SENES Consultants Limited

Specialists in Energy, Nuclear and Environmental Sciences

AIR QUALITY MONITORING AT GIANT MINE SITE – YELLOWKNIFE A BASELINE STUDY (Volume 7 – 2010)

Prepared for:

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1.0 INTRODUCTION

As a part of the Giant Mine Remediation Project (GMRP), and establishment of baseline conditions, the seventh round of air quality monitoring was carried out during the summer of 2010. Similar to the annual summer monitoring programs dating back to 2004, the purpose of the 2010 summer 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 2010 sampling program consisted of ambient air monitoring of TSP and PM_{10} at four locations within the boundary of the Giant Mine site. In addition, dustfall monitoring throughout the site was introduced for the 2010 sampling program. Following a meeting between Environment Canada (EC), the Government of the Northwest Territories (GNWT), and Indian and Northern Affairs Canada (INAC), the monitoring of TSP at the nearest residential location in the Giant Mine Town Site was discontinued in 2010 due to inactivity at this location. Similar to all previous monitoring campaigns, TSP and PM_{10} were monitored for 24-hours every 6^{th}-day at all four on-site sampling locations. The sampling program was undertaken to determine total and inhalable particulate loading, as well as particulate inorganic trace element (metal) content. The dustfall jars were placed at their respective sampling locations for a period of 30 days, beginning on August 6^{th}, 2010.

This report provides details of the monitoring program, the results and discussion of the findings, comparisons between 2010 data and data from the previous monitoring programs, as well as conclusions and recommendations. Reference should be made to the reports entitled "*Air Quality Monitoring at Giant Mine Site – Yellowknife, A Baseline Study Volume 1* though to *Volume 6* for details on the monitoring programs from 2004 through to 2009, respectively.

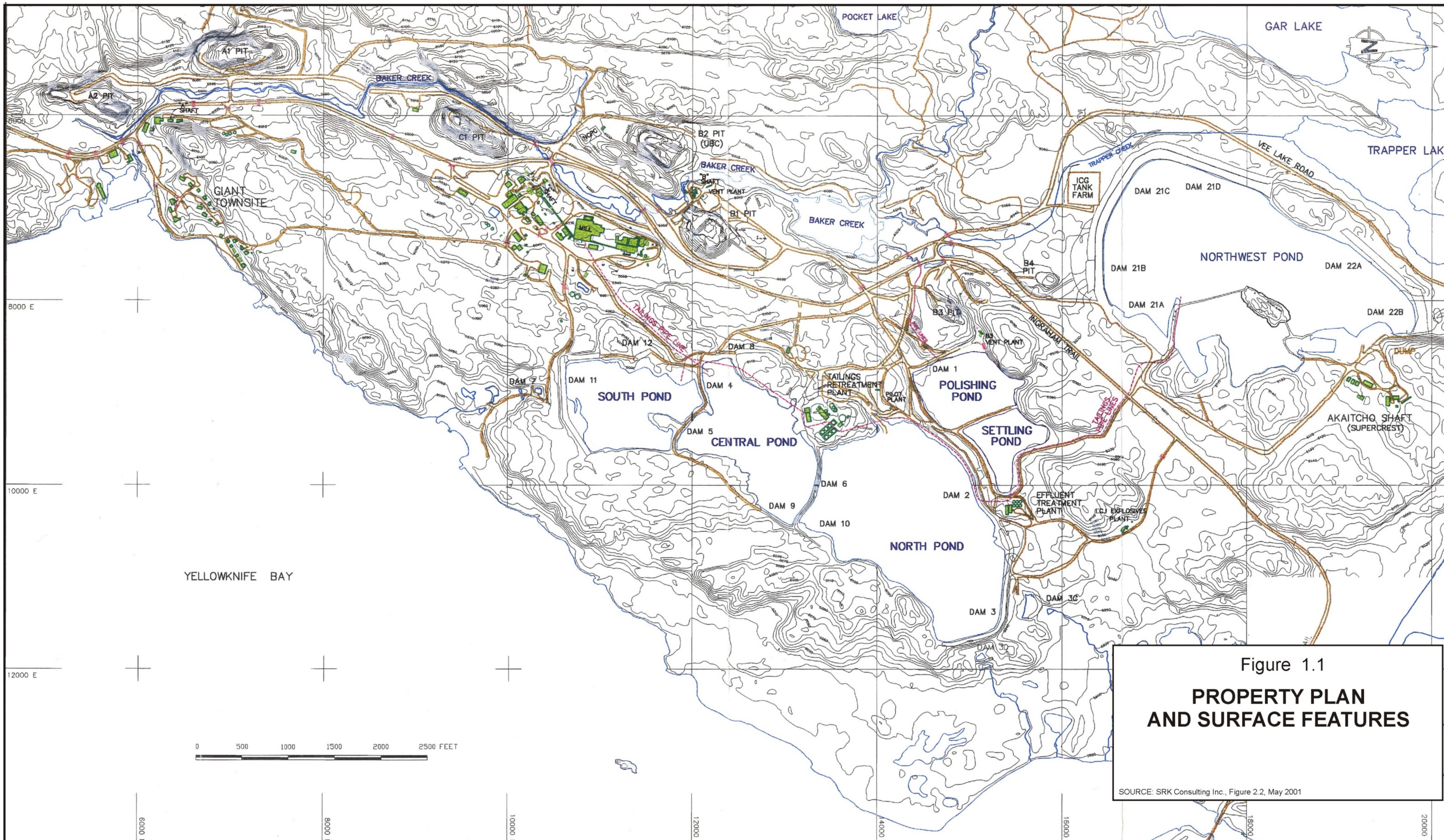
1.1 OVERVIEW OF THE GIANT MINE REMEDIATION PROJECT

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 continue 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, now INAC). 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, as the agreement concluded June 2005, INAC funds the ongoing care and maintenance necessary to protect public health and safety as well as to maintain environmental compliance at the mine.

INAC 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.

Figure 1.1 – Property Plan and Surface Features



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 each year since 2004. Simultaneous sampling of TSP and PM_{10} began in 2004 at one location only. The 2004 results indicated that 75% of the arsenic appeared to be associated with the coarse particles in TSP. In light of the health-related importance of the PM_{10} (inhalable) fraction, it was recommended that the monitoring program be modified to conduct simultaneous monitoring of TSP and PM_{10} at all of the on-site monitoring locations. This was implemented during the 2005 sampling program and has continued through all of the monitoring programs since.

In 2010, monitoring of dustfall throughout the site commenced. Also, the off-site TSP monitoring location at the Giant Mine Townsite was removed from the program in 2010 due to inactivity at this location. This decision was supported by EC and the GNWT.

This summary report for the 2010 monitoring program 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 2010 results. Section 5 provides a comparison analysis between the current and historical 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 that are 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 PM_{10} objective/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 (see Table 2.1).

Table 2.1 – Ambient Air Quality Criteria for TSP and PM_{10}

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

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 quality criteria, as defined in the MOE's 2008 Ambient Air Quality Criteria (AAQCs) document (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)] ($\mu g/m^3$)
Aluminium	n/a
Antimony	25 (incl. compounds)
Arsenic	0.3 (incl. compounds)
Barium	10 (total water soluble)
Beryllium	0.01 (incl. compounds)
Boron	120
Cadmium	0.025 (incl. compounds)
Calcium	n/a
Chromium	1.5 (di and trivalent forms)
Cobalt	0.1
Copper	50
Iron	4 (metallic)
Lead	0.5 (and lead compounds)
Manganese	2.5 (compounds, including permanganates)
Molybdenum	120
Nickel	2
Potassium	n/a
Selenium	10
Silver	1
Strontium	120
Tellurium	10
Tin	10
Vanadium	2
Zinc	120

(1) Ontario Ministry of the Environment's Ambient Air Quality Criteria (Feb. 2008)

2.3 DUSTFALL

The NWT does not currently have a standard for total dustfall or any specific constituents of dustfall (i.e., trace metals). A literature review revealed that very few jurisdictions have established standards for dustfall, and none of these jurisdictions have established standards or objective levels for trace elements in dustfall. The lowest standard found was 1 $mg/dm^2/day$

(applied in both the United Kingdom and New York). The nearest jurisdiction with a dustfall standard is British Columbia, which has established an objective level of 1.7 to 2.9 mg/dm^2/day. Alberta has also established guideline levels for total dustfall, which vary depending on the area of application. The most stringent Alberta guideline level, for residential and recreational areas, is 53 mg/dm^2/30-days which equates to 1.77 mg/dm^2/day. As the Alberta and British Columbia standards are comparable, the more stringent of these (1.7 mg/dm^2/day) was applied in this study. The basis of this standard is the protection of the quality of the environment, rather than a health-based objective.

Table 2.3 – Ambient Air Quality Criteria for Dustfall

Pollutant	Averaging Period	Guideline Level	Ambient Air Control Objective
Total Dustfall	30-days	B.C.	1.7 mg/dm^2/day

3.0 EQUIPMENT AND METHODOLOGY

3.1 EQUIPMENT

For the 2010 monitoring program, eight (8) AirMetrics Mini-Vols and eighteen (18) dustfall jars 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 (at the Giant Mine DC power from rechargeable batteries is employed).

On several occasions in 2010 the batteries failed to keep charge resulting in sample durations less than the desired period of 24-hours. The GNWT states that a sample must run within 25% of the desired sample duration in order to be valid. Out of a total of 88 attempted samples, a total of 16 samples (18%) were found to be invalid and therefore not considered appropriate for inclusion in the analysis. Performance has improved compared to 2009, in which 32% of attempted samples were found to be invalid. It is recommended that batteries continue to be replaced annually if DC power from rechargeable batteries is used in order to reduce the likelihood of missed samples. Details of the Mini-Vol samplers and sampling methodology are provided in Appendix A.

Dustfall jars are plastic containers with an open top to allow particulate matter in the air to settle within. The jars are of known diameter and volume, and are typically deployed with a volume of sampling solution provided by the laboratory that is performing the analysis. Dustfall jars are typically deployed for a period of approximately 30 days, during which time any dust particles in the air will naturally settle in the jar. The results are reported in terms of a deposition rate, in $mg/dm^2/day$.

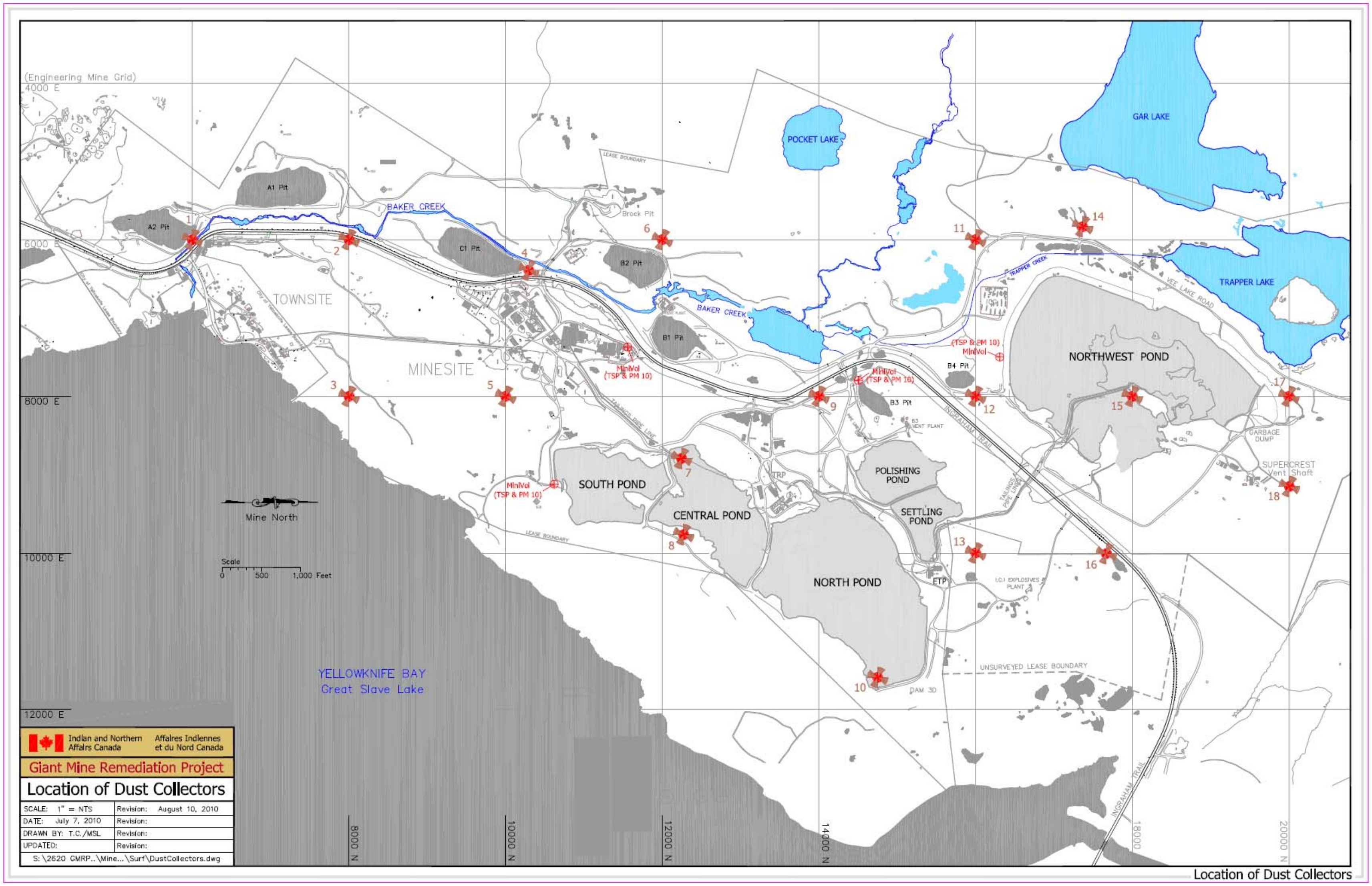
3.2 METHODOLOGY

3.2.1 Monitoring Locations

The Mini-vol monitoring locations were established at the outset of the monitoring initiative and have remained constant over the course of the various summer monitoring campaigns. The locations were established based on a review of the average observed wind data over a five-year period at the Yellowknife Airport. The predominant winds are from the east as will be discussed in Section 4.1 (see Figure 4.1). The locations chosen for the four monitoring locations are shown on Figure 3.1, followed by descriptions and photographs of each. Note that Location 1 (the former Giant Mine Townsite hi-vol location) has been removed from the program. The location numbers (Location 2 – 5) for the on-site monitoring locations have been maintained for consistency with previous reports.

The dustfall monitoring locations were established conceptually based on a review of the mine grid, and were adjusted based on accessibility considerations. The dustfall monitoring locations are represented by crosses on Figure 3.1, along with their reference identifier used in the discussion of results.

Figure 3.1 – Location of Air Quality Sampling Sites



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 3.2), 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 3.2 – Monitoring Location #2 (South End of South Tailings Pond)

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 3.3), 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 3.3 – Monitoring Location #3 (Mill/Roaster Complex)

Note: One monitor is shown as the photograph was taken in 2004 when there was only one monitor at this location. There are now two monitors (TSP and PM_{10}).

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 3.4).

