**APPENDIX 5C-2**

AIR QUALITY MONITORING DURING BULK SAMPLING PREPARATIONS 2007, MILNE INLET

# FINAL REPORT

## AIR QUALITY MONITORING DURING BULK SAMPLING PREPARATIONS (2007) BAFFINLAND IRON MINES CORPORATION MILNE INLET, NUNAVUT

**Project Number: #W07-5226B** **March 13, 2008**

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**Companion Documents:** Noise Monitoring During Bulk Sampling Preparations (2007)
Baseline Air Quality Assessment (Oct 30, 2007)

## EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) was retained by Knight Piésold to conduct an air quality monitoring program at Milne Inlet during preparations for the bulk sampling program, to be undertaken by Baffinlands Iron Mines Corporation (Baffinlands). The purpose of the monitoring program was to assess the air quality impacts from these preparation and construction activities. The monitoring results will also assist in understanding air quality impacts from the future construction of the mine and ancillary activities. An additional monitoring program is tentatively planned for February or March 2008 to establish air quality impacts from the bulk sampling program.

Air concentrations of selected air contaminants were measured in the vicinity of the Milne Inlet site over the course of a three week period (August 31 to September 23, 2007). Activities at this time included a sealift, which arrived on September 1st and finished unloading on September 7th. There were a number of pieces of equipment in use at the dock/beach area during the sealift including, cranes, barges, a tugboat, and front end loaders. Other activities during the monitoring period included five to seven aircraft flights a day, light-duty vehicle trips, and road construction.

The monitoring program was designed with consideration for the limited availability of AC power and the potential for harsh weather conditions. Equipment were selected that either required no power (so-called passive monitoring devices) or ran on DC batteries (active monitoring devices).

The passive sampling program involved the collection of $SO_2$, $NO_2$, $O_3$, and dustfall samples simultaneously at the airstrip, dock/beach area, near the road construction activities and, in the case of dustfall, near the hunting camp. Duplicate monitors for $SO_2$, $NO_2$, and $O_3$ were installed at the dock/beach location. Monitoring was conducted at each location for a 20 to 24-day period. The dustfall samples were analyzed for total dustfall and individual metals.

The active monitoring program involved the measurement of total suspended particulate matter (TSP) and various metal concentrations. Samples were collected simultaneously from three locations; the airstrip, the dock/beach area and near the road construction activities, using battery-powered Airmetrics "MiniVol" samplers. Each sample was collected over a 24-hour period. A duplicate monitor was set up at the dock/beach area.

This program also involved the use of DustTrak instruments to monitor particulate matter with aerodynamic diameters less than 10 µm (*i.e.*, $PM_{10}$). The instruments were set up at the same locations as above plus near a hunting camp, which although not widely used, is available to the Inuit as a refuge during hunting activities. While the TSP monitors involved collecting samples on a filter medium that is taken away to be analyzed later, the DustTraks are a light scattering device that provide continuous measurements in real time. The limitation of DustTraks is that they provide only $PM_{10}$ and do not provide information on metals.

The results of the program were compared to indicator thresholdsand baseline air quality levels established from the previous ambient monitoring program at Mary River. The ambient air quality criteria selected for the comparison were based on Federal Air Quality Objectives (AQOs), where available, and air quality criteria, objectives and standards from various Canadian provincial jurisdictions. There are currently no air quality criteria specific to Nunavut. The AQOs referenced are intended to provide protection against effects on soil, water, vegetation, materials, visibility, personal comfort and well being. The indicator thresholds for metals were based on standards and criteria for Ontario, which are generally based on human health effects. The indicator thresholds for dustfall were based on criteria for Alberta, which are based on nuisance considerations. These indicator thresholds are typically applied at and beyond a fenceline or project boundaries in the air quality assessment process.

Although the air quality monitoring program represented only a brief snapshot in time, it coincided with weather conditions and types of activities that were representative of what occurred throughout bulk sampling preparations. Elevated levels of TSP and dustfall in excess of the indicator thresholds adjacent to the dock/beach area were measured. These impacts, which were very localized, were likely due to a combination of the sealift activities and vehicle traffic

in the area. TSP levels decreased to one half of the indicator threshold at about 1 km from the dock/beach area. Dustfall levels decreased to a fraction of the threshold by 1 km from the dock/beach area. Similarly, elevated silicon concentrations in excess of the indicator threshold for silica were measured at the dock/beach area. These elevated levels are likely attributable to high silica levels in the sand beach and roadways adjacent to the monitoring location. Again, the silicon levels fell below the indicator threshold by about 1 km from the dock/beach area. Measured concentrations of all other metals were well below their respective thresholds at all locations.

Measured $PM_{10}$ levels were below the indicator thresholds at all locations. The maximum $PM_{10}$ concentrations were measured at the dock/beach area. Unlike the TSP measurements, however, there was little variability in measured $PM_{10}$ concentrations across all locations, with the exception of the dock/beach area. This is likely because the measured $PM_{10}$ levels were close to the detection limit of the DustTrak instruments at all of the locations, with the exception of the dock/beach area. Therefore, the $PM_{10}$ results may not be very reliable at these other locations (i.e., the air strip, adjacent to the road construction and the hunting camp). Based on the TSP measurements, one would expect the $PM_{10}$ concentrations to be lower than measured at these locations.

Measured $SO_2$ and $NO_2$ levels were much lower than the indicator thresholds and were fairly consistent with background ambient air quality levels at Mary River.

Measured monthly $O_3$ levels were in excess of the indicator thresholds at all of the locations. $O_3$ is not directly emitted, but rather results from a series of complex reactions of $NO_x$ and VOCs in the atmosphere. Given that the local sources of $NO_x$ are limited, as indicated in the measured $NO_2$ concentrations, the high $O_3$ concentrations, which were somewhat above the levels observed during the baseline program, are likely due regional rather than local factors.

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## FIGURES

# 1. INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by Knight Piésold to conduct an air quality monitoring program at Milne Inlet during preparations for the bulk sampling program, to be undertaken by Baffinlands Iron Mines Corporation (Baffinlands). The purpose of the monitoring program was to assess the air quality impacts from these preparation and construction activities. This information will also assist in understanding air quality impacts from the future construction of the mine and ancillary activities. An additional monitoring program is tentatively planned for February or March 2008 to establish air quality impacts from the bulk sampling program.

Air concentrations of selected air contaminants were measured in the vicinity of the Milne Inlet site over the course of a three week period (August 31 to September 23, 2007). Air contaminants monitored as part of the program included:

- total suspended particulate (TSP) and metals;
- inhalable particulate matter ($PM_{10}$);
- total particulate (dustfall) and metals deposition;
- sulphur dioxide ($SO_2$);
- nitrogen dioxide ($NO_2$); and
- ozone ($O_3$).

The selection of air contaminants was the same as those monitored in the baseline air quality report, with the exception of metals, so that impacts from the preparation and construction activities could be assessed against baseline air quality levels. The selection of air contaminants in the baseline air quality report were made in consultation with Knight Piésold, and took into consideration air contaminants typically associated with mining operations and with the anticipated activities of the BIMC project.[1] In addition, RWDI consulted with an Environment Canada air quality expert in Yellowknife who provides input to regional government authorities on air quality assessments for mining projects.[2]

[1] $PM_{2.5}$ measurements were not performed because – based on experience in such pristine environments, where particulate matter levels are very low – short-term monitoring would yield results below the levels of detection.
[2] Personal communication with Dave Fox, Environment Canada, Yellowknife, NWT: July 4, 2007.

The monitoring program was designed with consideration for the limited availability of AC power and the potential for harsh weather conditions. Equipment were selected that either required no power (so-called passive monitoring devices) or ran on DC batteries (active monitoring devices).

The passive sampling program involved the collection of $SO_2$, $NO_2$, $O_3$, and dustfall, while the active monitoring program involved the measurement of total suspended particulate matter (TSP), monitor particulate matter with aerodynamic diameters less than 10 µm (*i.e.*, $PM_{10}$) and various metal concentrations.

This report describes the details of the monitoring program, the preparation and construction activities that occurred during the monitoring period and provides a summary of the results. The findings are compared to relevant ambient air quality criteria and the baseline air quality levels as established from the previous ambient monitoring program at Mary River.

## 2. AMBIENT AIR QUALITY CRITERIA

There are currently no regulated air quality criteria specific to Nunavut. The criteria used to assess impacts from the preparation and construction activities for the bulk sampling program at the BIMC project site included:

- Federal Air Quality Objectives (AQOs) defined under the Canadian Environmental Protection Act (Health Canada 2005);
- Canada-Wide Standards (CWS) established by the Canadian Council of Ministers of the Environment (CCME, 2000); and,
- AQOs from the Northwest Territories and from other provincial jurisdictions (NWT Department of Resources, Wildlife and Economic Development, 2002).

Table 1 identifies and compares the Federal AQOs, the Northwest Territories criteria and the CWS. The criteria refer to different averaging periods to account for potential short-term acute exposures and long-term chronic exposures. Further explanation of the criteria for particulate matter, ozone, dust deposition and metals is provided in the baseline air quality assessment report (DRAFT Baseline Air Quality Assessment Baffinlands Iron Mines Corporation Mary River, Nunavut, submitted by RWDI AIR Inc to Knight Piesold Ltd., October 30, 2007).

Table 2 provides ambient air quality criteria and standards for metals for Ontario, which are generally based on human health effects.

Table 3 identifies dust deposition criteria for Alberta and Ontario. The basis for these criteria appears to be nuisance considerations. The Ontario values have been recalculated to be in the same units as the Alberta criteria.

