Baffinland Iron Mines Corporation

AIR QUALITY AND NOISE ABATEMENT MANAGEMENT PLAN

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Rev. 5

Prepared By: Andrew Vermeer
Department: Environment
Title: Environmental Coordinator
Date: March 16, 2015
Signature:

Approved By: James Millard
Department: Environment
Title: Environmental Manager
Date: March 16, 2015
Signature:

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TRACK CHANGES TABLE

A review and update of the Air Quality and Noise Abatement Management Plan has been undertaken, with the following salient revisions to the February 13, 2014 version (**BAF-PH1-830-P16-0002**, Rev 4).

Index of Major Changes/Modifications in Revision 5

Item No.	Description of Change	Relevant Section
1	Added Track Changes Table	-
2	Updated introduction section to consider the 2015 Work Plan	Section 1.1
3	Added GHG emissions EC reporting requirements	Section 1.2.3
4	Updated Roles and Responsibilities descriptions.	Section 4.2
5	Updated Table 5-1: Performance Indicators and Thresholds for Air Quality	Section 5.1
6	Updated Incinerator emissions testing sub-section	Section 6.2.2
7	Updated GHG reporting requirements sub-section	Section 7.1.3
8	Updated references	Section 10
9	Updated Dust Fall Monitoring Report	Attachment 6

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ABBREVIATIONS

ASL	Ambient sound level
Baffinland	Baffinland Iron Mines Corporation
CCME	Canadian Council of Ministers of the Environment
CO	carbon monoxide
CO_2	carbon dioxide
CO_2 eq	Carbon dioxide equivalent
CSL	comprehensive sound level
CWS	Canada-Wide Standards
dBA	decibel-acoustic
DFO	Fisheries and Oceans Canada
EHS	Environmental, Health, and Safety
EIS	Environmental impact statement
EPCM	Engineering, procurement, and construction management
EPP	Environmental Protection Plan
ERCB	Energy Resources Conservation Board
GHG	Greenhouse gases
Leq	energy equivalent sound level
LSA	Local Study Area
Mary River Project	the Project
MTPA	million metric tons per annum
NCB	balance noise criteria
NIRB	Nunavut Impact Review Board
NO_2	nitrogen dioxide
NO_X	nitrogen oxide emissions
NWT	Northwest Territories
O_3	Ozone
OSHA	Occupational Safety and Health Association
PDA	Project Development Area
PM	particulate matter
PSL	permissible sound level
RSA	regional study area
SARA	*Species At Risk Act*
SO_2	sulphur dioxide
TSP	total suspended particulate matter
VEC	valued ecosystem component
ZOI	Zone of Influence

1 INTRODUCTION

1.1 PURPOSE

The Air and Noise Abatement Management Plan provides guidance on management of air emissions and noise from construction and operation activities. The plan includes action to control airborne particulates and noise hazards. It also defines action to mitigate, prevent, or avoid to the extent practical noise nuisance to site personnel and nearby populations. The plan addresses greenhouse gas emissions and includes an assessment of emissions from the complete lifecycle of the product, aimed at improving management of energy and greenhouse gas emissions, building emissions abatement and energy saving considerations into the business decision-making processes.

1.2 REGULATORY REQUIREMENTS

1.2.1 AIR QUALITY GUIDELINES

There are ambient air quality guidelines for Nunavut for total suspended particulate matter (TSP), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) (Department of Sustainable Development, Environmental Protection Service, October 2011).

The National Air Quality Objectives, Canada-Wide Standards (CWS) and other Canadian jurisdictions provide guidelines for other air contaminants. The National Objectives are divided into three categories (Health Canada, 2005):

- ***"Maximum desirable level*** is the long-term goal for air quality and provides a basis for anti-degradation policy for the unpolluted parts of the country, and for continuing development of control technology."
- ***"Maximum acceptable level*** is intended to provide adequate protection against effects on soils, water, vegetation, materials, visibility, personal comfort, and well-being."
- ***"Maximum tolerable level*** denotes time-based concentrations of air contaminants beyond which, due to a diminishing margin of safety, appropriate action is required without delay to protect the health of the general public."

For a comparison of federal objectives, Northwest Territories (NWT) criteria, Nunavut guidelines and CWS, see Section 5. The criteria refer to different averaging periods to account for potential short-term acute exposures and long-term chronic exposures. For dust deposition criteria for the provinces of Alberta and Ontario, see Section 5.

1.2.2 NOISE

There are no regulations or guidelines in Nunavut that address environmental noise levels. However, noise has been addressed in recent environmental impact statements (EIS) developed for other mining projects in Nunavut (e.g., Meadowbank Gold Project, Doris North Gold Project, High Lake Project).

1.2.3 GREENHOUSE GAS EMISSIONS

Environment Canada current GHG reporting requirements stipulate that all persons who operate a facility that emits 50 000 tonnes of CO_2 eq or more of GHGs in a calendar year are subject to the reporting requirements and must report their emissions information to Environment Canada. The legal basis for the GHG reporting program is the Notice published annually in the Canada Gazette, Part I, under the authority of subsection 46(1) of the Canadian Environmental Protection Act, 1999.