Figure 3.4 – Monitoring Location #4 (B3 Pit)

Note: One monitor is shown as the photograph was taken in 2004 when there was only one monitor at this location. There are now two monitors (TSP and PM_{10}).

Monitoring Location #5 (South of Northwest Pond): A pair of Mini-Vols were located on the south side of the Northwest Pond 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 distinguishing between emissions that may originate from the Northwest Pond and those that are emitted from the nearby roads (see Figure 3.5).

Figure 3.5 – Monitoring Location #5 (South of Northwest Pond)

3.2.2 Monitoring Frequency and Duration

A total of 72 valid Mini-Vol samples were collected during the three months (July to September 2010) of monitoring. The 24-hour sampling was carried out on a 6-day cycle at all of the on-site sampling locations. The sampling was completed on the same 6-day schedule as the GNWT sampling activities to allow subsequent comparison of the results, if deemed appropriate. The GNWT sampling is performed on the same schedule as Environment Canada's National Air Pollution Surveillance (NAPS) Network sampling program. Samples were collected from midnight to midnight on each sampling day.

The dustfall jars were deployed simultaneously for a period of 30 days, beginning on August 6th, 2010.

3.2.3 Analysis

The 47 mm Mini-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 used in 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 of Mini-vol samples were conducted at Maxxam Analytics Inc. in Mississauga, Ontario.

The dustfall analysis was completed by ALS Canada Limited in Vancouver, British Columbia. The solution from the dustfall containers was analysed for particulate matter using the applicable particulate methods (total, insoluble, soluble) from Section G: Air Constituents – Inorganic of the 2009 British Columbia Environmental Laboratory Manual. The metals analysis was completed in accordance with the same U.S. EPA method as the Mini-vol samples.

3.2.4 QA/QC

The Quality Assurance/Quality Control (QA/QC) program for the sampling study included:

- Purchase of new batteries in July 2010 for the Mini-vols to reduce the likelihood of missed samples;

- Cleaning of Mini-vol samplers with compressed air prior to deployment;
- Sending the Mini-vols to the manufacturer for post-calibration at the end of the program; and
- Keeping records of samples provided to the laboratories through detailed chain of custody forms.

Analytical QA/QC procedures were also carried out by Maxxam Analytics and ALS Canada.

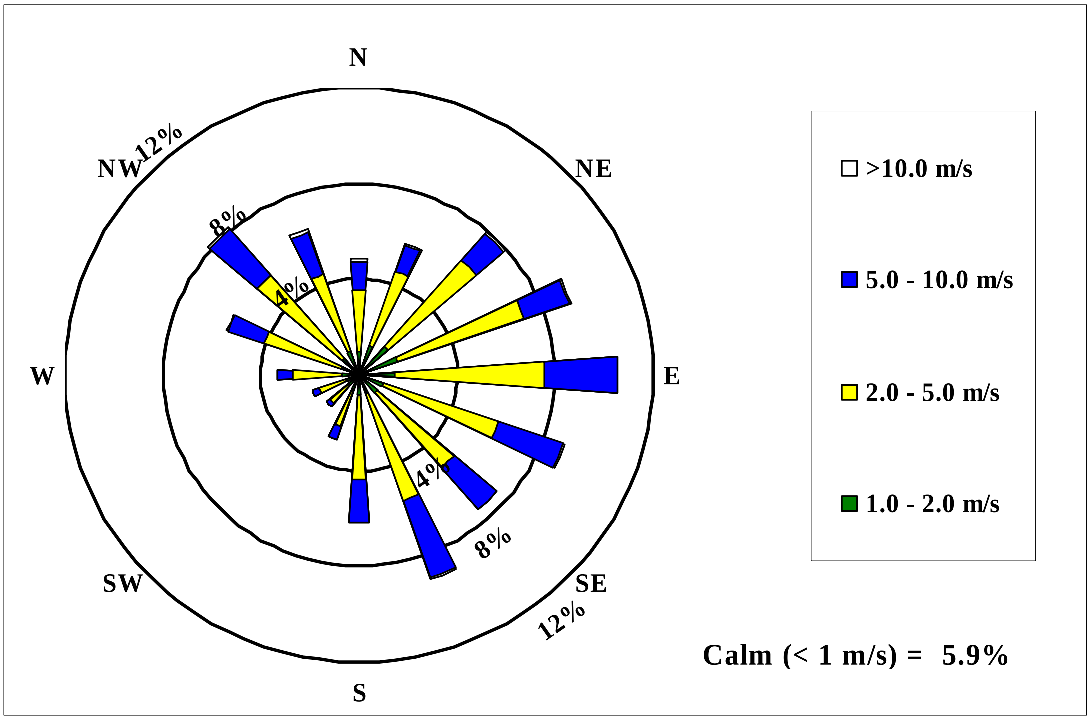
4.0 RESULTS AND DISCUSSION

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 already 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 to 2000) average wind speeds and percent frequencies by direction for Yellowknife Airport Meteorological Station.

Figure 4.1 – Windrose for Yellowknife Airport (1996 to 2000)



As shown in Figure 4.1, the predominant wind direction has a strong 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 easterly winds.

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 July, August and September 2010 are provided in Table 4.1.

Table 4.1 – Average Temperature and Precipitation Data at Yellowknife Airport (2010)

Temperature:	**July**	**August**	**September**
Daily Average (°C)	17.9	15.5	7.8
Daily Maximum (°C)	22.0	18.9	11.0
Daily Minimum (°C)	13.9	12.1	4.5
Precipitation:	**July**	**August**	**September**
Rainfall (mm)	46.6	24.4	27.6
Snowfall (cm)	0	0	5.0
Precipitation (mm)	46.6	24.4	32.2

4.2 TSP AND PM_{10} RESULTS

Gravimetric results for the TSP and PM_{10} fractions are summarized in Table 4.2. Exceedances of ambient air quality criteria are indicated in bold in this table. This table illustrates that the 24-hour criteria values for TSP and PM_{10} in ambient air were exceeded consistently throughout the monitoring program, and exceedances were noted at all of the on-site monitoring locations.

Table 4.2 also includes a summary of various statistical parameters calculated using the measured data at each location. While the maximum recorded concentration of TSP was noted at the B3 Pit, the highest concentrations of TSP and PM_{10} on an average basis were noted at the Northwest Pond location. The Northwest Pond is typically the location at which the average concentrations of particulate are highest, and therefore this observation is consistent with previous monitoring programs.

Note that in Table 4.2, 95th and 98th percentile values have been carried forward for consistency with historical reports. These parameters are not typically calculated on small datasets and should therefore be used with caution.

Figure 4.2 and Figure 4.3 depict the variability in TSP and PM_{10} concentrations, respectively, between the four sampling locations.

Table 4.2 – Results of TSP and PM_{10} Measurements

Sampling Date	South Pond		B3 Pit		Mill		NW Pond	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
13-Jul-10	97.2	**83.3**	111.1	**69.4**	69.4	**97.2**	**125.0**	**125.0**
19-Jul-10	83.3	NS-INS	97.2	**69.4**	69.4	**83.3**	111.1	**69.4**
25-Jul-10	69.4	**83.3**	69.4	ND	56.7	NS-INS	111.1	**97.2**
31-Jul-10	NS-INS	**55.6**	69.4	**97.2**	NS-INS	NS-INS	92.6	**69.4**
6-Aug-10	**180.6**	**138.9**	**152.8**	**83.3**	NS-INS	NS-INS	**180.6**	**125.0**
12-Aug-10	**138.9**	NS-INS	**166.7**	**138.9**	**138.9**	NS-INS	**180.6**	**152.8**
19-Aug-10	NS-INS	**138.9**	**125.0**	**152.8**	**166.7**	**125.0**	**166.7**	**166.7**
24-Aug-10	NS-INS	NS-INS	**191.0**	NS-INS	**152.8**	**152.8**	**152.8**	**125.0**
30-Aug-10	111.1	NS-INS	NS-INS	NS-INS	**166.7**	**152.8**	**180.6**	**125.0**
5-Sep-10	111.1	**111.1**	**138.9**	**138.9**	**152.8**	**125.0**	**152.8**	**166.7**
11-Sep-10	**138.9**	**97.2**	**125.0**	**138.9**	111.1	**97.2**	83.3	**138.9**
Maximum	180.6	138.9	191.0	152.8	166.7	152.8	180.6	166.7
98th Percentile	174.7	138.9	186.6	150.8	166.7	152.8	180.6	166.7
95th Percentile	166.0	138.9	180.0	147.9	166.7	152.8	180.6	166.7
Arithmetic Mean	116.3	101.2	124.7	111.1	120.5	119.0	139.7	123.7
Geometric Mean	111.7	96.9	118.6	106.0	111.8	116.3	135.1	119.0
Median	111.1	97.2	125.0	118.1	138.9	125.0	152.8	125.0

Notes:
All the samples exceeding the AAQC of 120 $\mu g/m^3$ for TSP or 50 $\mu g/m^3$ for PM_{10} are shown in **bold** in the table.
ND – Not Detectable (i.e., below the laboratory detection limit)
NI – No Information (i.e., filter was not submitted to the laboratory)
NS-INS – No Sample due to Insufficient Data (i.e., sample excluded due to unacceptable sample duration)
ND data were not included in calculation of statistics

Figure 4.2 - Variability in TSP Concentrations at All Locations (July – September 2010)

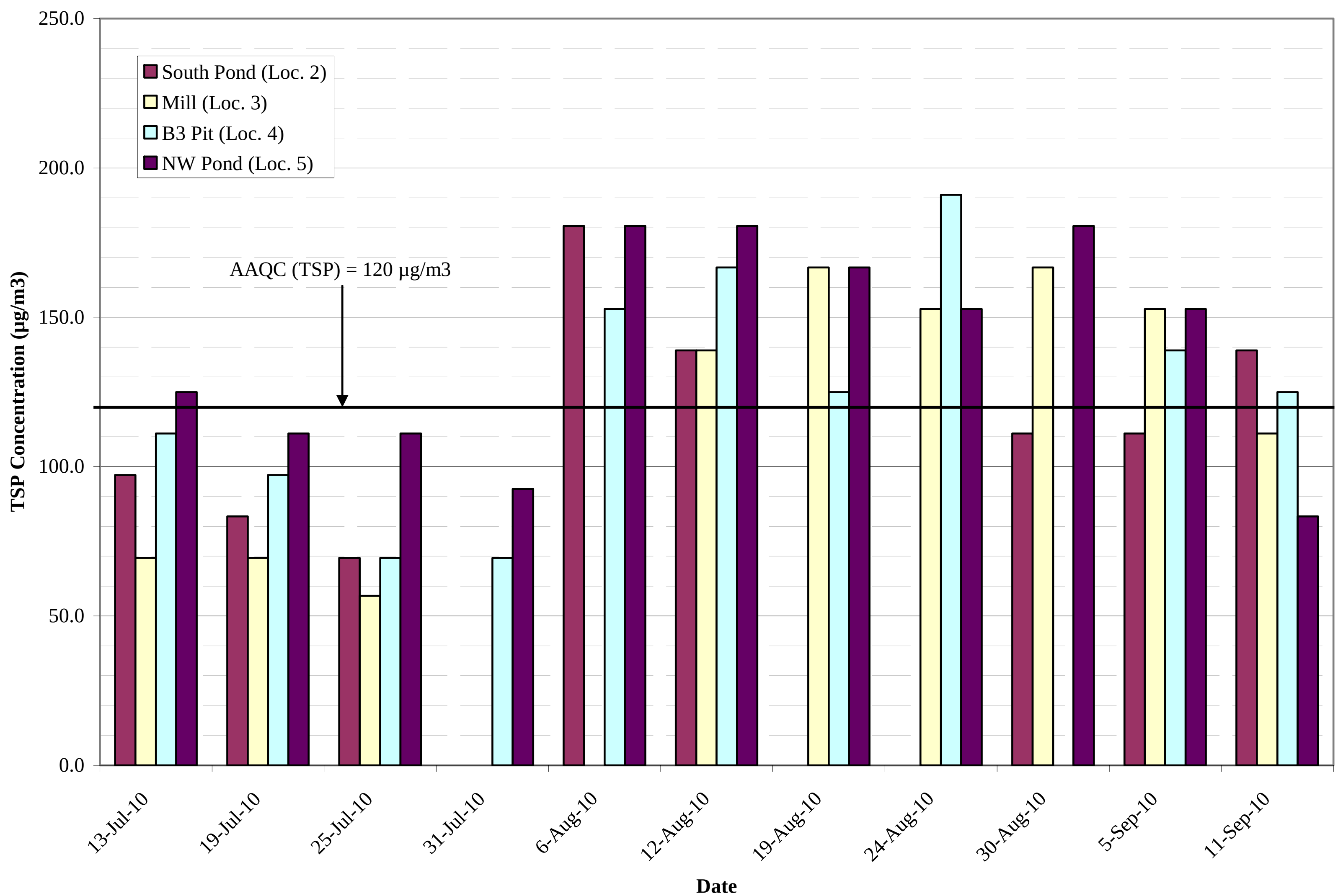


Figure 4.3 - Variability in PM_{10} concentrations at Locations 2 – 5 (July to September 2010)

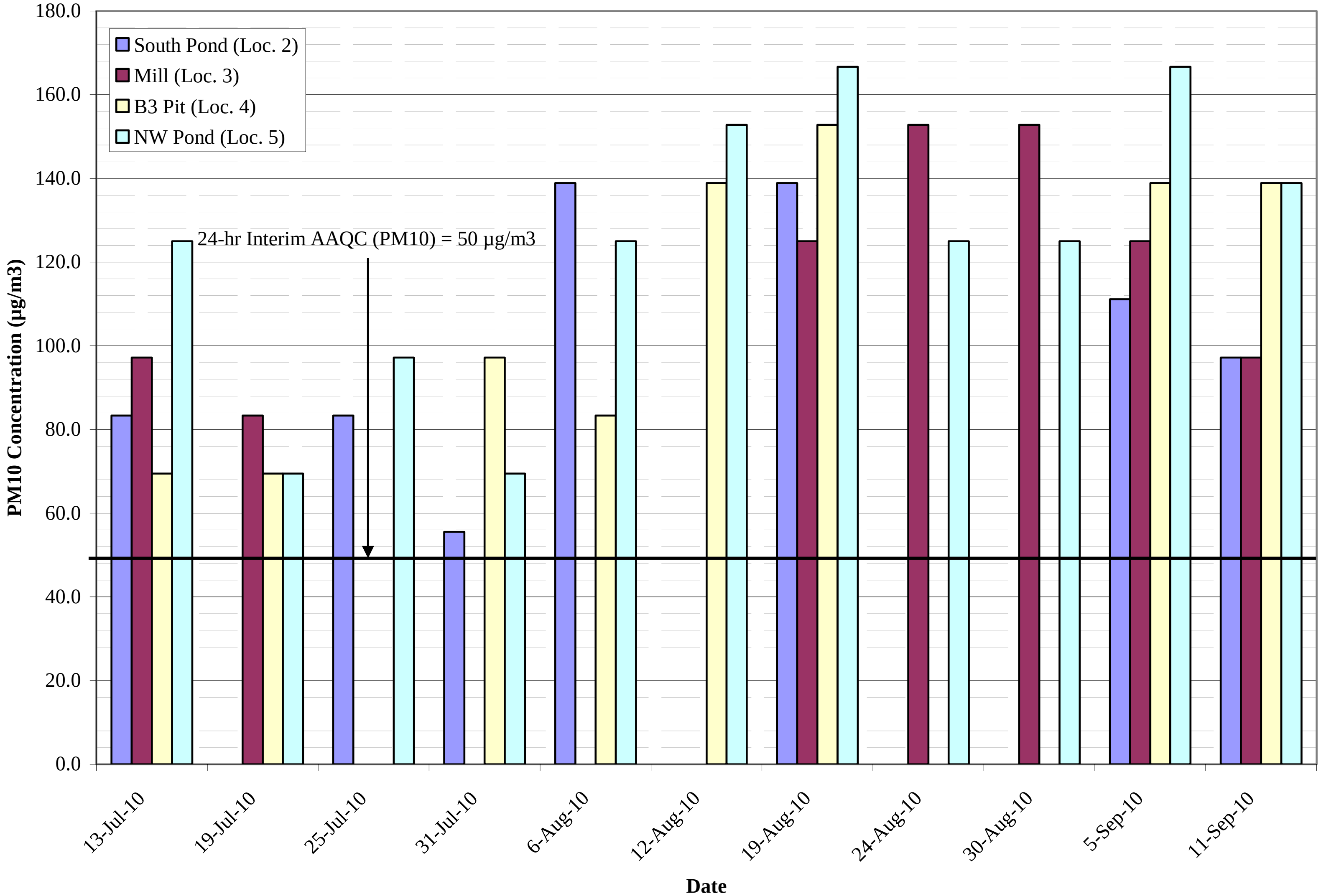


Figure 4.2 indicates that TSP concentrations exceeding the ambient air quality objective of 120 µg/m^3 were recorded at several locations throughout the monitoring program. In this span of time there were three exceedances at the South Pond, six at the B3 Pit, five at the Mill and seven at the Northwest Pond. Figure 4.3 indicates that all measurable PM_{10} concentrations exceeded the standard of 50 µg/m^3 (based on MOE's AAQC) during the 2010 air monitoring. Note that valid samples that resulted in non-detectable loadings are not represented on the above figures.