**Table 1: Ambient Air Quality Criteria, Standards and Objectives**

| Contaminant | Averaging Time | Federal Air Quality Objectives | | | Canada Wide Standard | NWT | Indicator Threshold |
|---|---|---|---|---|---|---|---|
| | | Desirable | Acceptable | Tolerable | | | |
| TSP ($\mu g/m^3$) | 24 hr | - | 120 | 400 | - | 120 | **120** |
| | Annual | 60 | 70 | - | - | 60 | **60** |
| $PM_{10}$ ($\mu g/m^3$) | 24 hr | - | - | - | - | 50* | **50** |
| $PM_{2.5}$ ($\mu g/m^3$) | 24 hr | - | - | - | 30 | 30 | **30** |
| $SO_2$ ($\mu g/m^3$) | 1 hr | 450 | 900 | - | - | 450 | **450** |
| | 24 hr | 150 | 300 | 800 | - | 150 | **150** |
| | Annual | 30 | 60 | - | - | 30 | **30** |
| $NO_2$ ($\mu g/m^3$) | 1 hr | - | 400 | 1,000 | - | - | **400** |
| | 24 hr | - | 200 | 300 | - | - | **200** |
| | Annual | 60 | 100 | - | - | - | **60** |
| CO ($\mu g/m^3$) | 1 hr | 15,000 | 35,000 | - | - | - | **15,000** |
| | 8 hr | 6,000 | 15,000 | 20,000 | - | - | **6,000** |
| $O_3$ ($\mu g/m^3$) | 1 hr | 100 | 160 | 300 | - | - | **100** |
| | 8 hr | - | - | - | 127 | 127 | **127** |
| | 24 hr | 30 | 50 | - | - | - | **30** |
| | Annual | - | 30 | - | - | - | **30** |

*Ontario Interim Ambient Air Quality Criterion (AAQC). Ontario Ministry of the Environment, September 2001.

**Table 2: 24-hour Criteria for Metals**

| Parameter | Ontario Air Quality Standards and Criteria ($\mu g/m^3$) |
|---|---|
| Ag | 1 |
| Al | N/A |
| As | 0.3 |
| B | 120 |
| Ba | 10 |
| Be | 0.01 |
| Bi | N/A |
| Ca | N/A |
| Cd | 2 |
| Cl | 10 |
| Co | 0.1 |
| Cr | 1.5 |
| Cu | 50 |
| Fe | 4 |
| Hg | 2 |
| K | N/A |
| Li | 20 |
| Mg | 120 |
| Mn | 2.5 |
| Mo | 120 |
| Na | N/A |
| Ni | 2 |
| P | N/A |
| Pb | 2 |
| S | N/A |
| Sb | 25 |
| Se | 10 |
| Si | 5* |

| Parameter | Ontario Air Quality Standards and Criteria (µg/m³) |
|---|---|
| Sn | 10 |
| Sr | 120 |
| Th | N/A |
| Ti | 120 |
| Tl | N/A |
| U | N/A |
| V | 2 |
| Zn | 120 |

**Notes:** * Represents the criterion for silica.

**Table 3: Dust Deposition Criteria**

| Averaging Time | Alberta Residential and Recreation Areas | Alberta Commercial and Industrial Areas | Ontario | Indicator Threshold |
|---|---|---|---|---|
| 1 Month | 53 mg/100cm$^2$/30 d | 158 mg/100cm$^2$/30 d | 70 mg/100 cm$^2$/30 d | **53 mg/100 cm$^2$/30 d** |
| | 5.3 g/m$^2$/30 d | 15.8 g/m$^2$/30 d | 7 g/m$^2$/30 d | |
| Annual | - | - | 4.6 g/m$^2$/yr | **46 mg/100 cm$^2$/yr** |
| | - | - | 46 mg/100 cm$^2$/yr | |

In general, the indicator thresholds are intended to provide protection against effects on soil, water, vegetation, materials, visibility, or human health effects. It should be noted, however that the indicator thresholds are typically applied at and beyond a fenceline or project boundaries in the air quality assessment process.

# 3. METHODOLOGY

## 3.1 Sampling Locations

The monitoring locations are shown in Figure 1. Table 4 provides the corresponding UTM coordinates.

Sampling locations were selected to represent areas potentially impacted from the activities occurring at the Milne Inlet port site and sensitive areas. The sampling locations included the airstrip, the dock/beach area, the road construction area and the camping area by the old cabin. Specific monitoring locations were selected based on the review of wind data collected at Milne Inlet, as summarized in the baseline meteorological report. An effort was made to locate monitors downwind of the air emission sources in order to determine worst-case impacts resulting from the emission sources. The camping area by the old cabin is the only existing sensitive land use within 3 km of the project and is mainly used in the summer (June, July and August). The old cabin provides a main focal point of the camp site and is used as a refuge for hunters in the area in the event of inclement weather.

**Table 4: Monitor Locations (UTM Zone 17, NAD83)**

| Monitor Location | NAD83 UTM Easting (m) | NAD83 UTM Northing (m) | Comments |
|---|---|---|---|
| Airstrip | 503127 | 7973418 | On flat area South of Milne Inlet |
| Dock/Beach | 503184 | 7976404 | On sloping terrain South of Milne Inlet |
| Road Construction | 507703 | 7969974 | On flat area South of Milne Inlet |
| Camping area by the old cabin | 504594 | 7976408 | On flat area South of Milne Inlet. DustTrak samples only. |

## 3.2 Activities during Sampling Period

Table 5 summarizes the activities that occurred during the sampling periods.

**Table 5: Activities During Sampling Period**

| Activity Area | Activities During Sampling Period |
|---|---|
| **Airstrip** | • Airstrip was in use only during daylight hours.<br>• There were approximately 20 planes scheduled to take off and land per day. That number became closer to 5-7 when fuel levels were shorter than expected.<br>• Planes generally touched down and took off on the southern half of the airstrip and rarely used the northern section.<br>• There is also a helicopter pad, but it was rarely used during the monitoring program.<br>• There is a local road around the north end of the air strip, which was used by light duty vehicles travelling to the camps and to the various construction areas.<br>• Air monitoring equipment was set up approximately 160 meters from the southwest edge of the airstrip.<br>• The air monitors were strategically located to capture emissions from the activities of the planes from touch downs, taxiing to the loading location, engines revving down, engines starting up, engines revving up, taxiing to the take off location and take off. |
| **Dock/Beach** | • The sealift arrived around September 1st and finished unloading around September 7th, 2007. This activity occurs approximately 7 days a month. Cranes on the sealift lifted the crates and equipment off the boat unto the barges. Two barges were in operation for the unloading process. A single tugboat manoeuvred the barge on the water. There were approximately 3 front end loaders that were in operation during the unloading of the barge. The unloading time varied significantly by day. On average they unloaded for 16-20 hours and then stopped for 6-8 hour periods.<br>• There were multiple generators in use. |

| Activity Area | Activities During Sampling Period |
|---|---|
| | • Two backhoes were used to move equipment around the camp.<br>• Air monitoring equipment was set up approximately 100 meters from the docking location of the barge. |
| **Road Construction Area** | • Multiple large scale pieces of equipment were in use, including, but not limited to backhoes, bull dozers, excavators, dump trucks, scrapers, roller and vibratory screens. At the time of the assessment, the construction of the road was approximately 10 km from the Milne Inlet camp site.<br>• Air monitoring equipment was set up approximately 30 m from the roadway. |

## 3.3 Sampling Methods

### 3.3.1 Active Monitoring Program: $PM_{10}$, TSP and Metals

The remote nature of the study area, lack of line power, and low ambient temperatures were factors that influenced the selection of monitoring methodologies and equipment. The methods selected are in many cases different from the reference methodologies used under normal conditions. The methodologies and equipment selected allowed for easy transportation of equipment and operated from a battery power source.

DustTrak instruments were used to monitor particulate matter with aerodynamic diameters less than 10 µm (*i.e.,* $PM_{10}$). A Dustrak is a light scattering device that provides continuous measurements in real time. The limitation of the DustTrak is that it provides only $PM_{10}$ and does not provide information on metals. The instruments were housed in an enclosure with the sample inlet located two metres above grade. Hourly averages of one-second concentration measurements were recorded, and 24-hour averages were calculated from the 1-hour average recorded data. The instruments operated on a continuous basis throughout the program. The sampling dates are summarized in Table 6.

**Table 6: $PM_{10}$ Sampling Locations and Dates**

| Location | Sample No. | Start Date | Stop Date | Sample Duration (hrs) |
|---|---|---|---|---|
| Air Strip | Test 1 | Aug 31 @ 17:14 | Sept 1 @ 16:54 | 23.7 |
| | Test 2 | Sept 1 @ 17:00 | Sept 2 @ 17:30 | 24.5 |
| | Test 3 | Sept 2 @ 17:30 | Sept 3 @ 17:26 | 23.9 |
| | Test 4 | Sept 3 @ 17:31 | Sept 4 @ 17:26 | 23.9 |
| Dock/Beach | Test 1 | Sept 1 @ 11:26 | Sept 2 @ 10:51 | 23.4 |
| | Test 2 | Sept 2 @ 11:25 | Sept 3 @ 9:58 | 22.5 |
| | Test 3 | Sept 3 @ 10:20 | Sept 4 @ 11:22 | 25.0 |
| | Test 4 | Sept 4 @ 11:28 | Sept 5 @ 11:29 | 24.0 |
| Road Construction | Test 1 | Sept 3 @ 14:39 | Sept 4 @ 15:38 | 25.0 |
| | Test 2 | Sept 4 @ 15:40 | Sept 5 @ 15:00 | 23.7 |
| Camping area by the old cabin | Test 1 | Sept 2 @ 21:21 | Sept 3 @ 21:43 | 23.7 |
| | Test 2 | Sept 3 @ 21:48 | Sept 4 @ 19:12 | 22.5 |
| | Test 3 | Sept 4 @ 19:14 | Sept 5 @ 18:27 | 23.3 |

The Dustrak instruments used during the $PM_{10}$ monitoring are influenced by ambient temperature. For all sampling periods, the ambient temperature was below the calibration temperature of 25$^{o}$C. The data recorded was corrected using the manufacturers stated correction factor of 1 µg/m$^3$ for every degree C below the calibration temperature.

A battery-powered Airmetrics "MiniVol" sampler was used to collect TSP and various metals samples as 110V AC power was not available. It was also more practical for shipping and deployment than the more conventional 110V AC based samplers that tend to be larger. While MiniVol samplers do not have accreditation as U.S. EPA equivalent method devices, they have been widely accepted by regulatory agencies in a number of jurisdictions **(Airmetrics, 2001). Although the instruments are not accredited, the analytical methods are accredited according to the U.S. EPA Compendium Method IO-2.3 "Sampling of Ambient Air for Total Suspended Particulate Matter and $PM_{10}$ Using a Low-Volume Sampler" (U.S. EPA Compendium Method IO-2.3, 2005). This compendium method was followed in this study.

