. Stop the pump.
17. Remove the filter holder assembly and place into a protective plastic baggie. If another sample is required, remove the fresh filter holder assembly prepared in Step 13 above from the plastic bag and place it on the sampler. Turn the unit on briefly and record the initial flow rate. (NOTE: IF THE TEMPERATURE AND/OR PRESSURE HAS CHANGED DRAMATICALLY SINCE CALIBRATION THE UNIT SHOULD BE RE-CALIBRATED TO ENSURE THAT THE SAMPLE FLOWRATE IS SET AT 5 L/MIN)
18. Transport the used filter holder assembly to an indoor location. Remove the filter from the holder and place in a petri slide for protection prior to and during transport to the lab.
19. Continue to repeat Steps 9 through 19 for the duration of the sampling programme. Re-calibrate the unit at the end of the sampling programme. [REMEMBER TO CLEAN AND GREASE IMPACTOR DISCS EVERY 7 SAMPLES] When approximately 12 samples have been collected, send the samples back to the laboratory for post-weighing and any subsequent analyses. To prevent erroneous results due to scale errors, it is important that post-weighing be done on the same scale as the pre-weighing.
20. For each sample, calculate the average indicated flow rate from the initial and final flow readings. Use the calibration curve to convert indicated flow to actual flow. For each sample, determine the total elapsed time in minutes by subtracting the final reading on the elapsed time indicator from the initial reading. Convert to minutes. Multiply the average actual flow rate by the total elapsed time to obtain the total volume of air sampled. When the lab results are available, divide the total mass of particulate collected on the filter by the total volume of air sampled to determine the ambient particulate concentration ($\mu g/m^3$).

APPENDIX B

HI-VOL AIR SAMPLING PROCEDURE

APPENDIX B HI-VOL AIR SAMPLING PROCEDURE

High Volume (Hi-Vol) sampling is a regulatory method for determining the concentration of air particulate (dust) in an area. A Hi-Vol is essentially a giant vacuum cleaner that sucks air into it and through a pre-weighed filter. The units generally run for 24 hours. The filters are then removed and sent to a lab for post-weighing.

Sampler operation consists of the following steps:

1. After performing calibration procedure (as in the following section) , remove filter holder frame by loosening the four wing nuts allowing the brass bolts and washers to swing down out of the way. Shift frame to one side and remove.
2. Carefully center a new filter, rougher side up, on the supporting screen. Properly align the filter on the screen so that when the frame is in position the gasket will form an airtight seal on the outer edges of the filter.
3. Secure the filter with the frame, brass bolts, and washers with sufficient pressure to avoid air leakage at the edges (make sure that the plastic washers are on top of the frame).
4. Wipe any dirt accumulation from around the filter holder with a clean cloth.
5. Close shelter lid carefully and secure with the "S" hook.
6. Make sure all cords are plugged into their appropriate receptacles and the rubber tubing between the blower motor pressure tap and the TE-5009 continuous flow recorder (or TE-5008 manometer) is connected (be careful not to pinch tubing when closing door).
7. Prepare TE-5009 continuous flow recorder as follows:

   a) Clean any excess ink and moisture on the inside of recorder by wiping with a clean cloth.

   b) Depress pen arm lifter to raise pen point and carefully insert a fresh chart.

   c) Carefully align the tab of the chart to the drive hub of the recorder and press gently with thumb to lower chart center onto hub. Make sure chart is placed under the chart guide clip and the time index clip so it will rotate freely without binding. Set time by rotating the drive hub clock-wise until the correct time on chart is aligned with time index pointer.

   d) Make sure the TE-160 pen point rests on the chart with sufficient pressure to make a visible trace.
8. Prepare the Timer as instructed on the following page
9. At the end of the sampling period, remove the frame to expose the filter. Carefully remove the exposed filter from the supporting screen by holding it gently at the ends (not at the corners). Fold the filter lengthwise so that sample touches sample.

10. It is always a good idea to contact the lab you are dealing with to see how they may suggest you collect the filter and any other information that they may need.

To set up the digital timer:

1. Start with the Sampler Switch (Timed – Off – On) Switch #1, in the Off position. If you need to test or adjust the blower motor turn the Sampler switch to On. When done with adjusting, turn it back to Off.
2. Place the rotary switches in the desired positions. If today is Friday and you want the first sample time on Sunday, turn the “Sample After Days” switch to position 2. If you want to run the sampler every Sunday after that, turn the “Sample Every Days” switch to position 7, (for six day sampling use position 6). Turn “Sample for Hours” to desired number of running hours.
3. Next put the Display switch, Switch #4, in the Start Time position. Then using the Set switch, Switch #3, enter the start time, hours and minutes.
4. Next put the Display switch, Switch #4, in the Time of Day position. Then using the Set switch, Switch #3, enter the current time, hours and minutes.
5. Now press and release the Reset switch, Switch #2, toward Timer. A small triangle on the display will start blinking. This indicates the timer is running.
6. If you need to, reset the Hour Meter to zero. Press and release the reset switch, Switch #2, twice, toward Hour Meter.
7. Last thing to do is place the Sampler switch, Switch #1, (Timed – Off – On) in the Timed position.

Hi-Vol Calibration Procedure

Any instrument or mechanical device is subject to errors and/or inaccuracies in their readings. Therefore, in order to use the flow chart recorder on the Hi-Vol to determine the flow rate, the recorder must be calibrated to ensure that the actual flow rate is known (versus what is read on the charts).