4.3 DUSTFALL

The dustfall results are summarized in Table 4.3. The maximum dustfall rate was found to be 0.87 mg/dm^2/day at Location 11, which is near the Northwest Pond. This is approximately 51% of the criteria of 1.7 mg/dm^2/day adopted for this report. Almost three quarters of the dustfall monitoring locations (72%) returned non-detectable levels of total dustfall (detection limit was 0.1 mg/dm^2/day). Detectable levels of dustfall were found at the A2 Pit (Location 1), the Central Pond (Location 7), the North Pond (Location 10), and the Northwest Pond (Location 11 and Location 14).

Table 4.3 – Dustfall Results

Analyte	Dustfall Deposition Rate (mg/dm^2/day)																	
	Loc. 1	Loc. 2	Loc. 3	Loc. 4	Loc. 5	Loc. 6	Loc. 7	Loc. 8	Loc. 9	Loc. 10	Loc. 11	Loc. 12	Loc. 13	Loc. 14	Loc. 15	Loc. 16	Loc. 17	Loc. 18
Fixed Dustfall	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.17	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Volatile Dustfall	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.19	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Dustfall	0.14	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1	0.58	0.87	< 0.1	< 0.1	0.63	< 0.1	< 0.1	< 0.1	< 0.1
Fixed Insoluble Dustfall	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Volatile Insoluble Dustfall	0.14	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1	0.21	0.74	< 0.1	0.11	0.63	< 0.1	< 0.1	< 0.1	< 0.1
Total Insoluble Dustfall	0.14	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1	0.21	0.74	< 0.1	0.11	0.63	< 0.1	< 0.1	< 0.1	< 0.1
Fixed Soluble Dustfall	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.17	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Volatile Soluble Dustfall	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.19	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Soluble Dustfall	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.37	0.13	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

4.4 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 $\mu g/m^3$, based on the calibrated flow rate of the sampling equipment. The trace element concentrations for all of the Mini-Vol filters that were run for an acceptable duration (±25% of 24 hours) are presented in Table 4.10 and , respectively (included at the end of this section). The results indicate that, with the exception of one exceedance of iron, all other metal concentrations were below their applicable AAQC.

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 summarizes the arsenic concentrations reported at all four sites during the 2010 monitoring program. The results indicate that arsenic levels did not exceed the health-based ambient air quality criterion for arsenic (AAQCs = 0.3 $\mu g/m^3$) for any samples collected during the 2010 monitoring program.

The data in Table 4.4 indicate that the arsenic levels in TSP and PM_{10} were noticeably higher at the Northwest Pond than at any of the other three on-site sampling locations. Note that close to 75% of the samples with valid durations submitted for analysis of metals in PM_{10} resulted in non-detectable levels of arsenic.

Figure 4.4 through Figure 4.9 show the trends and correlations in arsenic levels in both TSP and PM_{10} at locations 2 through 5. Arsenic was not present at detectable levels for any of the PM_{10} samples collected at the South Pond (Location 2), and therefore there is no opportunity to correlate with concentrations of arsenic in TSP at this location. Similarly, correlation at the Mill (Location 3) and B3 Pit (Location 4) was limited due to the number of non-detects and invalid samples. The figures for Locations 5 show that arsenic levels in the two particulate matter size fractions (i.e., TSP & PM_{10}) tracked each other quite well where data are available. Overall, peak arsenic concentrations in PM_{10} generally corresponded with peak arsenic concentrations in TSP. The figures indicate that at most of the monitoring locations the arsenic was present in the large particles (TSP), which are less likely to be of concern for human health. This agrees with the conclusions of the previous monitoring programs.

Concentrations of iron exceeded the AAQC of 4 $\mu g/m^3$ at the Northwest Pond on July 31st, 2010.

As no criteria were found for trace elements in dustfall, it was not possible to comment on the acceptability of the measured data. It was noted that the highest concentration of arsenic was noted at the monitoring location at the Central Pond (Location 7). The next highest concentrations were near the Northwest Pond (Location 11) and the North Pond (Location 10).

Table 4.4 – Arsenic Concentration in Particulate Matter

Sampling Date	South Pond		B3 Pit		Mill		NW Pond	
	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}
13-Jul-10	8.47E-03	ND	4.72E-02	1.10E-02	1.53E-02	1.94E-02	4.72E-02	2.92E-02
19-Jul-10	8.89E-03	NS-INS	ND	8.19E-03	ND	ND	1.67E-02	ND
25-Jul-10	2.50E-02	ND	ND	ND	ND	NS-INS	9.72E-03	ND
31-Jul-10	NS-INS	ND	2.08E-02	ND	NS-INS	NS-INS	2.04E-01	2.64E-02
6-Aug-10	1.03E-02	ND	3.19E-02	ND	NS-INS	NS-INS	4.86E-02	ND
12-Aug-10	9.72E-02	NS-INS	2.50E-02	8.61E-03	2.50E-02	NS-INS	4.86E-02	ND
19-Aug-10	NS-INS	ND	ND	ND	ND	ND	ND	ND
24-Aug-10	NS-INS	NS-INS	2.08E-02	NS-INS	1.53E-02	1.22E-02	1.67E-02	8.47E-03
30-Aug-10	ND	NS-INS	NS-INS	NS-INS	8.33E-03	ND	2.08E-02	ND
5-Sep-10	ND	ND	ND	ND	ND	ND	ND	1.11E-02
11-Sep-10	1.94E-02	ND	ND	ND	ND	ND	7.78E-03	ND
Maximum	9.72E-02	-	4.72E-02	1.10E-02	2.50E-02	1.94E-02	2.04E-01	2.92E-02
98th Percentile	9.00E-02	-	4.60E-02	1.09E-02	2.44E-02	1.93E-02	1.79E-01	2.90E-02
95th Percentile	7.92E-02	-	4.42E-02	1.07E-02	2.35E-02	1.91E-02	1.42E-01	2.88E-02
Arithmetic Mean	2.82E-02	-	2.92E-02	9.26E-03	1.60E-02	1.58E-02	4.66E-02	1.88E-02
Median	1.49E-02	-	2.50E-02	8.61E-03	1.53E-02	1.58E-02	2.08E-02	1.88E-02

Note:
All samples exceeding the AAQC of 0.3 $\mu g/m^3$ are shown in **bold**.
ND – Non Detectable (i.e., below the laboratory detection limit)
NI – No Information (i.e., filter was not submitted to the laboratory)
NS-INS – No Sample due to Insufficient Data (i.e., sample excluded due to unacceptable sample duration)
ND data were not included in calculation of statistics

Figure 4.4 - Variability in Arsenic Concentrations at All TSP Sampling Locations

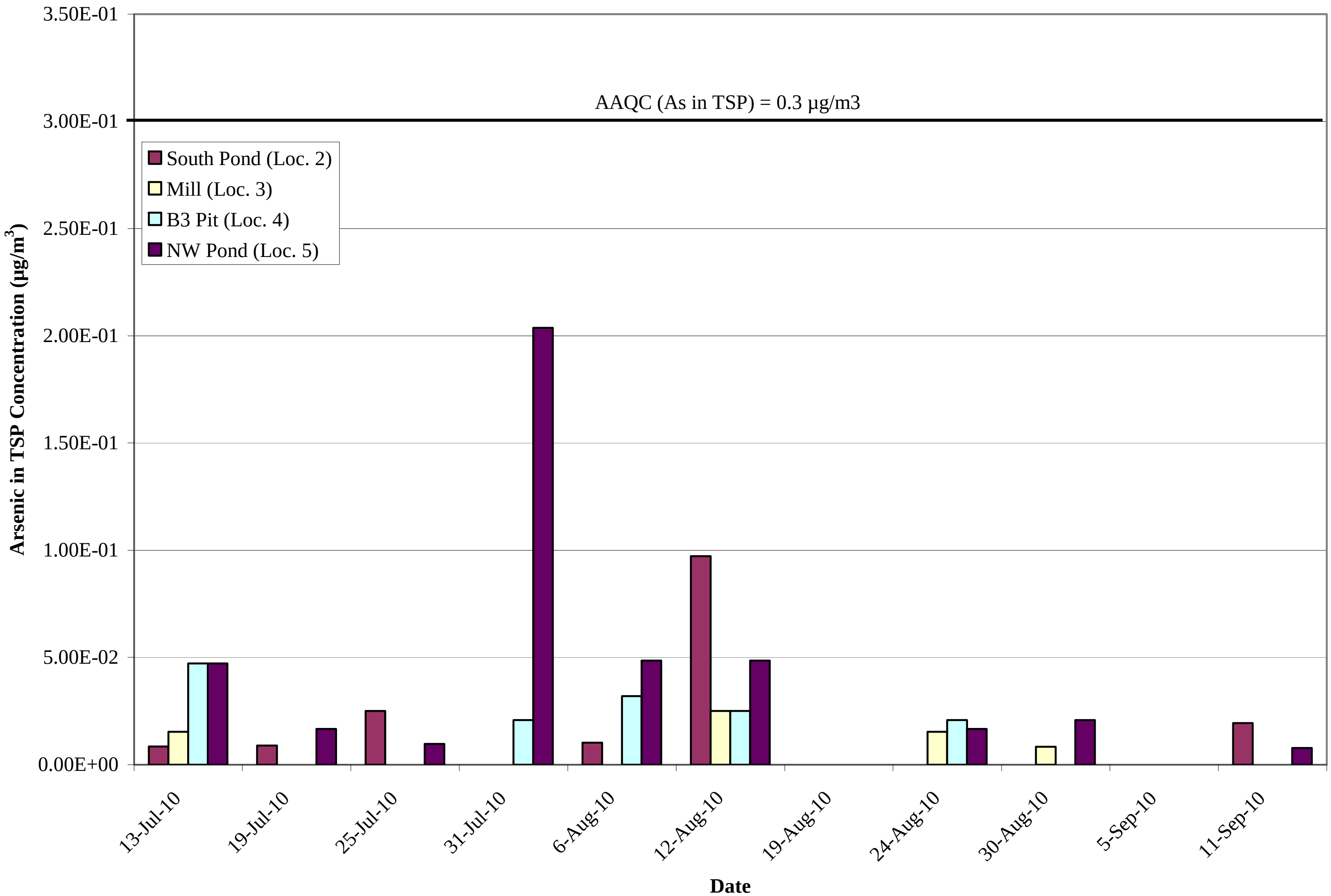


Figure 4.5 - Variability in Arsenic Concentrations at PM_{10} Sampling Locations

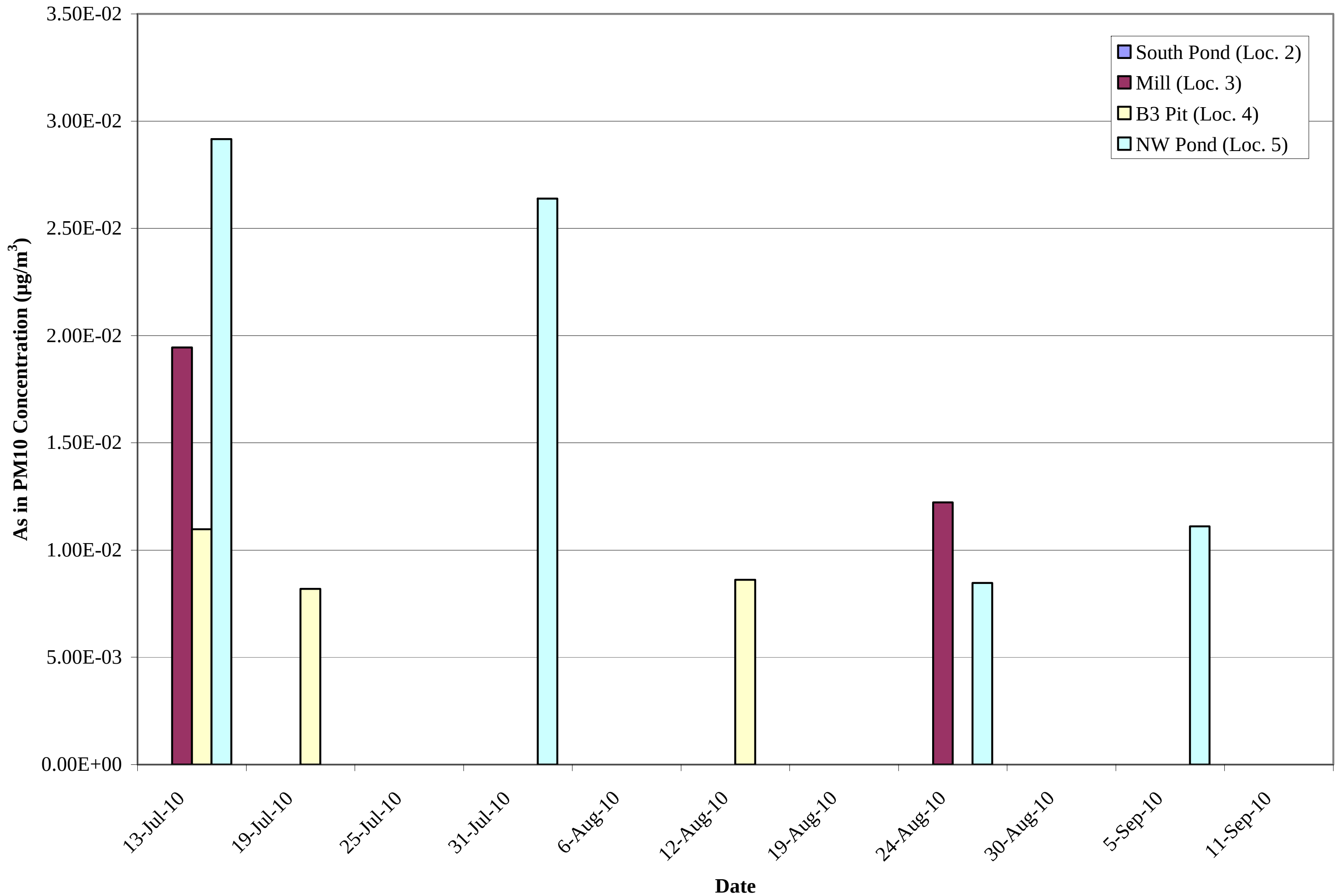


Figure 4.6 - Variability in Arsenic Concentrations in TSP/ PM_{10} Samples Collected at the South Pond (Location 2)