Duplicate samplers were installed at the dock/beach monitoring location but not at other locations as shipping delays reduced the amount of available equipment. A tripod assembly was used to support the sampler. The inlet height of the samplers was approximately two metres above grade.

All MiniVol samples were collected on filters at a flow rate of approximately 5 litres/min for a duration of approximately 24 hours. Samples were collected for a 4-day period. The TSP filters were sent to Alberta Research Council (ARC) for gravimetric and metals analysis. The TSP sampling locations and dates are summarized in Table 7.

**Table 7: Summary of TSP and Metals Sampling Locations Dates**

| Location | Sample No. | Start Date | Stop Date | Sample Duration (hrs) |
|---|---|---|---|---|
| Airstrip | P6068336 | Aug 31 @ 17:20 | Sept 1 @ 17:03 | 23.3 |
| | P6068292 | Sept 1 @ 17:03 | Sept 2 @ 17:30 | 24.5 |
| | P6068288 | Sept 2 @ 17:30 | Sept 3 @ 17:27 | 23.9 |
| | P6068316 | Sept 3 @ 17:27 | Sept 4 @ 17:30 | 24.1 |
| Dock/Beach | P6068335 | Sept 1 @ 11:24 | Sept 2 @ 11:20 | 23.9 |
| | P6068290 | Sept 2 @ 11:20 | Sept 3 @ 11:15 | 23.9 |
| | P6068287 | Sept 3 @ 11:15 | Sept 4 @ 11:19 | 24.1 |
| | P6068313 | Sept 4 @ 11:19 | Sept 5 @ 11:30 | 24.2 |
| Dock/Beach (duplicate) | P6068294 | Sept 1 @ 11:24 | Sept 2 @ 11:20 | 23.9 |
| | P6068291 | Sept 2 @ 11:20 | Sept 3 @ 11:15 | 23.9 |
| | P6068286 | Sept 3 @ 11:15 | Sept 4 @ 11:19 | 23.9 |
| | P6068314 | Sept 4 @ 11:19 | Sept 5 @ 11:30 | 24.2 |
| Road Construction | P6068293 | Sept 1 @ 14:39 | Sept 2 @ 15:10 | 24.5 |
| | P6068289 | Sept 2 @ 15:10 | Sept 3 @ 14:35 | 23.2 |
| | P6068285 | Sept 3 @ 14:35 | Sept 4 @ 15:35 | 25.0 |
| | P6068315 | Sept 4 @ 15:35 | Sept 5 @ 15:00 | 23.6 |

### 3.3.2 Passive Sampling Program ($SO_2$, $NO_2$, $O_3$ and Total Dustfall Deposition)

Sampling for $SO_2$, $NO_2$ and $O_3$ was conducted using passive monitors from Maxxam Analytics Inc. Passive monitors are devices that collect gaseous pollutants through diffusion or permeation onto a specially designed substrate. No power is required for these monitors. This monitoring technique, which was the only practical method of monitoring these contaminants at this site, had the disadvantage of providing only tong-term (approximately 1-month) concentrations. It did not provide information on short-term (1-hour or 24-hour) peak concentrations. The monitors were deployed at each location for a 20 to 24-day period. Monitors were supported by a tripod at a height of two metres above grade.

Particulate deposition (dustfall) samplers were also placed at each of the sampling locations, except for the camping area by the old cabin. These samplers are also passive in nature and require no power. Duplicate samples were collected at all of the locations. These samplers collect total deposited particulate, including metals. The dustfall samplers were deployed for a 20 to 21-day period. The samples were submitted to ARC for total deposition and metals analysis.

Samples using passive monitors and deposition samplers were collected at the locations and dates shown in Table 8 (locations also shown in Figure 1).

**Table 8: Passive Sampling Locations and Dates**

| Location | Type of Sample | Start Date | Stop Date |
|---|---|---|---|
| Airstrip | Dustfall Jars | Aug 31 @17:15 | Sept 23, 2007 |
| | Passive | Aug 31 @17:20 | Sept 23, 2007 |
| Dock/Beach | Dustfall Jars | Sept 1 @ 11:24 | Sept 23, 2007 |
| | Passive | Sept 3 @ 10:20 | Sept 23, 2007 |
| Road Construction | Dustfall Jars | Sept 1 @ 14:39 | Sept 23, 2007 |
| | Passive | Sept 3 @ 14:35 | Sept 23, 2007 |

## 3.4 Meteorological Conditions during Sampling Period

The location and description of the meteorological measurements are provided in the meteorological report (Draft Baseline Meteorological Assessment for Baffinland Iron Mines Corporation, Submitted by RWDI AIR Inc. November 6, 2007).

The average temperature during the monitoring program was about 1°C, ranging from 10 °C to -5 °C near the end of the three week monitoring period. Precipitation during the program was minimal and totalled 7.3 mm. The wind data during the active monitoring program corresponding to the period when maximum concentrations were measured are summarized in Figures 2 through 8. The wind data for the passive monitoring program are summarized in Figures 9 through 11.

## 3.5 Sample Analysis, Instrument Calibrations and Calculations

### 3.5.1 Active Monitoring Program

TSP filters were sent to Alberta Research Council (ARC) for weighing and metals analysis. The resultant masses were divided by the volume of airflow through the samplers, which was calculated based on the calibration sheets for the MiniVol samplers provided by the supplier [Airmetrics, September 2007]. This process yielded 24-hour average TSP and metals concentrations (µg/m³).

### 3.5.2 Passive Monitoring Program

$SO_2$, $NO_2$ and $O_3$ samples were sent to Maxxam Analytics Inc. for analysis. The results were provided in units of parts per billion (ppb) and were converted to µg/m³ assuming standard conditions of 25 ºC and 101.325 kPa.

Deposition samples were also collected using dustfall jars. The dustfall samples were sent to ARC for dust and metals analysis. The results were provided as total mass in grams. Deposition rates were calculated in units of mg/100 $cm^2$/30 days.

## 3.6 Quality Assurance Measures

A number of quality assurance measures were implemented during the sampling program to ensure the integrity of the results. These measures included detailed documentation of all field activities, analysis of unexposed samples (blanks), duplicate sampling and a number of laboratory related measures including sample handling procedures and instrument calibrations. Chain of custody forms were completed and submitted with the samples to the laboratory.

# 4. RESULTS

The results of the ambient monitoring program are summarized in Figures 2 to 11 along with coincident wind data.

Although the air quality monitoring program represented only a brief snapshot in time, it coincided with weather conditions and types of activities that were representative of what occurred throughout bulk sampling preparations.

## 4.1 TSP Concentrations

Table 9 shows the TSP concentrations measured at each monitoring location. The samples were taken over 24-hour time periods and are compared to the 24-hour threshold value.

**Table 9: TSP Concentrations**

| Sampling Location | Maximum TSP Concentrations During Bulk Sampling Preparations ($\mu g/m^3$) | Range of Maximum Baseline TSP Concentrations ($\mu g/m^3$) |
|---|---|---|
| ***24-hour Indicator Threshold*** | ***120 µg/m³*** | |
| Airstrip | 62 | 3.0-7.0 |
| Dock/Beach | 135 | |
| Dock/Beach (duplicate) | 128 | |
| Road Construction | 23 | |

The maximum measured 24-hour TSP concentration was 135 $\mu g/m^3$, which occurred at the dock/beach area (Figure 3). A similar level was measured at the duplicate sampler (128 $\mu g/m^3$). These levels are above the indicator threshold of 120 $\mu g/m^3$. These impacts, which were very localized, were likely due to a combination of the sealift activities and vehicle traffic immediately adjacent to the monitors. TSP levels decreased to one half of the indicator threshold at the airstrip monitoring location, which was about 1 km from the dock/beach area.

Maximum measured 24-hour TSP concentration, which was measured about 30 m from the roadway is much less than the indicator threshold.

## 4.2 Metals Concentrations

Table 10 shows the metal concentrations measured at each monitoring location. The samples were taken over a 24-hour time period and are compared to 24-hour threshold values, where available.

**Table 10: Metals Concentrations**

| Parameter | Ontario Metals Criteria (µg/m³) | Dock/Beach (µg/m³) | Dock/Beach (duplicate) (µg/m³) | Airstrip (µg/m³) | Construction (µg/m³) |
|---|---|---|---|---|---|
| Ag | ***1*** | 0.00003 | 0.00003 | 0.00003 | 0.00004 |
| Al | ***N/A*** | 3.4 | 3.1 | 0.9 | 0.5 |
| As | ***0.3*** | 0.0002 | 0.0002 | 0.0001 | 0.0000 |
| B | ***120*** | 0.01 | 0.01 | 0.00 | 0.00 |
| Ba | ***10*** | 0.028 | 0.026 | 0.009 | 0.006 |
| Be | ***0.01*** | 0.0001 | 0.0001 | 0.0000 | 0.0000 |
| Bi | ***N/A*** | 0.0001 | 0.0000 | 0.0001 | 0.0000 |
| Ca | ***N/A*** | 12.8 | 11.6 | 3.8 | 2.1 |
| Cd | ***2*** | 0.00006 | 0.00008 | 0.00011 | 0.00001 |
| Cl | ***10*** | 0.54 | 0.59 | 0.56 | 0.19 |
| Co | ***0.1*** | 0.0009 | 0.0013 | 0.0003 | 0.0002 |
| Cr | ***1.5*** | 0.003 | 0.002 | 0.005 | 0.001 |
| Cu | ***50*** | 0.002 | 0.006 | 0.004 | 0.014 |
| Fe | ***4*** | 2.1 | 1.8 | 0.9 | 0.4 |
| Hg | ***2*** | 0.00001 | 0.00001 | 0.00001 | 0.00001 |
| K | ***N/A*** | 2.9 | 2.6 | 0.8 | 0.5 |
| Li | ***20*** | 0.005 | 0.004 | 0.001 | 0.001 |
| Mg | ***120*** | 5.4 | 5.0 | 1.9 | 1.0 |
| Mn | ***2.5*** | 0.04 | 0.04 | 0.01 | 0.01 |
| Mo | ***120*** | 0.0001 | 0.0009 | 0.0004 | 0.0004 |
| Na | ***N/A*** | 0.60 | 0.58 | 0.55 | 0.22 |
| Ni | ***2*** | 0.002 | 0.002 | 0.001 | 0.004 |
| P | ***N/A*** | 0.07 | 0.05 | 0.03 | 0.01 |
| Pb | ***2*** | 0.002 | 0.002 | 0.002 | 0.002 |
| S | ***N/A*** | 0.7 | 0.8 | 0.7 | 0.8 |
| Sb | ***25*** | 0.00006 | 0.00021 | 0.00016 | 0.00008 |
| Se | ***10*** | 0.0003 | 0.0004 | 0.0003 | 0.0003 |
| Si | ***5*** | 15.1* | 13.6* | 4.6 | 3.3 |
| Sn | ***10*** | 0.0005 | 0.0018 | 0.0042 | 0.0008 |
| Sr | ***120*** | 0.01 | 0.01 | 0.00 | 0.00 |
| Th | ***N/A*** | 0.002 | 0.002 | 0.001 | 0.000 |
| Ti | ***120*** | 0.1 | 0.1 | 0.0 | 0.0 |
| Tl | ***N/A*** | 0.00004 | 0.00004 | 0.00001 | 0.00001 |