The following is a step-by-step process of the calibration of a TE-5170-DV Volumetric Flow Controlled TSP Particulate Sampling System. The air flow through these types of sampling systems is controlled by a Volumetric Flow Controller (VFC) or dimensional venturi device.

This calibration differs from that of a mass flow controlled TSP sampler in that a slope and intercept does not have to be calculated to determine air flows. Also, the calibrator orifice Qactual slope and intercept from the orifice certification worksheet can be used here, unlike a mass flow controlled TSP where Qstandard slope and intercept are used. The flows are converted from actual to standard conditions when the particulate concentrations are calculated.

With a Volumetric Flow Controlled (VFC) sampler, the calibration flow rates are provided in a Flow Look Up Table that accompanies each sampler.

Proceed with the following steps to begin the calibration:

Step one: Mount the calibrator orifice and top loading adapter plate to the sampler. A sampling filter is generally not used during this procedure. Tighten the top loading adapter hold down nuts securely for this procedure to assure that no air leaks are present.

Step two: Turn on the sampler and allow it to warm up to its normal operating temperature.

Step three: Conduct a leak test by covering the holes on top of the orifice and pressure tap on the orifice with your hands. Listen for a high-pitched squealing sound made by escaping air. If this sound is heard, a leak is present and the top loading adapter hold-down nuts need to be re-tightened.

Note: Avoid running the sampler for longer than 30 seconds at a time with the orifice blocked. This will reduce the chance of the motor overheating. Also, never try this leak test procedure with a manometer connected to the pressure tap on the calibration orifice or the pressure tap on the side of the sampler. Liquid from either manometer could be drawn into the system and cause motor damage.

Step four: Connect one side of a water manometer or other type of flow measurement device to the pressure tap on the side of the orifice with a rubber vacuum tube. Leave the opposite side of the manometer open to the atmosphere.

Step five: Connect a water manometer to the quick disconnect located on the side of the aluminum outdoor shelter (this quick disconnect is connected to the pressure tap on the side of the filter holder). If using the TE-5025A (a fixed orifice that uses load plates) orifice a longer manometer is used here as there is a possibility of great pressure difference from this port.

Step six: Make sure the TE-5028A orifice is all the way open (turn the black knob counter clockwise). Record both manometer readings the one from the orifice and the other from the side of the sampler. To read a manometer one side goes up and the other side goes down you add both sides, this is your inches of water. Repeat this process for the other four points by adjusting the knob on the variable orifice (just a slight turn) to four different positions and taking four different readings. You should have five sets of numbers, ten numbers in all.

Step seven: Remove the variable orifice and the top loading adapter and install a clean filter. Record the manometer reading from the side tap on the side of the sampler. This is used to calculate the operational flow rate of the sampler.

Step eight: Record the ambient air temperature, the ambient barometric pressure, the sampler serial number, the orifice serial number, the orifice Qactual slope and intercept with date last certified, today's date, site location and the operators initials.

The first step is to convert the orifice readings to the amount of actual air flow they represent using the following equation:

$$Qa = 1/m[Sqrt((H2O)(Ta/Pa))-b]$$

where:

Qa	=	actual flow rate as indicated by the calibrator orifice, m^3/min
H_2O	=	orifice manometer reading during calibration, in. H_2O
Ta	=	ambient temperature during calibration, K (K = 273 + °C)
Pa	=	ambient barometric pressure during calibration, mm Hg
m	=	Qstandard slope of orifice calibration relationship
b	=	Qstandard intercept of orifice calibration relationship

Once these standard flow rates have been determined for each of the run points, they are recorded in the column titled Qa, and are represented in cubic meters per minute. EPA guidelines state that at least three of these calibrator flow rates should be between 1.1 to 1.7 m^3/min (39 to 60 CFM). This is the acceptable operating flow rate range of the sampler. If this condition is not met, the sampler should be recalibrated. An air leak in the calibration system may be the source of this problem. In some cases, a filter may have to be in place during the calibration to meet this condition.

The sampler H_2O readings need to be converted to mm Hg and recorded in the column titled Pf. This is done using the following equation:

$$Pf = 25.4\ (in.\ H_2O/13.6)$$

where:
Pf is recorded in mm Hg
in. H_2O = sampler side pressure reading during calibration.

Po/Pa is calculated next. This is used to locate the sampler calibration air flows found in the Look Up Table. This is done using the following equation:

$$Po/Pa = 1 - Pf/Pa$$

where:
Pa = ambient barometric pressure during calibration, mm Hg.

Using Po/Pa and the ambient temperature during the calibration, consult the Look-Up Table to find the actual flow rate. Record these flows in the column titled Look Up.

Calculate the percent difference between the calibrator flow rates and the sampler flow rates using the following equation:

$$\%\ Diff. = (Look\ Up\ Flow - Qa)/Qa * 100$$

where:
Look Up Flow = Flow found in Look Up Table, m^3/min
Qa = orifice flow during calibration, m^3/min.

The EPA guidelines state that the percent difference should be within + or - 3 or 4%. If they are greater than this, a leak may have been present during calibration and the sampler should be recalibrated. The line on the worksheet labelled Operational Flow Rate is where the side tap reading is recorded which is taken with no resistance plates under the calibration orifice. With this side tap reading, Pf and Po/Pa are calculated with the same equations listed above. This completes the calibration of this sampler.