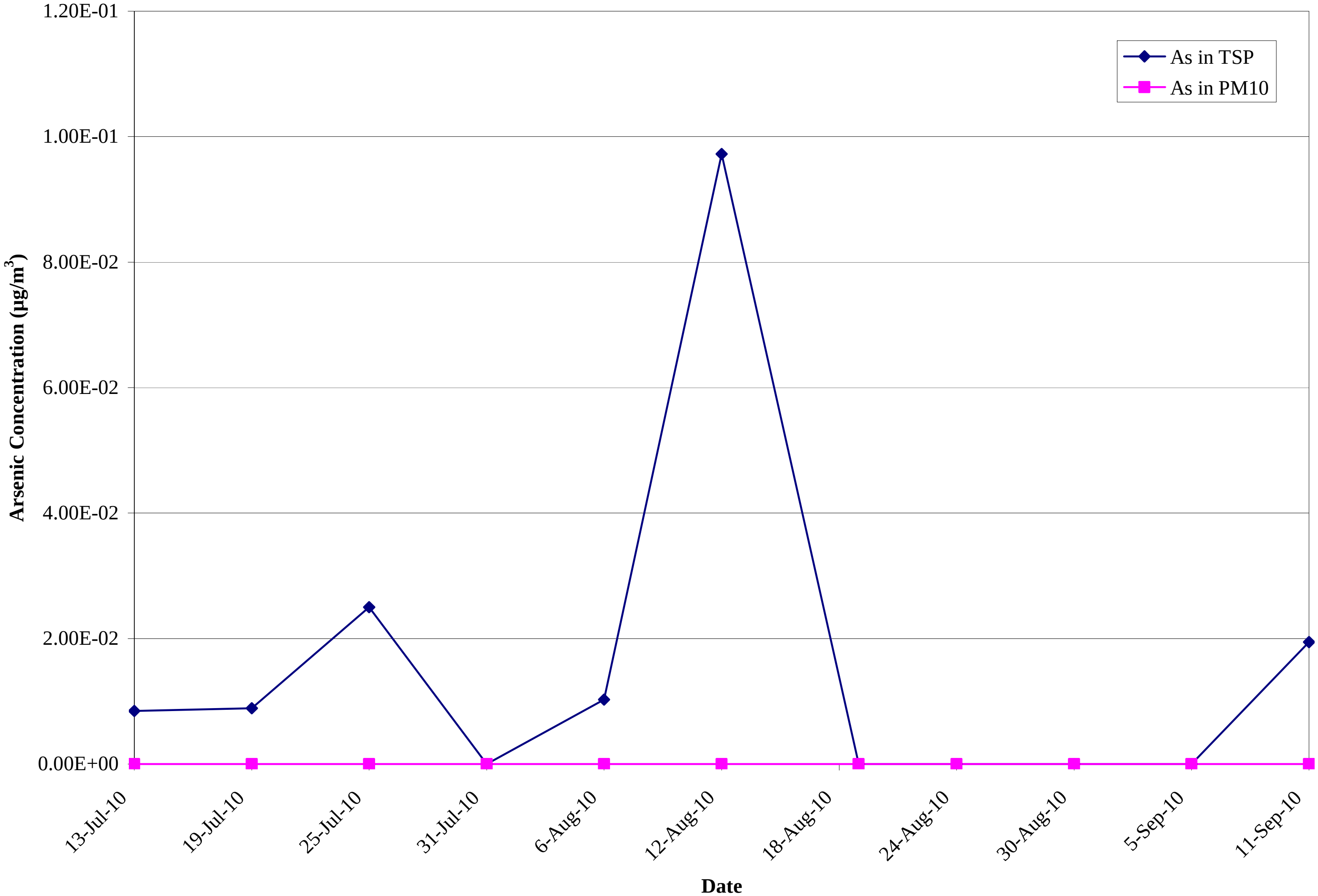


Figure 4.7 - Variability in Arsenic Concentrations in TSP/PM_{10} Samples Collected at the Mill (Location 3)

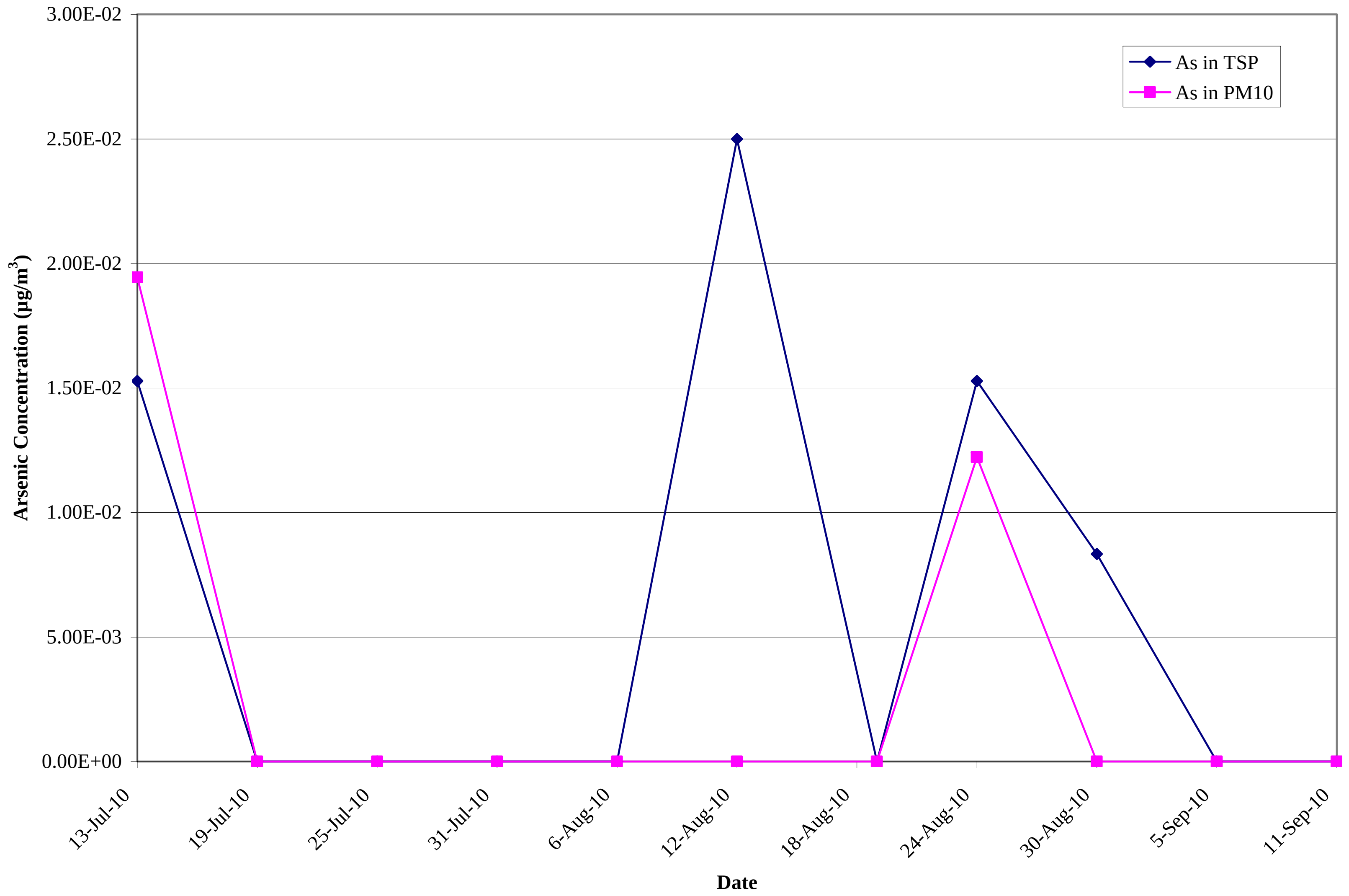


Figure 4.8 - Variability in Arsenic Concentrations in TSP/PM_{10} Samples Collected at the B3 Pit (Location 4)

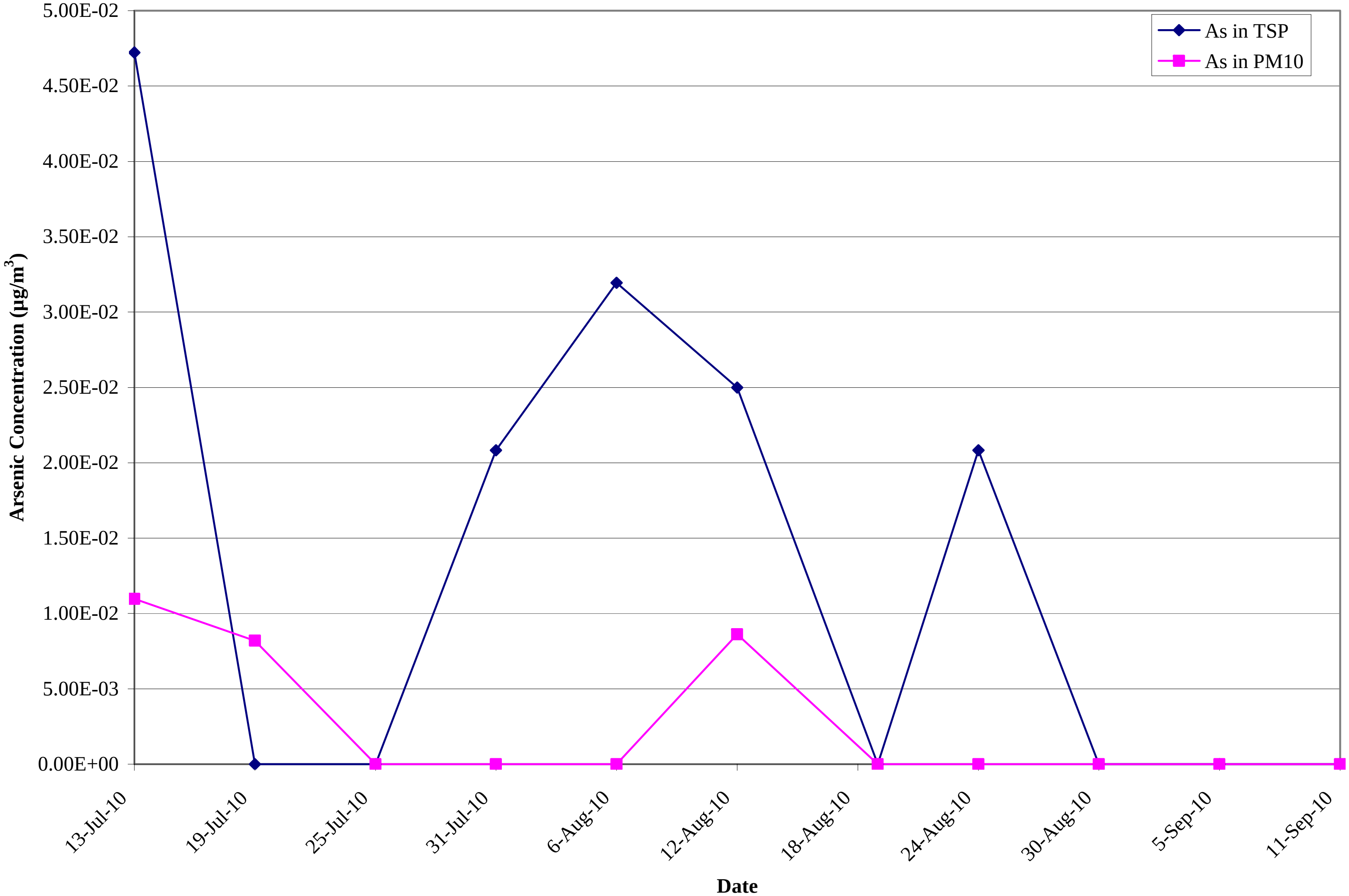
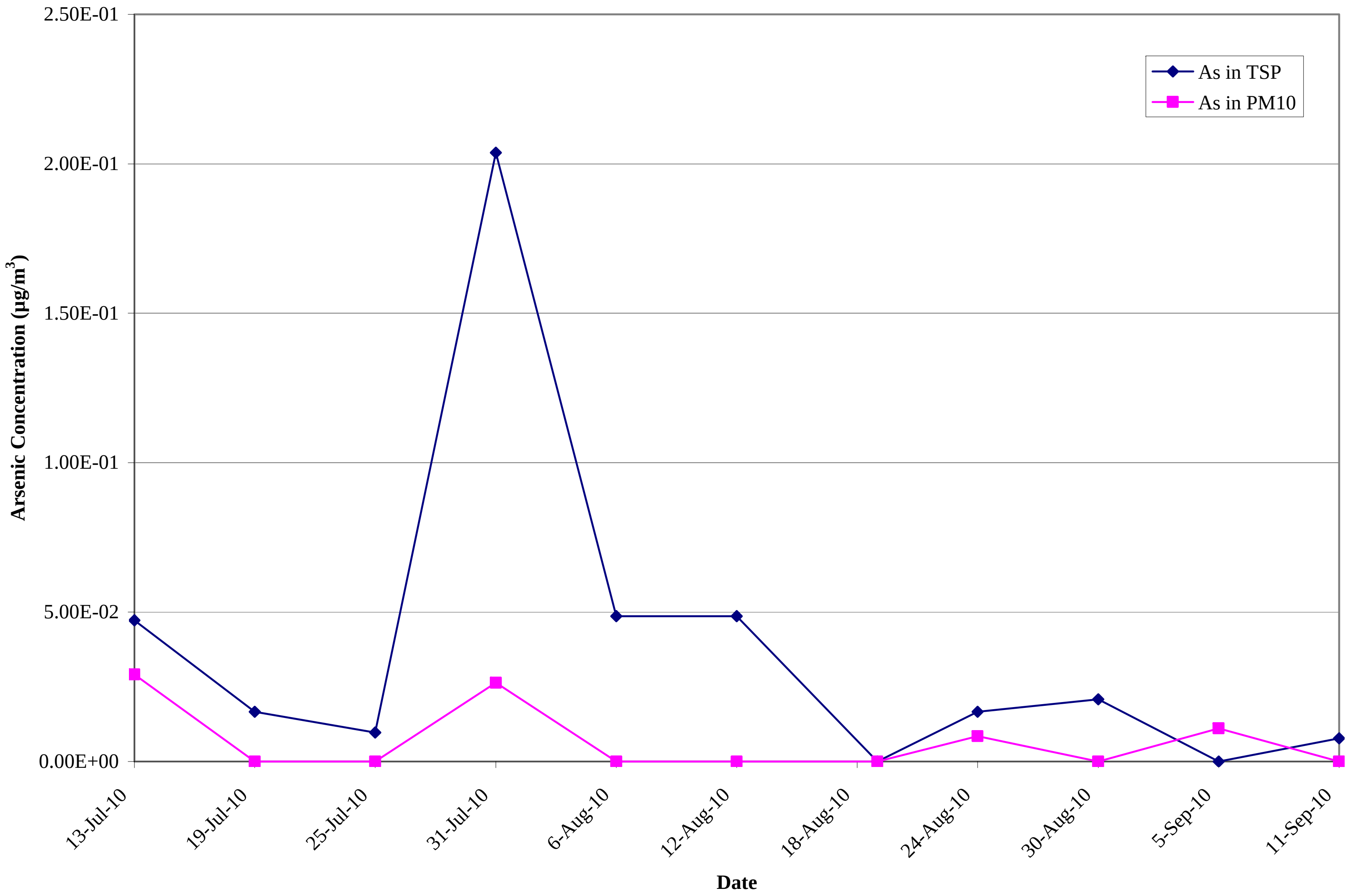


Figure 4.9 - Variability in Arsenic Concentrations in TSP/PM_{10} Samples Collected at the Northwest Pond (Location 5)



4.5 INTERPRETATION OF RESULTS

Table 4.5 summarizes the days on which the particulate matter (TSP and PM_{10}) and iron concentrations were reported to be above their respective AAQC. The table shows that the iron exceedance occurred on a day in which TSP was actually within its AAQC. The TSP concentration was at approximately 77% of the AAQC on July 31st at this location.