| Parameter | Ontario Metals Criteria (µg/m³) | Dock/Beach (µg/m³) | Dock/Beach (duplicate) (µg/m³) | Airstrip (µg/m³) | Construction (µg/m³) |
|---|---|---|---|---|---|
| U | ***N/A*** | 0.0004 | 0.0004 | 0.0001 | 0.0000 |
| V | ***2*** | 0.004 | 0.003 | 0.001 | 0.001 |
| Zn | ***120*** | 0.02 | 0.01 | 0.01 | 0.01 |

**Notes:** N/A – not applicable
***** - indicates an exceedance of the Ontario Metals Criteria.

Elevated silicon concentrations in excess of the indicator threshold for silica were measured at the dock/beach area. These elevated levels are likely attributable to high silica levels in the sand beach and roadways adjacent to the monitoring location. The silicon levels fell below the indicator threshold by about 1 km from the dock/beach area. Measured concentrations of all other metals were well below their respective thresholds at all locations.

### 4.3 $PM_{10}$ Concentrations

Table 11 shows the $PM_{10}$ concentrations measured at each monitoring location.

**Table 11: $PM_{10}$ Concentrations**

| Sampling Location | Average Method Detection Limit (µg/m3) | Maximum 24-hr $PM_{10}$ Concentration (µg/m³) | Range of Maximum Baseline $PM_{10}$ Concentrations (µg/m³) |
|---|---|---|---|
| ***24-hour Indicator Threshold*** | ***50*** | | |
| Airstrip | 20.3 | 22.2 | 1.5-3.8 |
| Dock/Beach | 20.1 | 31.9 | |
| Road Construction | 19.9 | 21.6 | |
| Camping area by the old cabin | 22.6 | 20.2 | |

Measured $PM_{10}$ levels were below the indicator thresholds at all locations. The maximum $PM_{10}$ concentrations were measured at the dock/beach area. Unlike the TSP measurements, however, there was little variability in measured $PM_{10}$ concentrations across all locations, with the exception of the dock/beach area. This is likely because the measured $PM_{10}$ levels were close to the detection limit of the DustTrak instruments at all other locations.

Furthermore, the ambient temperatures were much lower than the calibration temperature for the instrument. These factors introduce a significant level of uncertainty into the $PM_{10}$ results. Based on the TSP measurements, one would expect the $PM_{10}$ concentrations to be lower than measured at the Airstrip, road construction area and the camping area by the old cabin.

### 4.4 $SO_2$, $NO_2$ and $O_3$ Concentrations

Table 12 shows $SO_2$, $NO_2$ and $O_3$ concentrations at each monitoring location for the nominal 30-day averaging period. The concentrations are compared to 24-h and annual threshold indicators. These results along with the coincident wind conditions are shown in Figures 9 to 11. The area's limited human activity means that ambient concentrations of $SO_2$ and $NO_2$ are likely to vary less over time than is typically the case in less remote sites. As a result, their respective 24-h and annual average concentrations will be relatively similar to each other. Therefore, it is possible to make approximate comparisons of the measured 30-day average with 24-h and annual threshold indicators.

**Table 12: $SO_2$, $NO_2$ and $O_3$ Concentrations**

| | **Concentrations During Bulk Sampling Preparations (µg/m³)** | | | **Range of Maximum Baseline Concentrations (µg/m³)** | | |
|---|---|---|---|---|---|---|
| **Monitor Location** | **$SO_2$** 30-day average | **$NO_2$** 30-day average | **$O_3$** 30-day average | **$SO_2$** 30-day average | **$NO_2$** 30-day average | **$O_3$** 30-day average |
| ***Indicator Threshold*** | ***150 (24-h) 30 (annual)*** | ***200 (24-h) 60 (annual)*** | ***30 (24-h) 30 (annual)*** | ***150 (24-h) 30 (annual)*** | ***200 (24-h) 60 (annual)*** | ***30 (24-h) 30 (annual)*** |
| Airstrip | <0.284 | 1.42 | 60.7 | <0.262-0.262 | <0.188-0.188 | 44.0-52.8 |
| Dock/Beach | 0.114 | 3.28 | 60.5 | | | |
| Dock/Beach (Duplicate) | 0.856 | 2.46 | 66.3 | | | |
| Road Construction | 0.285 | 1.02 | 58.6 | | | |

Measured $SO_2$ and $NO_2$ levels were much lower than the indicator thresholds and were fairly consistent with background ambient air quality levels at Mary River.

Measured monthly $O_3$ levels were in excess of the indicator thresholds at all of the locations. $O_3$ is not directly emitted, but rather results from a series of complex reactions of $NO_x$ and VOCs in the atmosphere. Given that the local sources of $NO_x$ are limited, as indicated in the measured $NO_2$ concentrations, the high $O_3$ concentrations, which were somewhat above the levels observed during the baseline program, are likely due regional rather than local factors.

## 4.5 Total Dust and Metals Deposition

During transport of the deposition samples from Milne Inlet to the RWDI AIR office in Guelph, Ontario, the bags that held the deposition samples leaked. The samples were tied up in a plastic bag surrounded by a Ziploc bag. The inner bag broke and the samples leaked into the Ziploc bag. The samples were sent to Airmetrics in hopes that they would be able to recover the samples. Airmetrics were able to rinse the bags and analyze the remaining contents. The resultant concentrations, which are presented in Tables 13 and 14, are not expected to be compromised and are expected to be fairly representative of the activities that occurred during the sampling time. Total dustfall deposition rates are compared to 30-day dustfall indicators where applicable. There are no applicable indicators for metal deposition.

**Table 13: Total Dust Deposition Results**

| Location | Maximum Bulk Sampling Dust Fall Results ($mg/100cm^2/30days$) | Range of Maximum Baseline Dust Fall Results ($mg/100cm^2/30days$) |
|---|---|---|
| ***1-Month Indicator Threshold*** | ***53 mg/100cm²/30 d*** | |
| Airstrip | 1.8 | 0.135-0.398 |
| Airstrip (Duplicate) | 0.97 | |
| Dock/Beach | 112 | |
| Dock/Beach (Duplicate) | 122 | |
| Road Construction | 18.1 | |
| Road Construction (Duplicate) | 6.1 | |

Elevated dustfall levels in excess of the indicator thresholds were measured adjacent to the dock/beach. These impacts, which were very localized, were likely due to a combination of the sealift activities and vehicle traffic in the area. Dustfall levels decreased to a fraction of the threshold at the Airstrip monitoring location, which was about 1 km from the dock/beach area.

**Table 14: Total Metals Deposition Results from Dustfall**

| Parameter | Airstrip (µg/100cm$^2$/30 days) | Airstrip (Duplicate)(µg/100cm$^2$/30days) | Dock/Beach (µg/100cm$^2$/30 days) | Dock/Beach (Duplicate) (µg/100cm$^2$/30 days) | Road Construction (µg/100cm$^2$/30 days) | Road Construction (Duplicate) (µg/100cm$^2$/30 days) |
|---|---|---|---|---|---|---|
| Ag | <0.00112 | <0.00272 | 0.078 | 0.0366 | <0.00186 | <0.0082 |
| Al | 115 | 85 | 2935 | 3318 | 214 | 571 |
| As | 0.0125 | 0.00348 | 0.201 | 0.169 | 0.0142 | 0.0453 |
| B | 0.323 | 0.120 | 6.0 | 4.65 | 0.462 | 1.08 |
| Ba | 0.95 | 0.95 | 44.4 | 45.1 | 2.01 | 5.92 |
| Be | 0.00210 | 0.00131 | 0.057 | 0.055 | 0.00426 | <0.0099 |
| Bi | 0.00063 | <0.000202 | 0.0080 | 0.0082 | 0.00077 | 0.00398 |
| Ca | 452 | 209 | 8397 | 11108 | 903 | 3236 |
| Cd | 0.00311 | 0.000438 | 0.0189 | 0.0152 | 0.00263 | 0.0476 |
| Cl | 152 | 71 | 596 | 118 | <6.8 | 153 |
| Co | 0.062 | 0.057 | 1.00 | 0.81 | 0.118 | 0.289 |
| Cr | 0.219 | 0.068 | 2.37 | 2.59 | 0.221 | 0.77 |
| Cu | 0.265 | 0.083 | 1.25 | 1.13 | 0.183 | 2.00 |
| Fe | 70 | 34.9 | 1455 | 1687 | 128 | 342 |
| Hg | <0.000385 | <0.000378 | <0.00255 | <0.00237 | <0.00063 | <0.00144 |
| K | 110 | 79 | 2555 | 2785 | 187 | 577 |
| Li | 0.111 | 0.055 | 2.47 | 2.17 | 0.237 | 0.531 |
| Mg | 175 | 87 | 4983 | 5701 | 491 | 1715 |
| Mn | 1.13 | 0.61 | 29.9 | 35.2 | 2.19 | 8.9 |
| Mo | 0.0079 | 0.00101 | 0.082 | 0.111 | 0.0065 | 0.0313 |
| Na | 100 | 51.4 | 863 | 654 | 39.1 | 164 |
| Ni | 0.101 | 0.0356 | 1.12 | 1.39 | 0.122 | 1.73 |
| P | <1.56 | <0.99 | 29.0 | 32.5 | 4.15 | <11.9 |
| Pb | 0.62 | 0.070 | 2.89 | 2.35 | 0.132 | 2.16 |
| S | 8.8 | <8.1 | <36.6 | 21.1 | <14.1 | <29.9 |
| Sb | 3.44 | 3.71 | 2.86 | 2.73 | 4.39 | 9.4 |
| Se | 0.0073 | <0.00432 | 0.0482 | 0.055 | <0.0090 | <0.0238 |
| Si | <412 | <354 | 14530 | 11586 | 844 | <1973 |
| Sn | 0.0114 | 0.0065 | 0.110 | 0.105 | 0.0329 | 0.0518 |
| Sr | 0.65 | 0.420 | 10.3 | 10.8 | 0.83 | 2.39 |
| Th | 0.0362 | 0.0193 | 1.32 | 1.89 | 0.077 | 0.260 |
| Ti | 18.5 | 20.1 | 107 | 111 | 28.1 | 59.9 |
| Tl | 0.00141 | 0.00094 | 0.0478 | 0.058 | 0.00429 | 0.0097 |
| U | 0.0077 | 0.00361 | 0.285 | 0.330 | 0.0123 | 0.0402 |
| V | 0.109 | 0.0538 | 2.41 | 2.73 | 0.210 | 0.600 |
| Zn | 1.56 | 0.93 | 5.06 | 3.48 | 1.77 | 7.2 |

There are no metal deposition criteria for comparison to measured levels. The silicon deposition levels are very high, especially at the dock site. It is expected that these high levels are likely attributable to high silica levels in the sand beach and roadways adjacent to the monitoring location.

## 5. SUMMARY

A monitoring program was undertaken to assess the air quality impacts from the preparation and construction for the bulk sampling program to be undertaken by Baffinlands.

The results of the monitoring program can be summarized as follows:

- Elevated levels of TSP and dustfall in excess of the indicator thresholds adjacent to the dock/beach area were measured. These impacts, which were very localized, were likely due to a combination of the sealift activities and vehicle traffic in the area. TSP levels decreased to one half of the indicator threshold at about 1 km from the dock/beach area. Dustfall levels decreased to a fraction of the threshold by 1 km from the dock/beach area.
- Elevated silicon concentrations in excess of the indicator threshold for silica were measured at the dock/beach area. These elevated levels are likely attributable to high silica levels in the sand beach and roadways adjacent to the monitoring location. The silicon levels fell below the indicator threshold by about 1 km from the dock/beach area.
- Measured concentrations of all other metals were well below their respective thresholds at all locations.
- Measured $PM_{10}$ levels were below the indicator thresholds at all locations. The maximum $PM_{10}$ concentrations were measured at the dock/beach area.
- Measured $SO_2$ and $NO_2$ levels were much lower than the indicator thresholds and were fairly consistent with background ambient air quality levels at Mary River.
- Measured monthly $O_3$ levels were in excess of the indicator thresholds at all of the locations. The high $O_3$ concentrations, which were somewhat above the levels observed during the baseline program, are likely due regional rather than local factors.

## 6. REFERENCES


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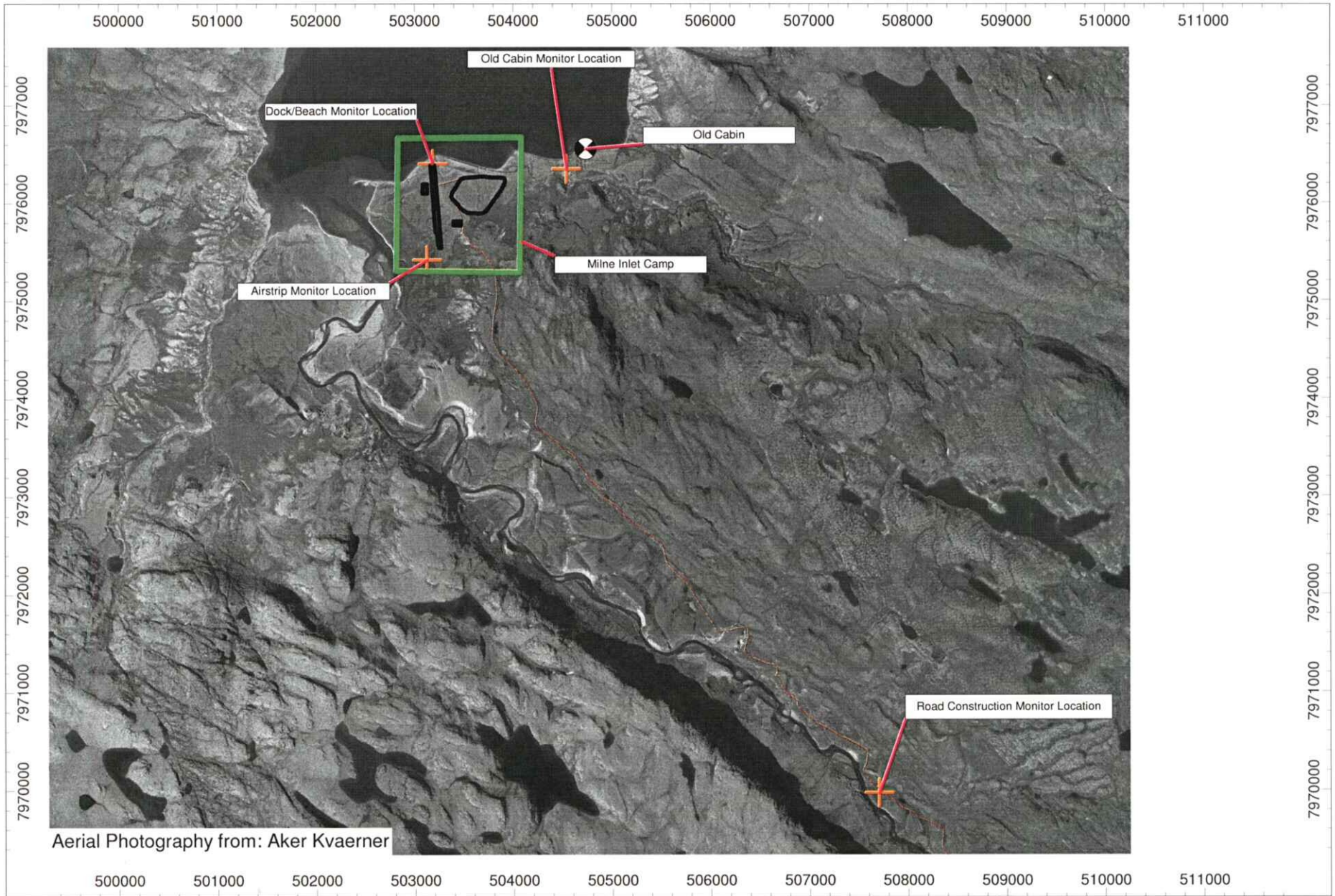
# FIGURES




**Milne Inlet Sampling Locations**

True North

| | |
|---|---|
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| Scale: | 1:55000 |
| Date: | Jan 15, 2008 |

KPL - BIMC Mary River EA - Milne Inlet, Nunavut

Project #W07-5226B

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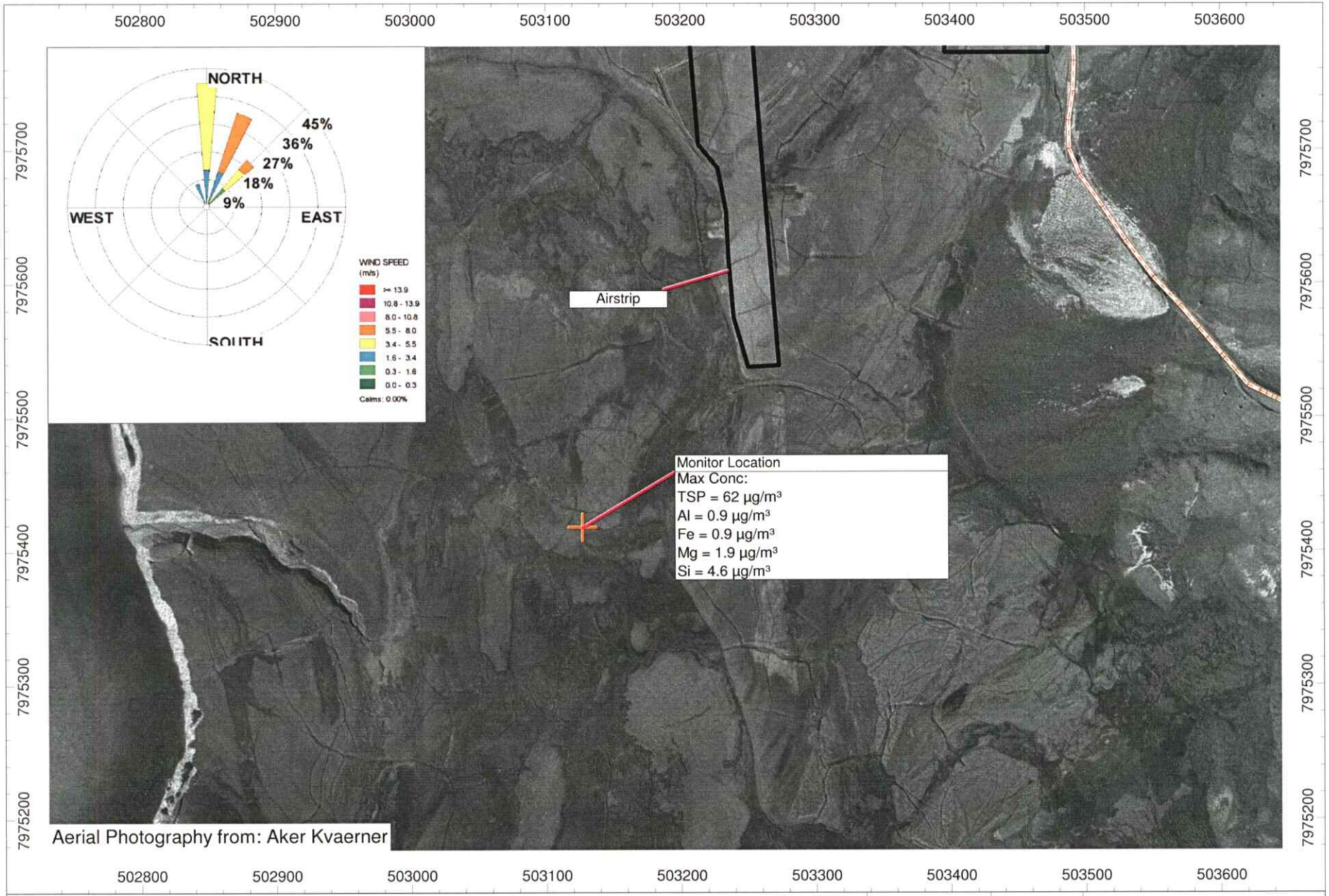