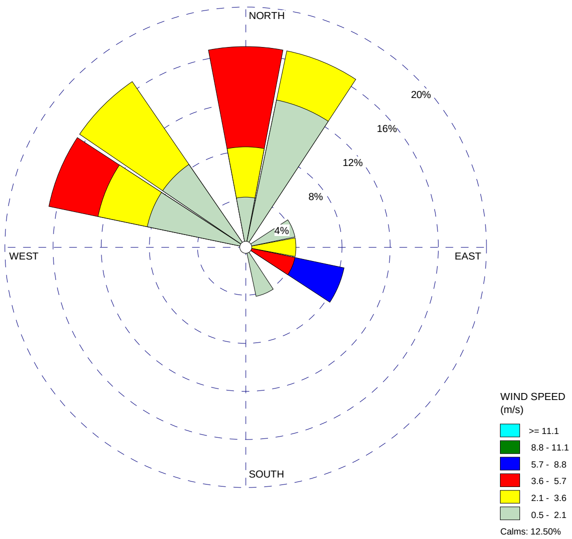
The AAQCs for TSP and/or PM_{10} were exceeded at two or more locations on each of the eleven sampling days. Windroses for each of these days are presented below in Figure 4.10.

Table 4.5 – Summary of Exceedance Dates

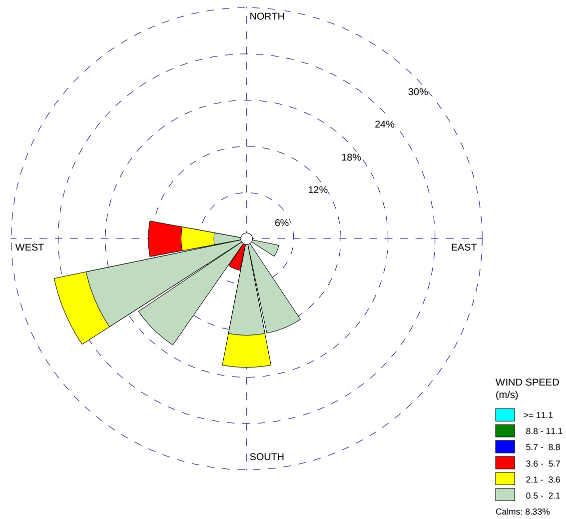
Parameter (µg/m3)	TSP				PM10				Arsenic in TSP				Arsenic in PM10				Iron in TSP				Iron in PM10			
Location	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**
13-Jul-10				x	x	x	x	x																
19-Jul-10						x	x	x																
25-Jul-10					x			x																
31-Jul-10					x		x	x												x				
6-Aug-10	x		x	x	x		x	x																
12-Aug-10	x	x	x	x			x	x																
19-Aug-10		x	x	x	x	x	x	x																
24-Aug-10		x	x	x		x		x																
30-Aug-10		x		x		x		x																
5-Sep-10		x	x	x	x	x	x	x																
11-Sep-10	x		x		x	x	x	x																

Figure 4.10 – Windroses for PM Exceedance Days

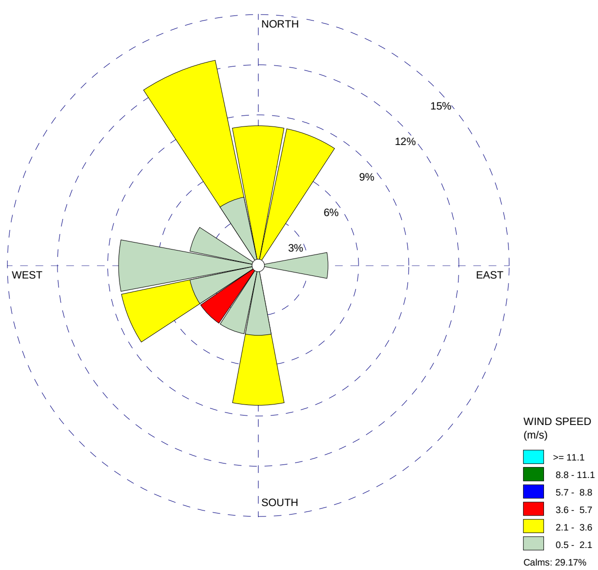
July 13th, 2010



July 19th, 2010



July 25th, 2010



July 31st, 2010

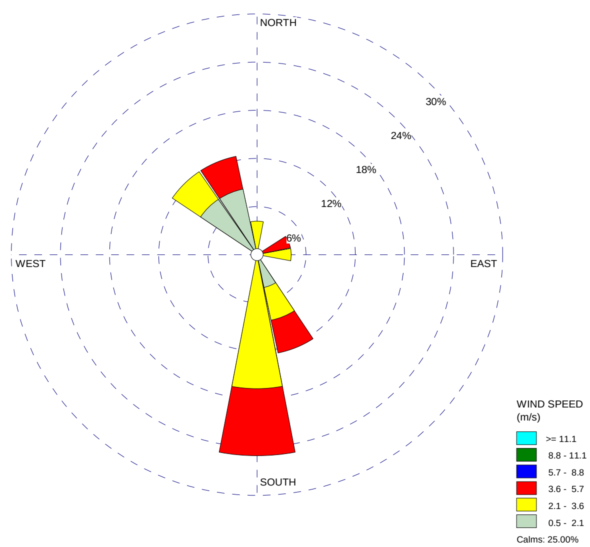
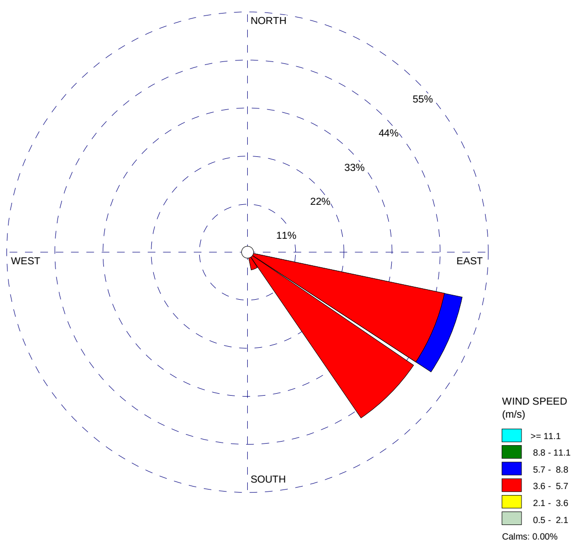
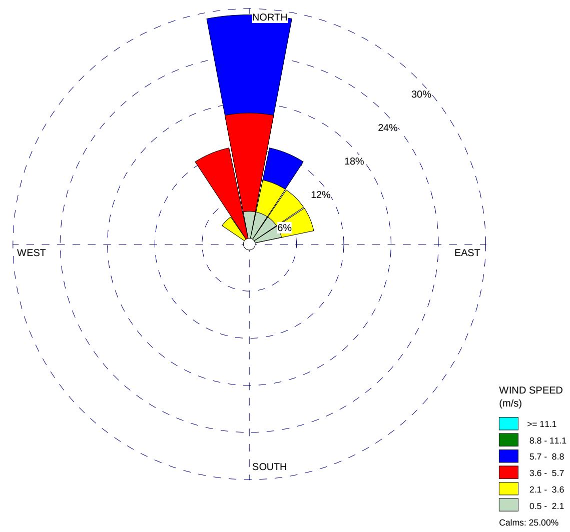


Figure 4.10 (Cont'd) - Windroses for PM Exceedance Days

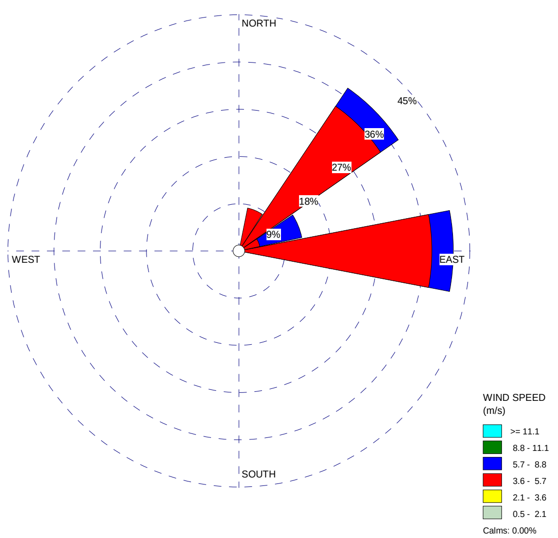
August 6th, 2010



August 12th, 2010



August 19th, 2010



August 24th, 2010

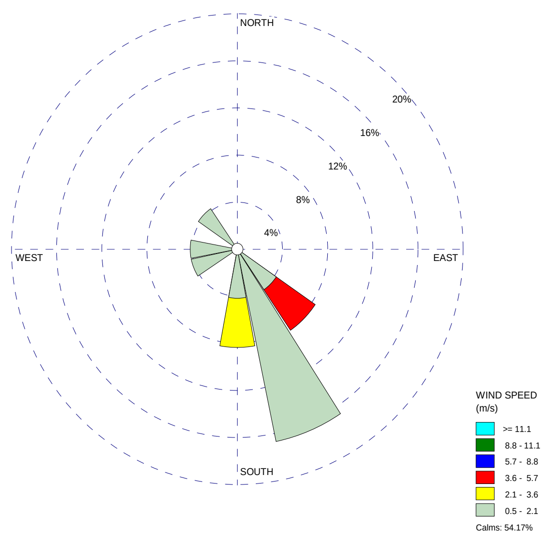
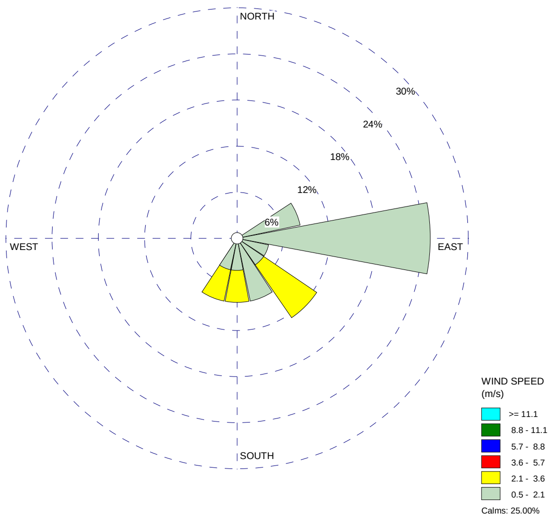
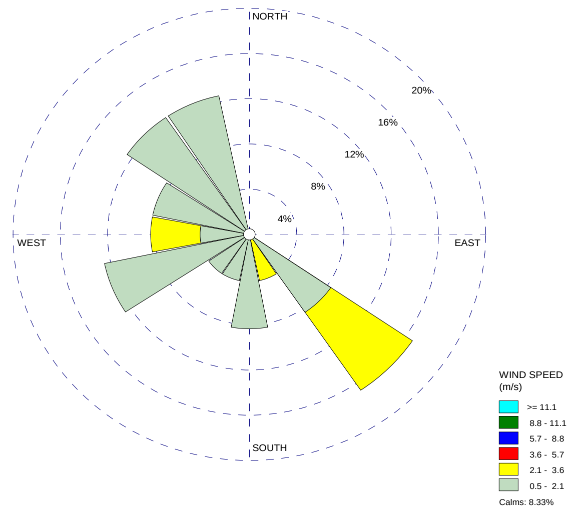


Figure 4.10 (Cont'd) - Windroses for PM Exceedance Days

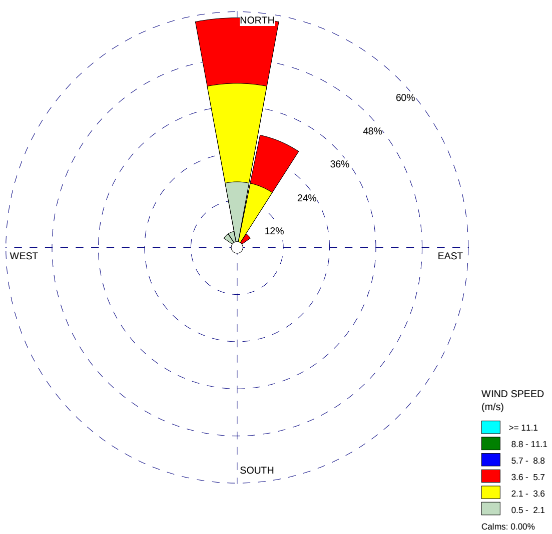
August 30th, 2010



September 5th, 2010



September 11th, 2010



The above figures illustrate that the monitors were collecting samples under a wide range of meteorological conditions. Exceedances of particulate matter were observed at the various stations under various meteorological conditions and therefore a clear correlation between exceedances of particulate matter and wind direction does not appear to exist.

To further explore the potential causes of these exceedances, site activities on the days for which the particulate matter (TSP), arsenic and/or iron criteria were exceeded were reviewed, as summarized in Table 4.7. Soil cement was applied to the Northwest Pond and South Pond towards the end of August. There were construction activities at the FOS sporadically during the monitoring period. The location of activities, wind direction and location of monitoring stations recording the exceedance show no clear pattern.