**Airstrip - Maximum 24-Hour TSP, Al, Fe, Mg, and Si Concentration**

**Sampling Period from Aug. 31 to Sept. 1, 2007**

KPL - BIMC Mary River EA - Milne Inlet, Nunavut

True North

Project #W07-5226B

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|---|---|
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| Scale: | 1:4000 |
| Date: | Jan 15, 2008 |

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**Dock/Beach - Maximum 24-Hour TSP, Al, Fe, Mg, and Si Concentration**

**Sampling Period from Sept.3 to Sept. 4, 2007**

KPL - BIMC Mary River EA - Milne Inlet, Nunavut

True North

Project #W07-5226B

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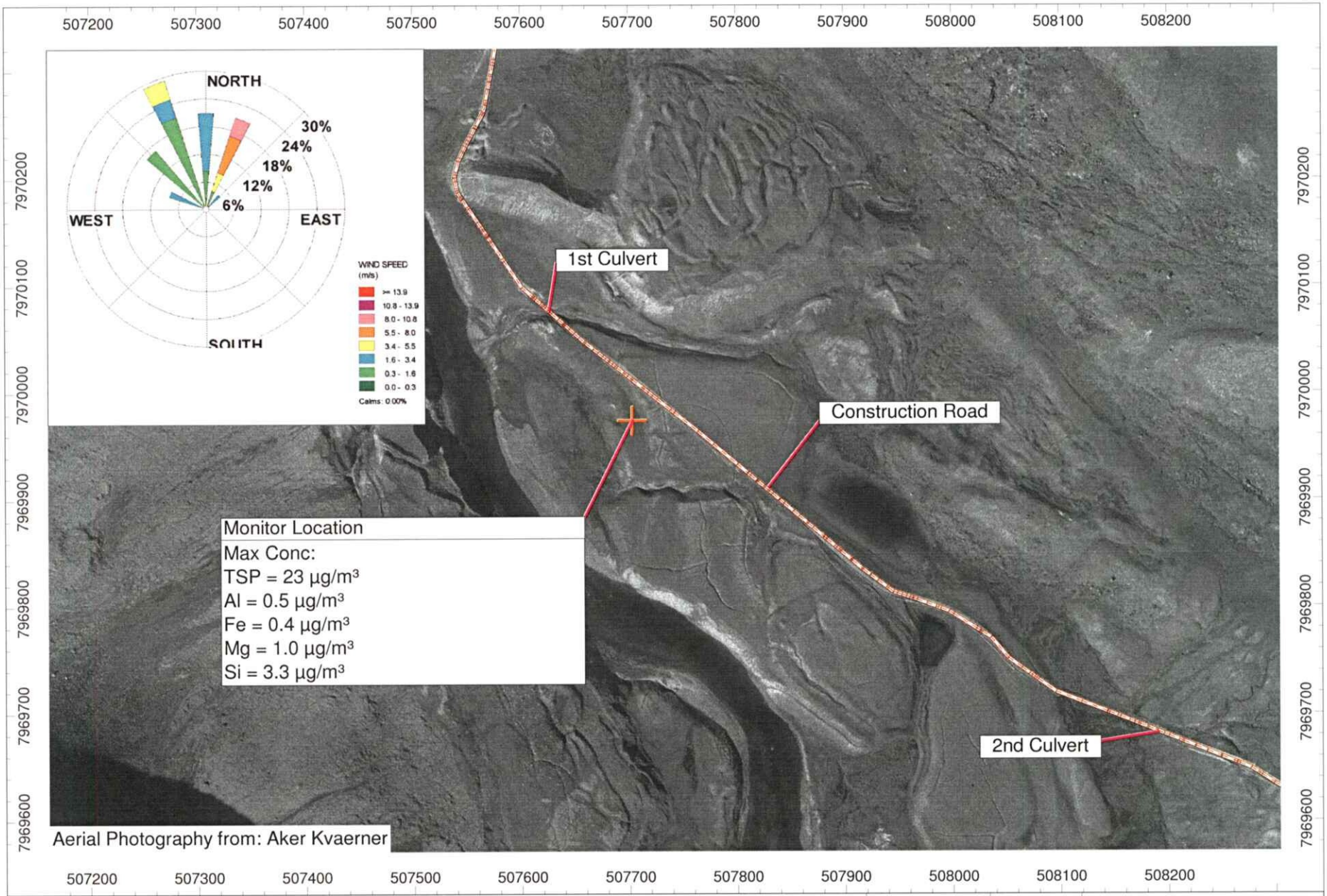


**Road Construction - Maximum 24-Hour TSP, Al, Fe, Mg, and Si Concentration**

Sampling Period from Sept. 2 to Sept. 3, 2007

KPL - BIMC Mary River EA - Milne Inlet, Nunavut

True North

Project #W07-5226B

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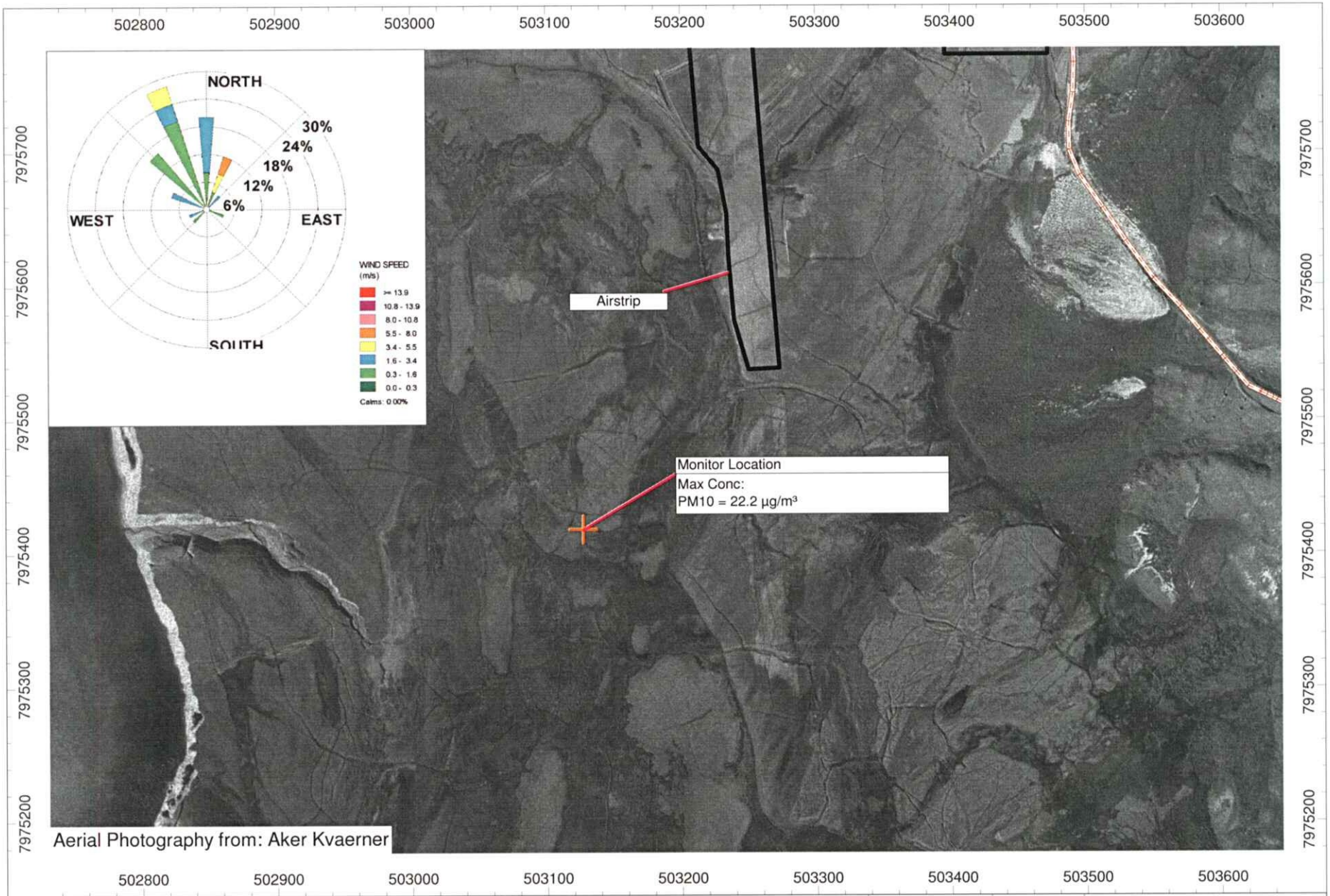


**Airstrip - Maximum 24-Hour PM10 Concentration**

**Sampling Period from Sept 2 to Sept. 3, 2007**

KPL - BIMC Mary River EA - Milne Inlet, Nunavut

True North

Project #W07-5226B

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| Date: | Jan 15, 2008 |

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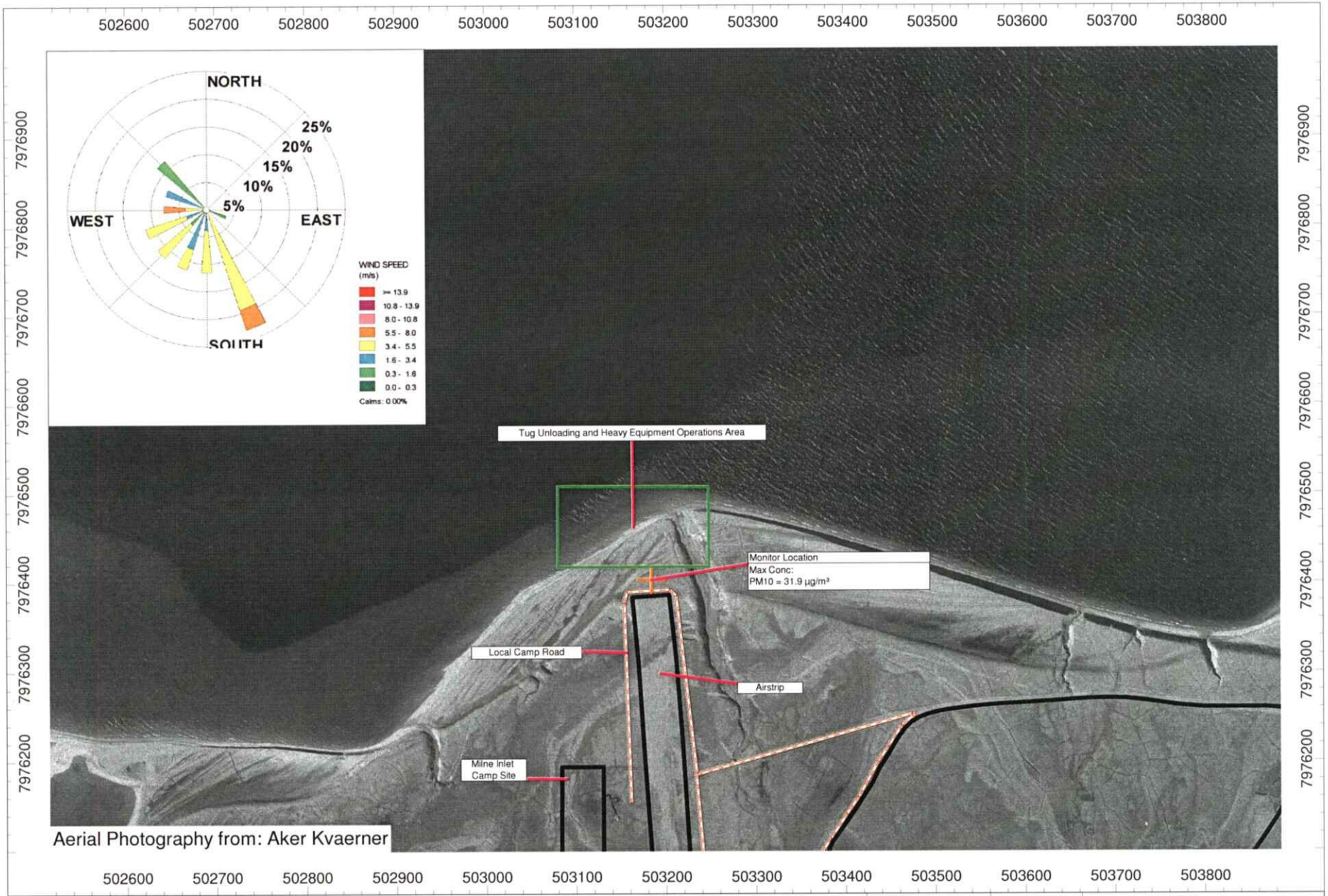


**Dock/Beach - Maximum 24-Hour PM10 Concentration**

**Sampling Period from Sept. 3 to Sept. 4, 2007**

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True North

Project #W07-5226B

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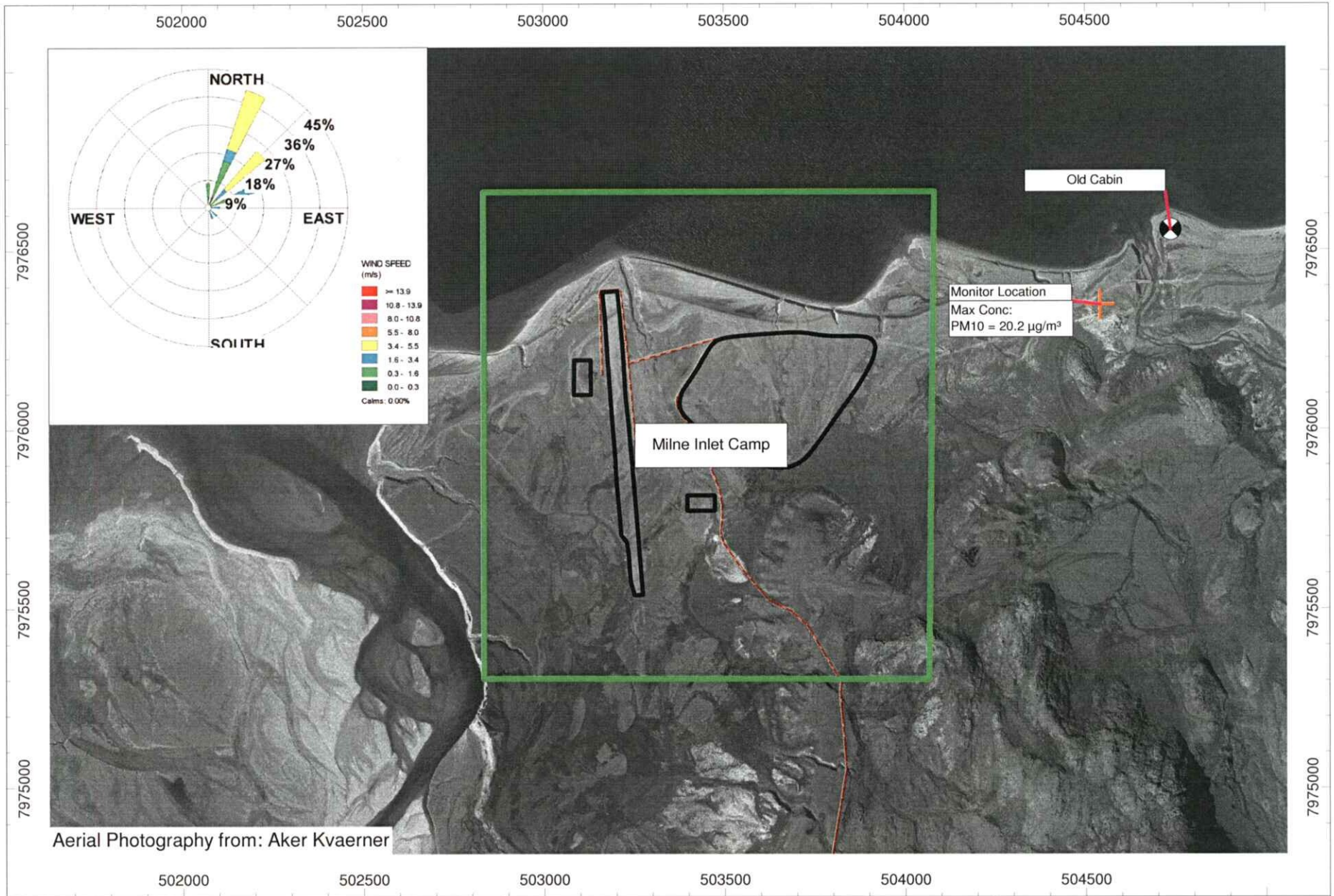


**Hunting Camp - Maximum 24-Hour PM10 Concentration**

**Sampling Period from Sept. 4 to Sept. 5, 2007**

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True North

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| Date: | Jan 15, 2008 |

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**Road Construction - Maximum 24-Hour PM10 Concentration**

**Sampling Period from Sept. 4 to Sept. 5, 2007**

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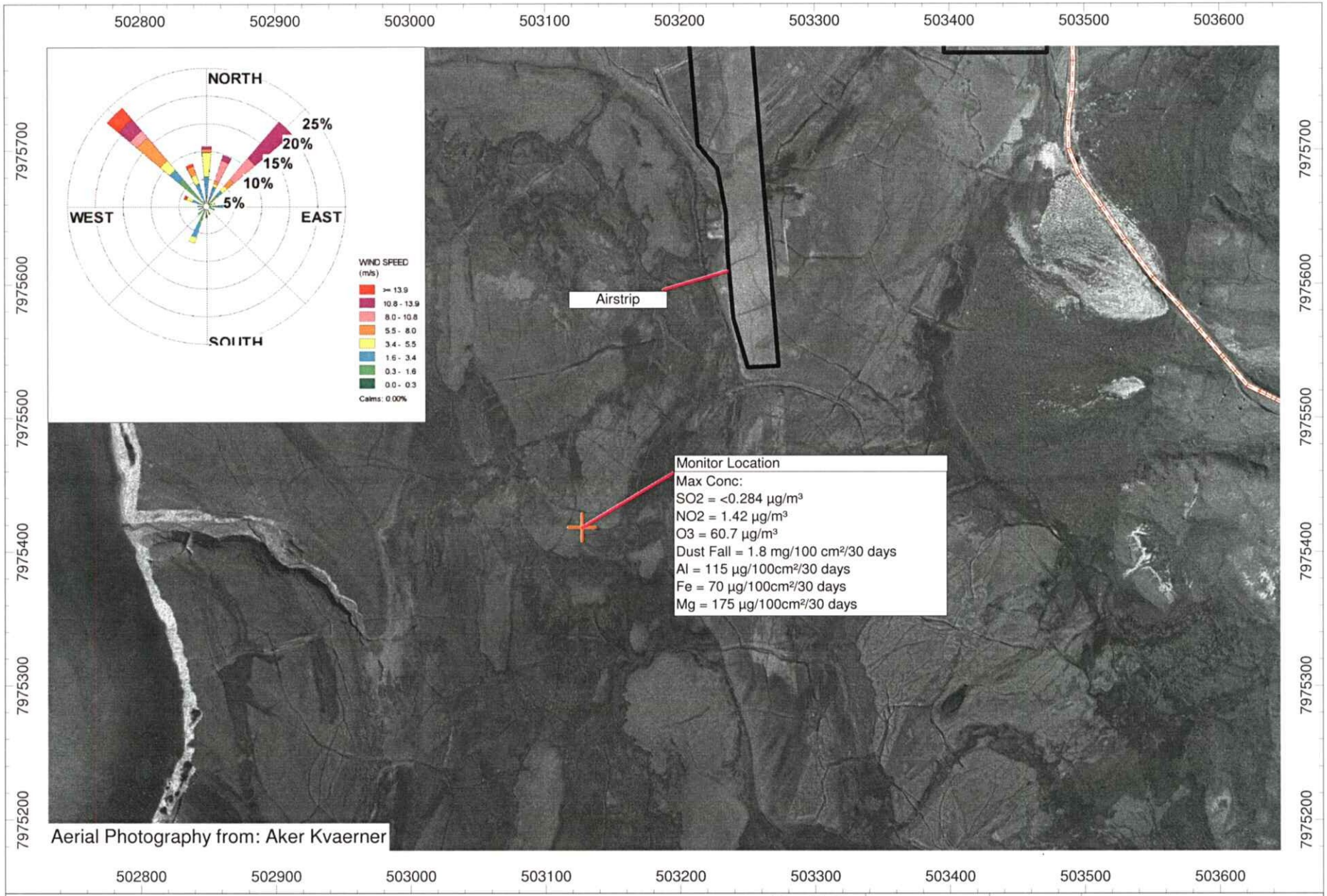