Table 4.6 – Wind Directions for PM Exceedance Dates

Sample Date	Location(s) with Exceedance	Dominant Wind Direction
13 July 2010	**TSP:** NW Pond **PM_{10}:** All Locations	N, NW
19 July 2010	**TSP:** None **PM_{10}:** Mill, B3 Pit, NW Pond	SW
25 July 2010	**TSP:** None **PM_{10}:** South Pond, NW Pond	NW
31 July 2010	**TSP:** None **PM_{10}:** South Pond, B3 Pit, NW Pond	S
6 August 2010	**TSP:** South Pond, B3 Pit, NW Pond **PM_{10}:** South Pond, B3 Pit, NW Pond	SE
12 August 2010	**TSP:** All Locations **PM_{10}:** B3 Pit, NW Pond	N
19 August 2010	**TSP:** Mill, B3 Pit, NW Pond **PM_{10}:** All Locations	E, NE
24 August 2010	**TSP:** Mill, B3 Pit, NW Pond **PM_{10}:** Mill, NW Pond	SE
30 August 2010	**TSP:** Mill, NW Pond **PM_{10}:** Mill, NW Pond	E
5 September 2010	**TSP:** Mill, B3 Pit, NW Pond **PM_{10}:** All Locations	SE
11 September 2010	**TSP:** South Pond, B3 Pit **PM_{10}:** All Locations	N

Table 4.7 – Summary of Activities on Exceedance Dates

Parameter ($\mu g/m^3$)	TSP				PM_{10}				Site Activities
Location	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**	
13-Jul-10				x	x	x	x	x	Construction activities (fence repair, FOS building pads)
19-Jul-10						x	x	x	
25-Jul-10					x			x	
31-Jul-10					x		x	x	
6-Aug-10	x		x	x	x		x	x	
12-Aug-10	x	x	x	x			x	x	
19-Aug-10		x	x	x	x	x	x	x	Installation of piping, craning of freeze plants onto FOS pad
24-Aug-10		x	x	x		x		x	
30-Aug-10		x		x		x		x	Soil cement applied to Northwest Pond and South Pond
5-Sep-10		x	x	x	x	x	x	x	
11-Sep-10	x		x		x	x	x	x	

4.6 COMPARISON OF CURRENT AND HISTORICAL MONITORING RESULTS

4.6.1 Sample Collection Efficiency

The 2010 monitoring program was similar in design to the previous programs in that samples of TSP and PM_{10} were collected at all of the same on-site locations since 2005. The most significant difference from previous programs is that the off-site sampling location was discontinued in 2010. There was an improvement in sample collection efficiency for the Mini-vol samplers compared to 2009, which is likely due to the purchase of new batteries at the outset of the 2010 program. Sample collection efficiencies for all years are summarized in Table 4.8. The table includes 2005 and forward as the Northwest Pond location was not part of the program before 2005, and PM_{10} samples were only collected at the South Pond location before 2005.

Table 4.8 – Summary of Historical Sample Collection Efficiency

Year	% Valid On-Site TSP/PM_{10} Samples	% Valid Off-Site TSP Samples
2005[1]	80%	100%
2006[2]	68%	95%
2007[3]	72%	87%
2008[3]	78%	50%
2009[3]	68%	24%
2010[3]	82%	N/A

1 – Note that no screening criteria were employed to eliminate samples based on a sample duration that was too short. Missed samples were therefore the result of the monitors not operating.
2 – A screening criteria of ±10% of the desired sample time was implemented to eliminate non-representative samples.
3 – A screening criteria of ±25% of the desired sample duration, which is acceptable to the government of the Northwest Territories, was applied to eliminate non-representative samples

4.6.2 Particulate Matter Results

In the previous three years of monitoring (2007 to 2009), there has been a decreasing trend in the number of TSP samples that exceeded the AAQC. This trend did not continue in 2010, with the number of exceedances increasing from 13% in 2009 to 55% in 2010. Similarly, there was an increase in the percentage of PM_{10} samples that exceeded the AAQC compared to 2009, with all but one valid sample exceeding the PM_{10} criteria.

Table 4.9 summarizes the number of on-site Mini-vol samples that exceeded the particulate matter AAQCs during the 2010 monitoring season and the previous years.

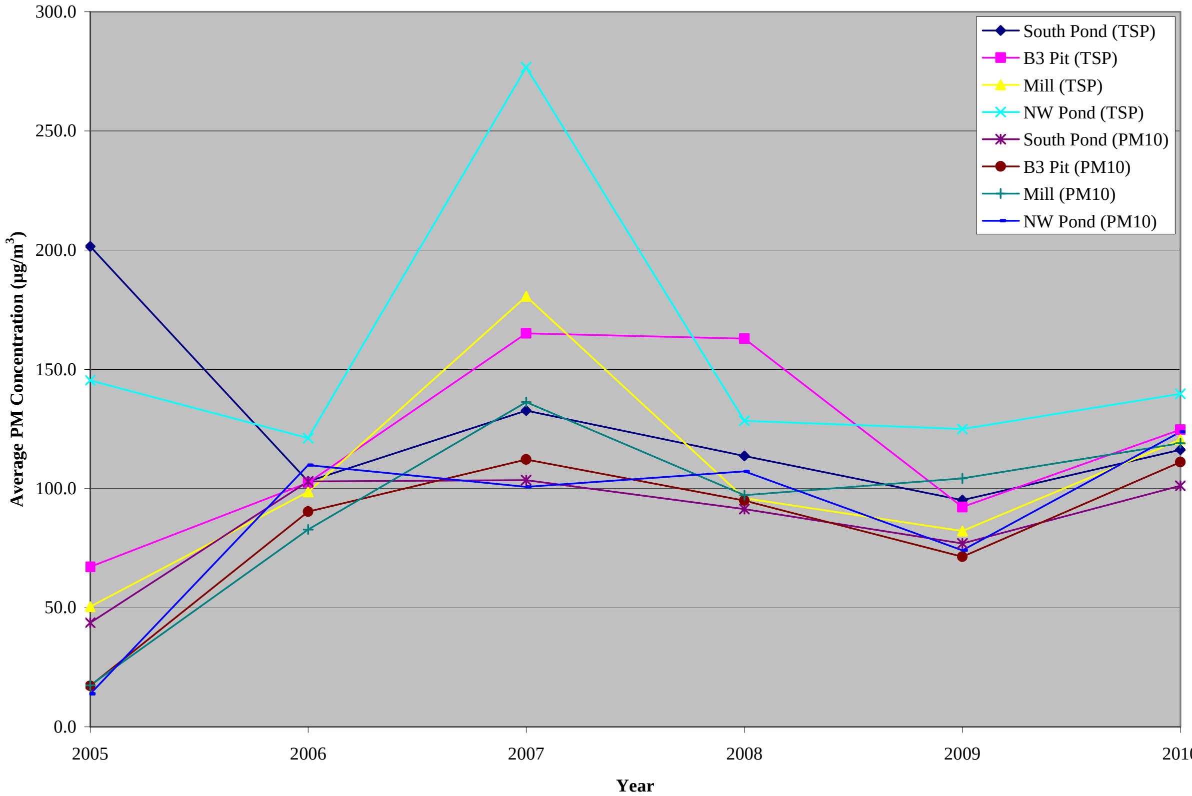
Table 4.9 – Summary of Historical PM Exceedances

Year	TSP		PM_{10}	
	No. of Valid Samples	% Exceeding AAQC (120 μg/m^3)	No. of Valid Samples	% Exceeding AAQC (50 μg/m^3)
2005	54	19%	50	12%
2006	62	26%	54	80%
2007	44	73%	42	93%
2008	45	40%	55	60%
2009	47	13%	45	78%
2010	38	55%	34	97%

In addition to the decreasing trend in exceedances, the previous three years of monitoring data show a general decrease in average concentrations of both TSP and PM_{10} at the monitoring locations from 2007 to 2009. This decreasing trend did not continue in 2010, as illustrated by Figure 4.11 which shows that the average concentration of particulate increased at all stations in 2010 compared to 2009 values.

It should be noted that the amount of precipitation during the sampling period was greater in 2009 than in 2010, which may explain the increase in the number of exceedances and the increase in average particulate concentrations in 2010. In 2009, the total precipitation for the months of July – September was 150.4 mm. In 2010 the total precipitation for the same months was 103.2 mm. As 2010 was drier than 2009, it would be expected that particulate concentrations would be greater.

Figure 4.11 – Summary of Historical Average PM Concentrations



4.6.3 Trace Elements Results

Trace element results are presented in Table 4.10 for Mini-vol and Table 4.11 for dustfall samples.

There were no exceedances of the AAQC for arsenic during the 2010 monitoring program. This is an improvement over previous years, in which there was at least one arsenic exceedance. During the 2009 monitoring program, there was one exceedance of the AAQC for arsenic. This was detected at the Northwest Pond location. In 2008 there was one exceedance, and in each of 2006 and 2007 there were three exceedances, all detected at the Northwest Pond location. In 2005 there were a total of eight exceedances of arsenic, four of which were at the Northwest Pond. Of the remaining four, three were at the South Pond location and one was at the B3 Pit. One of the exceedances at the South Pond was found in the inhalable size fraction (PM_{10}). It is therefore noted that there is a decreasing trend with regard to arsenic concentrations at the Giant Mine site. There has not been an arsenic concentration above the AAQC in the PM_{10} size fraction since 2005.

Similar to previous years, the only other trace element that exceeded its respective AAQC was iron. There was one exceedance in 2010, which is an improvement over previous years. There were four exceedances in 2009, compared to three exceedances in 2008, and five in 2007. It should be noted however that in 2008 one of the values above the AAQC was associated with the inhalable size fraction (PM_{10}), whereas none were detected in this size fraction in 2009. In 2006, there were sixteen exceedances of the iron AAQC, with three of them occurring in PM_{10} samples. In 2005 there were nineteen exceedances of the iron AAQC, with six occurring in the PM_{10} samples. Exceedances notably decreased after 2006, and results for 2007 to 2009 remained more or less constant. The single exceedance in 2010 is the least in any sampling year.

As 2010 was the first year of dustfall monitoring, there is no opportunity for a trend analysis. Trends will be evaluated as data becomes available in future monitoring programs.

4.6.4 Arsenic in Coarse Particles

In 2004, only one location had paired TSP and PM_{10} samplers (the South Pond location). This data was used to estimate the amount of arsenic that is contained in the coarse particles and how much is in the inhalable size fraction. This initial data 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. As paired samplers were adopted into the program starting in 2005, this figure has been tracked in the subsequent years. The years 2006 and 2007 show very similar results, indicating that an average of 63% of the measured arsenic is in the coarse size fraction. The 2005 arsenic concentrations in TSP and PM_{10} were highly variable, however, on average indicated that more than half of the measured ambient arsenic concentration was contained within the course particles. In 2008, an average of all the stations for which there was a valid sample for both TSP and PM_{10} samplers revealed that approximately 58% of the total arsenic is in the coarse size fraction. In the samples for the Northwest Pond location only (i.e., where most of the exceedances have occurred historically), it was found that approximately 70% of the arsenic is entrained in the coarse size fraction.

With the decrease in sampling efficiency in 2009, there were only 9 sampling days in which both a TSP and PM_{10} sample were collected at any given location. Averaging the arsenic levels in the inhalable size fraction versus the total particulate indicates that approximately 74% of the arsenic is entrained in the coarse size fraction.

In 2010, many of the valid PM_{10} samples were found to have non-detectable levels of arsenic. Between these non-detects and a number of invalid samples, there were only five sampling days with valid samples of both TSP and PM_{10} for use in making a comparison. The average percentage of arsenic entrained in the coarse size fraction was found to be 56%. While 2009 saw a decrease in the measured amount of arsenic in the inhalable size fraction, the 2010 result is very similar to the results from 2006 to 2008.

Table 4.10 – Ambient Air Metal Concentrations at the On-site Monitoring Locations

Start Date	Location	Al (µg/m3)	Sb (µg/m3)	As (µg/m3)	Ba (µg/m3)	Be (µg/m3)	B (µg/m3)	Cd (µg/m3)	Cr (µg/m3)	Co (µg/m3)	Cu (µg/m3)	Fe (µg/m3)	Pb (µg/m3)	Mn (µg/m3)	Mo (µg/m3)	Ni (µg/m3)	Se (µg/m3)	Ag (µg/m3)	Sr (µg/m3)	Tl (µg/m3)	Sn (µg/m3)	Ti (µg/m3)	V (µg/m3)	Zn (µg/m3)
13-Jul-10	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND
13-Jul-10	South Pond - TSP	ND	ND	8.47E-03	ND	ND	ND	ND	ND	ND	6.81E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND
13-Jul-10	B3 Pit -PM10	ND	ND	1.10E-02	ND	ND	ND	ND	8.33E-03	ND	ND	ND	ND	7.22E-03	ND	7.22E-03	ND	ND	ND	ND	6.39E-03	NI	ND	ND
13-Jul-10	B3 Pit -TSP	5.97E-01	ND	4.72E-02	ND	ND	ND	ND	9.58E-03	ND	7.36E-03	1.36E+00	ND	2.22E-02	ND	1.94E-02	ND	ND	ND	ND	ND	NI	ND	ND
13-Jul-10	Mill-PM10	ND	ND	1.94E-02	ND	ND	ND	ND	8.33E-03	ND	1.53E-02	ND	5.97E-03	8.75E-03	ND	ND	ND	ND	ND	ND	ND	NI	ND	ND
13-Jul-10	Mill-TSP	ND	ND	1.53E-02	ND	ND	ND	ND	8.75E-03	ND	5.83E-03	ND	ND	1.17E-02	ND	2.36E-02	ND	ND	ND	ND	ND	NI	ND	ND
13-Jul-10	NW Pond-PM10	3.33E-01	ND	2.92E-02	ND	ND	ND	ND	9.44E-03	ND	5.56E-03	9.03E-01	ND	1.25E-02	ND	8.47E-03	ND	ND	ND	ND	ND	NI	ND	ND
13-Jul-10	NW Pond-TSP	3.33E-01	7.36E-03	4.72E-02	ND	ND	ND	1.39E-02	9.44E-03	ND	8.47E-03	1.22E+00	8.19E-03	1.94E-02	ND	1.18E-02	ND	ND	ND	ND	7.64E-03	NI	ND	2.78E+00
19-Jul-10	South Pond - PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
19-Jul-10	South Pond - TSP	ND	ND	8.89E-03	ND	ND	ND	ND	1.18E-02	ND	5.69E-03	ND	ND	9.86E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Jul-10	B3 Pit -PM10	ND	ND	8.19E-03	ND	ND	ND	ND	1.04E-02	ND	2.08E-02	ND	4.44E-03	ND	ND	8.33E-03	ND	ND	ND	ND	2.22E-02	ND	ND	ND
19-Jul-10	B3 Pit -TSP	ND	ND	ND	ND	ND	ND	ND	1.06E-02	ND	1.13E-02	7.22E-01	ND	1.33E-02	ND	8.47E-03	ND	ND	ND	ND	ND	ND	ND	ND
19-Jul-10	Mill-PM10	ND	ND	ND	ND	ND	ND	ND	1.10E-02	ND	1.11E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Jul-10	Mill-TSP	ND	ND	ND	ND	ND	ND	ND	1.29E-02	ND	ND	ND	ND	9.44E-03	ND	7.64E-03	ND	ND	ND	ND	ND	ND	ND	ND
19-Jul-10	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	1.07E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Jul-10	NW Pond-TSP	ND	ND	1.67E-02	ND	ND	ND	ND	1.21E-02	ND	4.86E-03	ND	ND	9.72E-03	ND	8.47E-03	ND	ND	ND	ND	ND	ND	ND	ND
25-Jul-10	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	1.01E-02	ND	5.28E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
25-Jul-10	South Pond - TSP	ND	ND	2.50E-02	ND	ND	ND	ND	1.15E-02	ND	5.00E-03	8.33E-01	4.72E-03	1.35E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
25-Jul-10	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	1.10E-02	ND	5.56E-03	ND	ND	7.08E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
25-Jul-10	B3 Pit -TSP	ND	ND	ND	ND	ND	ND	ND	1.36E-02	ND	1.13E-02	ND	ND	7.50E-03	ND	8.19E-03	ND	ND	ND	ND	ND	ND	ND	ND
25-Jul-10	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
25-Jul-10	Mill-TSP	ND	ND	ND	ND	ND	ND	ND	9.50E-03	ND	5.25E-03	ND	ND	ND	ND	7.52E-03	ND	ND	ND	ND	ND	ND	ND	ND
25-Jul-10	NW Pond-PM10	ND	ND	ND	9.86E-03	ND	ND	ND	1.26E-02	ND	1.29E-02	ND	ND	ND	ND	1.35E-02	ND	ND	ND	ND	ND	ND	ND	ND
25-Jul-10	NW Pond-TSP	ND	ND	9.72E-03	9.58E-03	ND	ND	ND	1.15E-02	ND	9.58E-03	ND	ND	1.01E-02	ND	7.22E-03	ND	ND	ND	ND	5.42E-03	ND	ND	ND
31-Jul-10	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	9.31E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
31-Jul-10	South Pond - TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
31-Jul-10	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	9.58E-03	ND	ND	ND	ND	ND	ND	9.03E-03	ND	ND	ND	ND	ND	ND	ND	ND
31-Jul-10	B3 Pit -TSP	3.61E-01	ND	2.08E-02	ND	ND	ND	ND	1.10E-02	ND	6.39E-03	ND	4.44E-03	1.31E-02	ND	1.11E-02	ND	ND	ND	ND	ND	ND	ND	ND
31-Jul-10	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
31-Jul-10	Mill-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
31-Jul-10	NW Pond-PM10	ND	ND	2.64E-02	ND	ND	ND	ND	9.72E-03	ND	ND	ND	ND	7.22E-03	ND	7.50E-03	ND	ND	ND	ND	ND	ND	ND	ND
31-Jul-10	NW Pond-TSP	7.22E-01	3.33E-02	2.04E-01	ND	ND	ND	ND	7.59E-02	ND	2.22E-01	4.44E+00	2.22E-02	9.26E-02	1.81E-02	1.44E-01	ND	ND	ND	ND	1.48E-02	ND	ND	2.96E-01
6-Aug-10	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6-Aug-10	South Pond - TSP	ND	ND	1.03E-02	ND	ND	ND	ND	ND	ND	7.64E-03	ND	ND	1.00E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6-Aug-10	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	7.08E-03	ND	ND	ND	ND	ND	ND	7.78E-03	ND	ND	ND	ND	ND	ND	ND	ND
6-Aug-10	B3 Pit -TSP	6.39E-01	ND	3.19E-02	ND	ND	ND	ND	8.19E-03	ND	1.03E-02	1.38E+00	ND	2.36E-02	ND	8.89E-03	ND	ND	ND	ND	ND	2.22E-02	ND	ND
6-Aug-10	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
6-Aug-10	Mill-TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
6-Aug-10	NW Pond-PM10	ND	ND	ND	7.78E-03	ND	ND	ND	7.78E-03	ND	4.17E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6-Aug-10	NW Pond-TSP	6.67E-01	ND	4.86E-02	7.64E-03	ND	ND	ND	1.07E-02	ND	1.07E-02	1.33E+00	6.67E-03	2.64E-02	ND	9.03E-03	ND	ND	ND	ND	4.86E-03	2.36E-02	ND	8.61E-02
12-Aug-10	South Pond - PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
12-Aug-10	South Pond - TSP	ND	1.53E-02	9.72E-02	ND	ND	ND	ND	8.47E-03	ND	5.83E-03	1.94E+00	9.86E-03	1.94E-02	ND	8.19E-03	ND	ND	ND	ND	ND	ND	ND	ND
12-Aug-10	B3 Pit -PM10	ND	ND	8.61E-03	ND	ND	ND	ND	7.64E-03	ND	4.58E-03	ND	ND	ND	ND	6.94E-03	ND	ND	ND	ND	ND	ND	ND	ND

Start Date	Location	Al (µg/m3)	Sb (µg/m3)	As (µg/m3)	Ba (µg/m3)	Be (µg/m3)	B (µg/m3)	Cd (µg/m3)	Cr (µg/m3)	Co (µg/m3)	Cu (µg/m3)	Fe (µg/m3)	Pb (µg/m3)	Mn (µg/m3)	Mo (µg/m3)	Ni (µg/m3)	Se (µg/m3)	Ag (µg/m3)	Sr (µg/m3)	Tl (µg/m3)	Sn (µg/m3)	Ti (µg/m3)	V (µg/m3)	Zn (µg/m3)
12-Aug-10	B3 Pit -TSP	2.92E-01	ND	2.50E-02	ND	ND	ND	ND	9.31E-03	ND	5.69E-03	ND	ND	1.32E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.08E-02
12-Aug-10	Mill-PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
12-Aug-10	Mill-TSP	ND	ND	2.50E-02	ND	ND	ND	ND	1.06E-02	ND	1.11E-02	ND	4.31E-03	1.17E-02	ND	1.00E-02	ND	ND	ND	ND	7.92E-03	ND	ND	2.08E-01
12-Aug-10	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	9.03E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12-Aug-10	NW Pond-TSP	3.19E-01	ND	4.86E-02	ND	ND	ND	ND	8.61E-03	ND	7.22E-03	9.03E-01	5.28E-03	1.67E-02	ND	9.31E-03	ND	ND	ND	ND	ND	ND	ND	ND
19-Aug-10	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.69E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Aug-10	South Pond - TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
19-Aug-10	B3 Pit -PM10	ND	ND	ND	1.81E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Aug-10	B3 Pit -TSP	ND	ND	ND	ND	ND	ND	ND	1.18E-02	ND	5.28E-03	ND	ND	ND	ND	7.78E-03	ND	ND	ND	ND	ND	ND	ND	ND
19-Aug-10	Mill-PM10	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.72E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Aug-10	Mill-TSP	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.86E-03	ND	ND	ND	ND	8.19E-03	ND	ND	ND	ND	ND	ND	ND	1.00E-01
19-Aug-10	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.28E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19-Aug-10	NW Pond-TSP	ND	ND	ND	9.17E-03	ND	ND	ND	1.13E-02	ND	1.15E-02	ND	ND	1.04E-02	ND	8.75E-03	ND	ND	ND	ND	ND	ND	ND	ND
24-Aug-10	South Pond - PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Aug-10	South Pond - TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Aug-10	B3 Pit -PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
24-Aug-10	B3 Pit -TSP	3.65E-01	ND	2.08E-02	ND	ND	ND	ND	ND	ND	2.43E-02	ND	ND	1.44E-02	ND	1.15E-02	ND	ND	ND	ND	ND	2.43E-02	ND	1.13E-01
24-Aug-10	Mill-PM10	ND	ND	1.22E-02	ND	ND	ND	ND	ND	ND	8.47E-03	ND	ND	1.04E-02	ND	7.22E-03	ND	ND	ND	ND	ND	1.67E-02	ND	ND
24-Aug-10	Mill-TSP	3.89E-01	ND	1.53E-02	ND	ND	ND	ND	1.00E-02	ND	2.08E-02	8.47E-01	ND	1.53E-02	ND	9.72E-03	ND	ND	ND	ND	ND	2.78E-02	ND	ND
24-Aug-10	NW Pond-PM10	ND	ND	8.47E-03	ND	ND	ND	ND	ND	ND	1.53E-02	ND	ND	1.01E-02	ND	1.19E-02	ND	ND	ND	ND	ND	ND	ND	ND
24-Aug-10	NW Pond-TSP	3.47E-01	ND	1.67E-02	ND	ND	ND	ND	7.64E-03	ND	1.25E-02	7.08E-01	ND	1.28E-02	ND	1.07E-02	ND	ND	ND	ND	ND	1.53E-02	ND	ND
30-Aug-10	South Pond - PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Aug-10	South Pond - TSP	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.58E-03	ND	ND	ND	ND	8.06E-03	ND	ND	ND	ND	ND	ND	ND	ND
30-Aug-10	B3 Pit -PM10	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Aug-10	B3 Pit -TSP	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS	NS-INS
30-Aug-10	Mill-PM10	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.56E-03	ND	ND	8.06E-03	ND	7.64E-03	ND	ND	ND	ND	ND	ND	ND	7.50E-02
30-Aug-10	Mill-TSP	4.17E-01	ND	8.33E-03	ND	ND	ND	ND	ND	ND	8.06E-03	7.36E-01	ND	1.14E-02	ND	8.33E-03	ND	ND	ND	ND	ND	2.50E-02	ND	ND
30-Aug-10	NW Pond-PM10	3.61E-01	ND	ND	1.26E-02	ND	ND	ND	1.22E-02	ND	6.39E-03	ND	ND	1.31E-02	ND	1.25E-02	ND	ND	ND	ND	ND	2.08E-02	ND	ND
30-Aug-10	NW Pond-TSP	5.42E-01	ND	2.08E-02	ND	ND	ND	ND	8.06E-03	ND	6.67E-03	1.18E+00	ND	1.81E-02	ND	1.01E-02	ND	ND	ND	ND	ND	2.36E-02	ND	ND
5-Sep-10	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	1.06E-02	ND	5.14E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-Sep-10	South Pond - TSP	ND	ND	ND	ND	ND	ND	ND	2.92E-02	ND	8.61E-03	ND	ND	9.44E-03	ND	1.31E-02	ND	ND	ND	ND	ND	ND	ND	ND
5-Sep-10	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	1.13E-02	ND	5.14E-03	ND	4.86E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-Sep-10	B3 Pit -TSP	ND	ND	ND	7.64E-03	ND	ND	ND	ND	ND	5.97E-03	ND	ND	7.78E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-Sep-10	Mill-PM10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-Sep-10	Mill-TSP	ND	ND	ND	ND	ND	ND	ND	1.01E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-Sep-10	NW Pond-PM10	ND	ND	1.11E-02	ND	ND	ND	ND	7.78E-03	ND	5.42E-03	ND	ND	3.75E-02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5-Sep-10	NW Pond-TSP	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.72E-03	ND	ND	ND	ND	7.36E-03	ND	ND	ND	ND	ND	ND	ND	ND
11-Sep-10	South Pond - PM10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.25E-03	ND	ND	1.01E-02	ND	ND	ND	ND	ND	ND	ND	ND
11-Sep-10	South Pond - TSP	ND	ND	1.94E-02	ND	ND	ND	ND	ND	ND	1.14E-02	ND	4.86E-03	9.03E-03	ND	1.13E-02	ND	ND	ND	ND	ND	ND	ND	ND
11-Sep-10	B3 Pit -PM10	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.53E-03	ND	ND	9.72E-03	ND	2.22E-02	ND	ND	ND	ND	ND	ND	ND	ND
11-Sep-10	B3 Pit -TSP	ND	ND	ND	1.15E-02	ND	ND	ND	ND	ND	6.53E-03	ND	ND	ND	ND	1.53E-02	ND	ND	ND	ND	ND	ND	ND	ND
11-Sep-10	Mill-PM10	ND	ND	ND	1.01E-02	ND	ND	ND	ND	ND	9.72E-03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11-Sep-10	Mill-TSP	ND	ND	ND	1.67E-02	ND	ND	ND	ND	ND	1.17E-02	ND	ND	7.64E-03	ND	2.22E-02	ND	ND	ND	ND	ND	ND	ND	ND
11-Sep-10	NW Pond-PM10	ND	ND	ND	ND	ND	ND	ND	8.33E-03	ND	7.50E-03	ND	ND	ND	ND	1.35E-02	ND	ND	ND	ND	8.89E-03	ND	ND	ND
11-Sep-10	NW Pond-TSP	ND	ND	7.78E-03	ND	ND	ND	ND	8.89E-03	ND	9.03E-03	ND	ND	7.22E-03	ND	8.47E-03	ND	ND	ND	ND	ND	ND	ND	ND