**Airstrip - 30 Day Averaging S02, NO2, O3, Dust Fall, Al, Fe, and Mg Concentration**

Sampling Period from Aug. 31 to Sept. 23, 2007

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Project #W07-5226B

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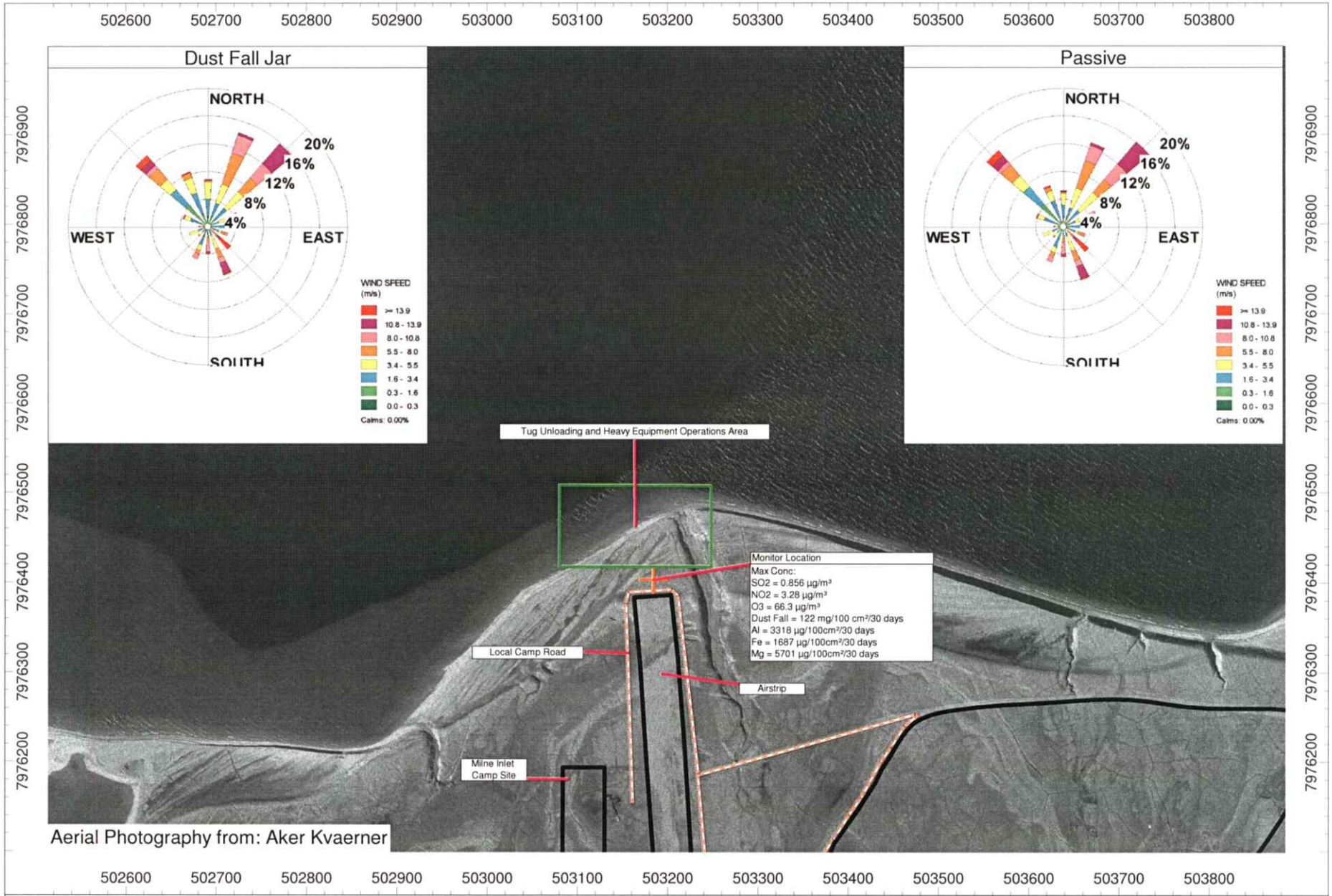


**Dock/Beach - 30 Day Averaging S02, NO2, O3, Dust Fall, Al, Fe, and Mg Concentration**

**Sampling Period from Sept. 1 (Dust Fall Jars) and Sept. 3 (Passive) to Sept. 23, 2007**

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Project #W07-5226B

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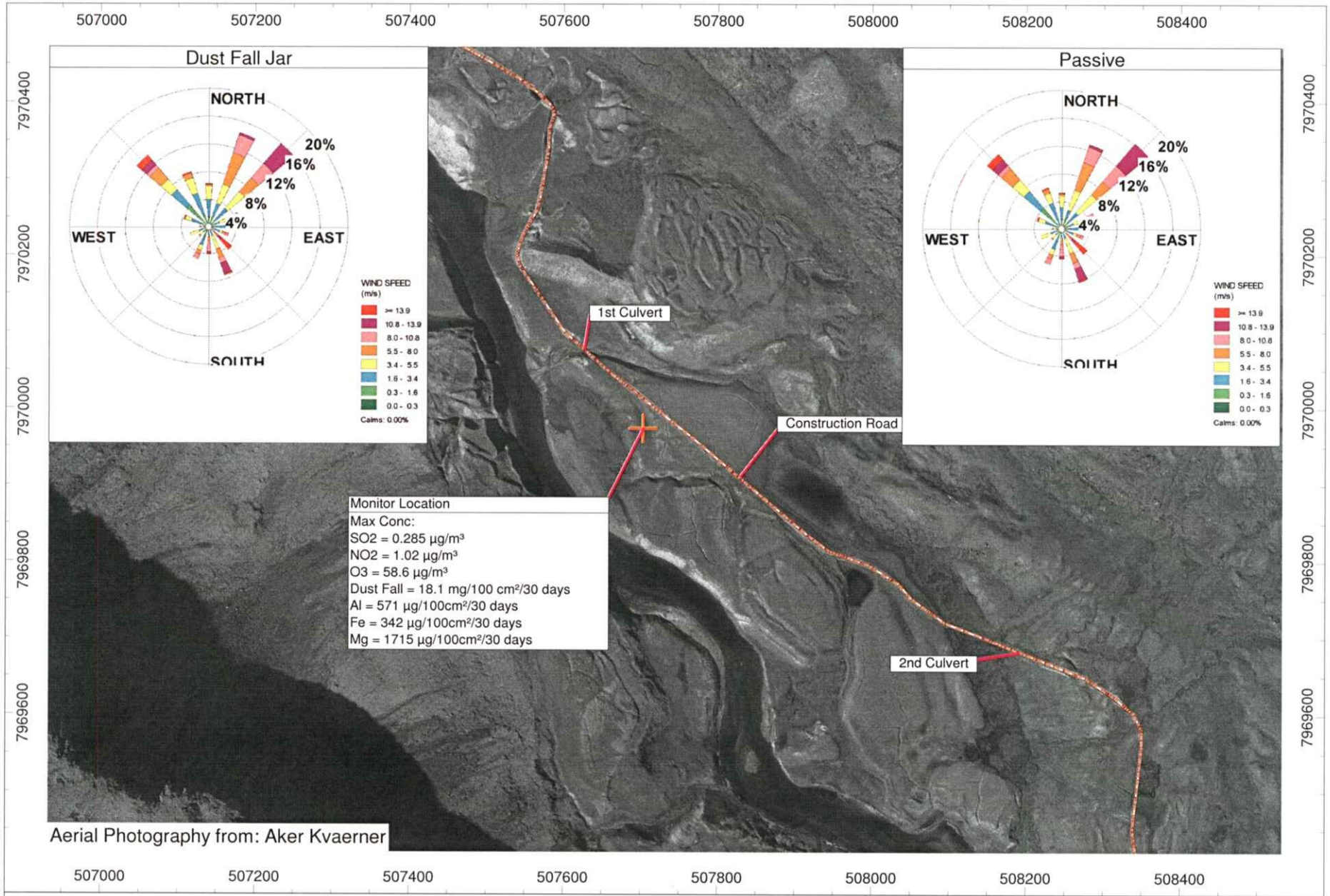


**Road Construction - 30 Day Averaging S02, NO2, O3, Dust Fall, Al, Fe, and Mg Concentration**

**Sampling Period from Sept. 1 (Dust Fall Jars) and Sept. 3 (Passive) to Sept. 23, 2007**

KPL - BIMC Mary River EA - Milne Inlet, Nunavut

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Project #W07-5226B

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