Table 4.11 – Trace Element Deposition Rates from Dustfall Sampling

Analyte	Location 1 (mg/dm^2.day)	Location 2 (mg/dm^2.day)	Location 3 (mg/dm^2.day)	Location 4 (mg/dm^2.day)	Location 5 (mg/dm^2.day)	Location 6 (mg/dm^2.day)	Location 7 (mg/dm^2.day)	Location 8 (mg/dm^2.day)	Location 9 (mg/dm^2.day)	Location 10 (mg/dm^2.day)	Location 11 (mg/dm^2.day)	Location 12 (mg/dm^2.day)	Location 13 (mg/dm^2.day)	Location 14 (mg/dm^2.day)	Location 15 (mg/dm^2.day)	Location 16 (mg/dm^2.day)	Location 17 (mg/dm^2.day)	Location 18 (mg/dm^2.day)
Aluminum (Al)	2.14E-03	1.50E-03	5.30E-04	2.14E-03	1.33E-03	9.78E-04	4.71E-03	6.08E-04	2.29E-03	9.30E-04	2.26E-02	2.19E-03	2.03E-03	2.13E-02	7.87E-04	1.04E-03	1.91E-03	1.08E-03
Antimony (Sb)	1.70E-06	3.60E-06	1.70E-06	1.81E-05	1.01E-05	4.30E-06	1.41E-04	7.20E-06	8.10E-06	5.20E-06	1.09E-04	9.90E-06	6.40E-06	3.89E-05	2.15E-05	< 1.50E-06	1.27E-05	1.80E-06
Arsenic (As)	1.98E-05	3.04E-05	1.77E-05	1.43E-04	6.85E-05	3.49E-05	9.77E-04	5.58E-05	6.21E-05	7.13E-04	8.09E-04	6.31E-05	5.49E-05	3.87E-04	1.54E-04	1.49E-05	6.93E-05	1.77E-05
Barium (Ba)	3.02E-05	2.49E-05	1.56E-05	1.60E-05	5.06E-05	1.68E-05	2.81E-05	1.37E-05	2.62E-05	5.68E-05	8.51E-05	3.05E-05	2.07E-05	2.05E-04	1.63E-05	2.11E-05	2.26E-05	1.97E-05
Beryllium (Be)	< 6.90E-06	< 8.30E-06	< 8.00E-06	< 7.20E-06	< 7.40E-06	< 7.20E-06	< 7.30E-06	< 7.20E-06	< 7.60E-06	< 7.20E-06	< 7.90E-06	< 7.20E-06	< 7.20E-06	< 7.90E-06	< 7.20E-06	< 7.60E-06	< 6.90E-06	< 6.90E-06
Bismuth (Bi)	< 6.90E-06	< 8.30E-06	< 8.00E-06	< 7.20E-06	< 7.40E-06	< 7.20E-06	< 7.30E-06	< 7.20E-06	< 7.60E-06	< 7.20E-06	< 7.90E-06	< 7.20E-06	< 7.20E-06	< 7.90E-06	< 7.20E-06	< 7.60E-06	< 6.90E-06	< 6.90E-06
Boron (B)	< 1.40E-04	< 1.70E-04	< 1.60E-04	< 1.40E-04	< 1.50E-04	< 1.40E-04	< 1.50E-04	< 1.40E-04	< 1.50E-04	< 1.40E-04	< 1.60E-04	< 1.40E-04	< 1.40E-04	< 1.60E-04	< 1.40E-04	< 1.50E-04	< 1.40E-04	< 1.40E-04
Cadmium (Cd)	1.20E-05	< 8.30E-06	1.29E-06	1.10E-06	1.26E-05	2.05E-06	5.42E-06	8.59E-06	2.16E-06	5.01E-06	1.87E-06	7.37E-06	9.40E-07	< 7.90E-07	1.56E-06	4.01E-06	8.80E-07	4.57E-06
Calcium (Ca)	7.38E-03	5.34E-03	2.89E-03	7.72E-03	7.19E-03	5.80E-03	1.97E-02	5.12E-03	1.03E-02	1.59E-02	4.79E-02	1.61E-02	6.71E-03	2.70E-02	7.19E-03	3.88E-03	9.28E-03	4.40E-03
Chromium (Cr)	2.57E-05	< 8.30E-06	< 8.00E-06	1.09E-05	< 7.40E-06	< 7.20E-06	1.85E-05	< 7.20E-06	1.21E-05	1.06E-05	8.72E-05	1.03E-05	9.00E-06	8.69E-05	8.40E-06	< 7.60E-06	1.29E-05	< 6.90E-06
Cobalt (Co)	2.30E-06	2.30E-06	< 1.60E-06	4.00E-06	3.20E-06	2.10E-06	2.02E-05	2.30E-06	3.30E-06	2.30E-06	3.02E-05	3.30E-06	2.60E-06	2.14E-05	4.90E-06	< 1.50E-06	3.60E-06	< 1.40E-06
Copper (Cu)	1.48E-04	1.30E-04	1.59E-04	2.72E-05	1.03E-04	1.19E-04	1.25E-04	5.51E-05	3.68E-05	3.75E-04	7.71E-05	8.95E-05	2.58E-05	4.87E-05	< 2.30E-05	2.38E-04	< 1.90E-05	1.68E-04
Lead (Pb)	1.07E-05	6.29E-06	4.90E-06	1.35E-05	9.23E-06	4.24E-06	9.84E-05	3.88E-06	7.45E-06	6.91E-06	9.59E-05	7.33E-06	7.77E-06	3.15E-05	1.81E-05	6.65E-06	1.04E-05	5.81E-06
Lithium (Li)	< 6.90E-05	< 8.30E-05	< 8.00E-05	< 7.20E-05	< 7.40E-05	< 7.20E-05	< 7.30E-05	< 7.20E-05	< 7.60E-05	< 7.20E-05	< 7.90E-05	< 7.20E-05	< 7.20E-05	< 7.90E-05	< 7.20E-05	< 7.60E-05	< 6.90E-05	< 6.90E-05
Magnesium (Mg)	2.50E-03	1.73E-03	8.77E-04	2.78E-03	1.88E-03	1.53E-03	6.98E-03	1.42E-03	3.40E-03	1.03E-02	2.73E-02	3.45E-03	2.52E-03	1.94E-02	1.70E-03	1.21E-03	2.71E-03	1.28E-03
Manganese (Mn)	1.01E-04	8.51E-05	4.98E-05	1.38E-04	1.52E-04	8.71E-05	3.09E-04	9.77E-05	1.67E-04	1.97E-04	9.34E-04	2.12E-04	1.42E-04	6.20E-04	1.45E-04	5.96E-05	1.38E-04	6.98E-05
Molybdenum (Mo)	1.85E-06	< 8.30E-07	< 8.00E-07	< 7.20E-07	< 7.40E-07	< 7.20E-07	1.28E-06	< 7.20E-07	7.70E-07	4.45E-06	1.67E-06	< 7.20E-07	< 7.20E-07	1.11E-06	9.90E-07	< 7.60E-07	1.28E-06	< 6.90E-07
Nickel (Ni)	7.07E-04	6.93E-05	9.80E-06	1.63E-05	2.21E-05	< 7.20E-06	9.43E-05	3.32E-05	6.42E-05	2.25E-04	2.61E-04	5.90E-05	5.17E-05	7.66E-05	1.11E-04	7.02E-05	1.20E-04	3.59E-05
Potassium (K)	2.77E-03	1.22E-03	1.09E-03	1.91E-03	2.48E-03	7.30E-04	2.61E-03	1.00E-03	1.71E-03	1.01E-01	4.38E-03	1.22E-03	2.89E-03	8.10E-03	< 7.20E-04	1.04E-03	1.11E-03	2.78E-03
Selenium (Se)	< 1.40E-05	< 1.70E-05	< 1.60E-05	< 1.40E-05	< 1.50E-05	< 1.40E-05	< 1.50E-05	< 1.40E-05	< 1.50E-05	< 1.40E-05	< 1.60E-05	< 1.40E-05	< 1.40E-05	< 1.60E-05	< 1.40E-05	< 1.50E-05	< 1.40E-05	< 1.40E-05
Silver (Ag)	2.30E-07	< 1.70E-07	2.60E-07	1.40E-07	2.40E-07	< 1.40E-07	6.40E-07	< 1.40E-07	< 1.50E-07	5.20E-07	4.20E-07	< 1.40E-07	< 1.40E-07	1.70E-07	< 1.40E-07	< 1.50E-07	< 1.40E-07	< 1.40E-07
Sodium (Na)	2.49E-03	1.79E-03	< 8.00E-04	1.17E-03	1.69E-03	< 7.20E-04	4.85E-03	1.20E-03	1.20E-03	3.81E-03	2.84E-03	1.21E-03	9.50E-04	2.08E-03	1.58E-03	1.26E-03	1.20E-03	9.30E-04
Strontium (Sr)	1.87E-05	1.24E-05	< 8.80E-06	1.70E-05	2.08E-05	1.34E-05	4.94E-05	1.07E-05	2.76E-05	4.65E-05	5.72E-05	3.95E-05	1.40E-05	4.07E-05	1.32E-05	1.14E-05	1.47E-05	1.15E-05
Thallium (Tl)	< 1.40E-06	< 1.70E-06	< 1.60E-06	< 1.40E-06	< 1.50E-06	< 1.40E-06	< 1.50E-06	< 1.40E-06	< 1.50E-06	< 1.40E-06	< 1.60E-06	< 1.40E-06	< 1.40E-06	< 1.60E-06	< 1.40E-06	< 1.50E-06	< 1.40E-06	< 1.40E-06
Tin (Sn)	2.10E-06	< 1.70E-06	< 1.60E-06	< 1.40E-06	< 1.50E-06	< 1.40E-06	< 1.50E-06	< 1.40E-06	< 1.50E-06	1.70E-06	1.80E-06	< 1.40E-06	< 1.40E-06	< 1.60E-06	< 1.40E-06	2.20E-06	< 1.40E-06	< 1.40E-06
Uranium (U)	< 1.40E-07	< 1.70E-07	< 1.60E-07	2.10E-07	< 1.50E-07	< 1.40E-07	< 1.50E-07	< 1.40E-07	< 1.50E-07	1.60E-07	7.70E-07	< 1.40E-07	< 1.40E-07	1.01E-06	< 1.40E-07	< 1.50E-07	< 1.40E-07	< 1.40E-07
Vanadium (V)	< 1.40E-05	< 1.70E-05	< 1.60E-05	< 1.40E-05	< 1.50E-05	< 1.40E-05	< 1.50E-05	< 1.40E-05	< 1.50E-05	< 1.40E-05	7.20E-05	< 1.40E-05	< 1.40E-05	6.90E-05	< 1.40E-05	< 1.50E-05	< 1.40E-05	< 1.40E-05
Zinc (Zn)	3.09E-04	1.33E-04	8.00E-05	1.70E-04	2.31E-04	1.61E-04	2.67E-04	1.38E-04	1.60E-04	1.00E-03	2.81E-04	1.95E-04	1.37E-04	1.66E-04	1.88E-04	2.09E-04	1.62E-04	2.15E-04

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 each summer since 2004 to establish a baseline for the fugitive emissions from the tailings areas and other disturbed areas at the mine site.

The 2010 program was carried out from July through to mid September. The program consisted of ambient air monitoring of TSP and PM_{10} at four locations within the property boundary of the Giant Mine site, as well as dustfall sampling at eighteen locations throughout 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 2010 suspended particulate monitoring results indicate that the concentrations at the four sampling locations vary considerably with respect to average TSP and PM_{10} concentrations. The highest TSP concentration was detected at the B3 Pit; however the location with the highest average TSP concentration over the course of the 2010 program was the Northwest Pond location. The Northwest Pond location also had the maximum PM_{10} concentration and the highest average PM_{10} concentration.

The analyses of inorganic elements indicated that, with the exception of iron, all other concentrations were below their applicable AAQC. There was one exceedance of the AAQC for iron. This is an improvement over 2009 when there were four exceedances of iron, as well as one exceedance of arsenic. There were no exceedances of arsenic in 2010. Similar to previous monitoring years, the iron exceedance in 2010 was detected at the Northwest Pond location.

Overall, there was an increase in average TSP and PM_{10} concentrations in 2010 as compared to 2009. This increase was also accompanied by increases in the relative number of exceedances of the AAQCs for both TSP and PM_{10}. This may be due in part to the fact that 2010 was a drier summer than 2009.

A comparison of the amount of arsenic in the total particulate samples versus that in the inhalable size fraction revealed that on average, 56% of the arsenic is entrained in the coarse particles. This result is in line with previous monitoring programs which concluded that more than half of the total arsenic is entrained in the coarse particles as opposed to the inhalable particles. Arsenic contained in the coarse particles is less likely to have an impact on human health.

There were no dustfall samples that exceeded the criteria adopted for this assessment. The highest deposition rate, detected near the Northwest Pond, was approximately half of the criteria.

5.2 RECOMMENDATIONS

The results of the monitoring program do not strongly correlate when broad comparisons are made to meteorological data for exceedance days. Elevated concentrations are more likely associated with on-site activities close to the monitoring stations. For purposes of comparison to historical data and as a measure of general site air quality, it is recommended that the same monitoring program be continued for the period during the remediation activities at the Giant Mine site.

While there was an improvement in sampling efficiency, close to 20% of attempted samples were invalid in the 2010 program. For the Mini-vol sampling, this was attributable to equipment battery malfunction (data for 16 of 88 samples were not appropriate for inclusion in the analysis because of unacceptable variations in the sample duration of greater than ±25% of 24 hours). Under separate cover, SENES has made a number of recommendations to INAC to improve both data collection efficiency and data quality.

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:

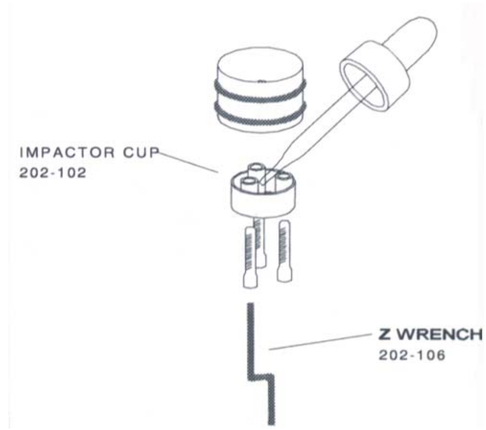
- 1 Mini-Vol pump module
- 2 battery packs
- 1 battery charger/transformer
- 1 tube of impactor grease
- hexane solvent
- 47 mm filters
- 1 field calibration kit including calibration orifice and flow measurement device (magnahelic or manometer)
- 1 tripod (for indoor or sampling in a protected area)
- 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.

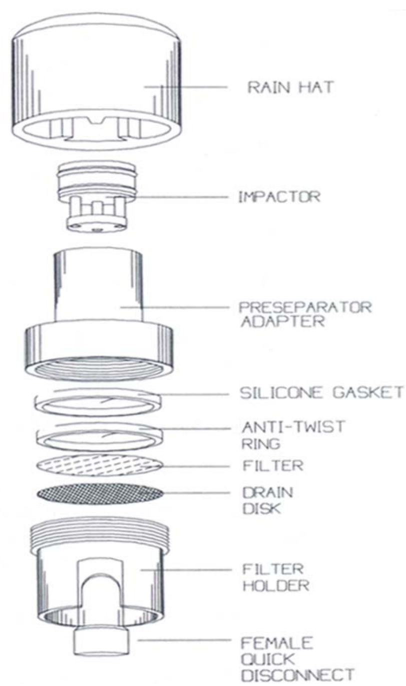
4. Prepare the sampler for initial use. Ensure that the filter holder assemblies, impactor discs and rain hats are free of dust and debris. Clean all parts with hexane to remove any grease and/or debris. Make up a suspension of 1” of impactor grease to 100 mL of hexane. Shake well until all grease is 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

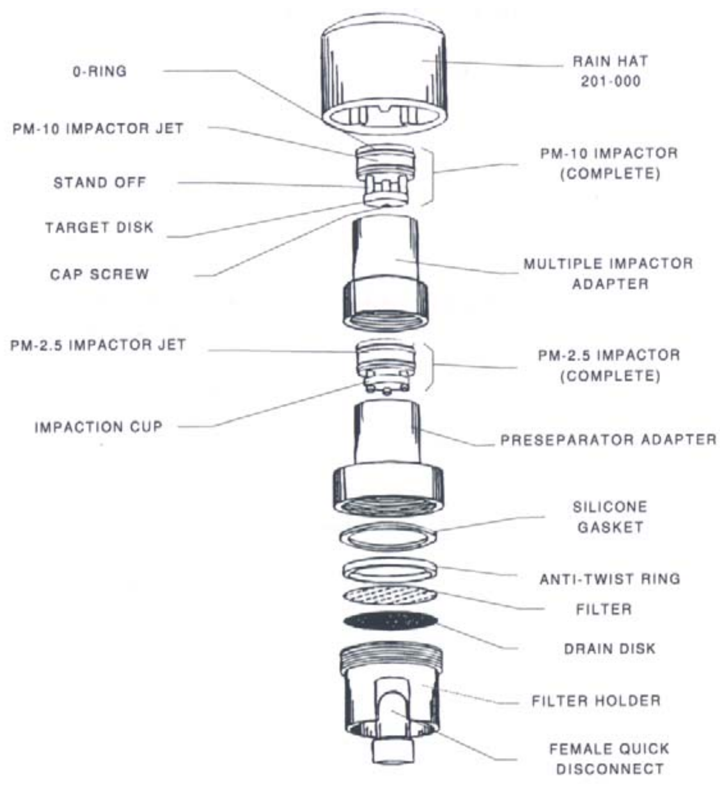


6. Assemble the filter holder and impactor assemblies. Unscrew the filter holder assembly and remove the drain disc filter support screen assembly. Use a narrow, flat edge (such as a flat head screwdriver) to pop the filter support ring off, and place a preweighed, numbered filter on the support screen 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 ($\mu g/m^3$).