In addition, the Nunavut Climate Change Strategy was outlined in October 2003 by the Department of Sustainable Development. One of the objectives of this strategy is to "encourage Nunavummiut, including government, non-government, industry, and the public to take action to control greenhouse gas emissions through energy management and alternative energy supply technology."

1.3 BAFFINLAND'S COMMITMENTS

Baffinland provides adequate resources to implement and maintain the Health, Safety, and Environment (HSE) Management System, including the necessary human, material, and financial resources. Baffinland's Sustainable Development Policy is presented in Attachment 1.

Baffinland also made a number of commitments during the Project Certificate review process. These commitments as well as the Terms and Conditions of the Project Certificate applicable to Meteorology, Climate Change, Air Quality and Noise are listed in Attachment 2. The Air Quality and noise Abatement Management Plan provides the mechanism by which Baffinland tracks its compliance to these commitments and Terms and Conditions of the Project Certificate.

1.4 RELATIONSHIP TO OTHER MANAGEMENT PLANS

This plan should be viewed in concert with the following additional plans prepared for the EIS:

- Health, Safety, and Environmental Management Framework
- Environmental Design Guidelines
- EHS Management Framework
- Hazard and Risk Assessment Methodology
- Environmental Protection Plan
- Borrow Pit and Quarry Management Plan

- Road Management Plan
- Abandonment and Reclamation Plan.

1.5 UPDATE OF THIS MANAGEMENT PLAN

The Air Quality and Noise Abatement Management Plan is a "living document" and will be regularly updated based on management reviews (see Section 9), incident investigations, regulatory changes, or other Project-related changes.

Note that this plan has been updated to meet annual reporting requirements and addresses the Early Revenue Phase of the Mary River Project. Therefore, any references to actions required along the railway or at Steensby Port have been removed.

2 TARGETED VECS

Targeted valued ecosystem components (VECs) for the Air Quality and Noise Abatement Management Plan are:

- Air quality
- Noise
- Greenhouse gas emissions and climate change.

2.1 AIR QUALITY

Both gaseous and particulate emissions can result in air contaminants such as Total Suspended Particles (TSP), particulate matter (PM10, PM2.5), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO), which can be measured as concentrations on a contaminant mass per volume of air basis ($\mu g/m^3$). Because of gravitational settling and other influences, TSP can be deposited to the earth's surface and potentially accumulate in terrestrial aquatic systems. Here the contaminant is measured as deposition on a mass per area basis (g/m^2). Depending on the composition of TSP, this deposition can range from nuisance to environmental concern. The VEC associated with these contaminants is air quality.

Baseline air quality conditions for the Mary River Project are presented in Attachment 3.

2.1.1 KEY ISSUES AND CONCERNS FOR AIR QUALITY

Air quality key issues and concerns for the Project are listed in Table 1.

2.1.2 AIR QUALITY METRICS

For the Mary River Project, the concerns are mainly TSP, SO_2 and NO_x, and greenhouse gas emissions (GHG). The air quality metrics are thus:

- TSP and total particulate deposition (dustfall)
- Sulphur dioxide (SO_2) and nitrogen dioxide (NO_2)
- GHG emissions.

TABLE 1: AIR QUALITY KEY ISSUES AND CONCERNS FOR THE PROJECT PHASES

Project Phase	Issue/Concern	Relevance
Construction	Dust concentration and deposition	Vehicle emissions will occur from transportation of materials and workers to the site. Fugitive emissions will result from earthworks, construction of roads, laydown areas, railway, and other infrastructure.
Operation	Project effect on ambient SO_2 concentrations	The Project will result in an increase in regional emissions of SO_2, a gaseous contaminant. Ambient SO_2 concentrations can increase airway resistance in exercising asthmatics for 10-minute exposures at concentrations of 1000 µg/m3 (Legge, 1995).
	Project effect on ambient NO_2 concentrations	The Project will increase regional nitrogen oxide emissions (NO_X). Ambient NO_2 concentrations have shown small, statistically significant, reversible effects for mildly exercising asthmatics for 30-minute exposures at concentrations of 560 µg/m³. A direct link between ambient NO_2 exposure and vegetation effects is more difficult to establish.
	Project effect on ambient CO concentrations	The Project will increase regional CO emissions. Ambient CO concentrations can inhibit the blood's ability to carry oxygen to body tissues including vital organs.
	Project effect on regional acid deposition	The Project will result in an increase of NO_X and SO_2 emissions. Ambient NO_X and SO_2 form acidifying chemicals in the atmosphere, and are removed from the atmosphere by wet and dry removal processes (deposition). The deposition is represented as sulphur and nitrogen deposition.
	Project effect on ambient $PM_{2.5}$ concentrations	Respirable particulate matter ($PM_{2.5}$) and precursor $PM_{2.5}$ emissions are projected to increase due to the Project. Particulates with aerodynamic diameters less than 2.5 µm (i.e., $PM_{2.5}$) are of specific interest because they are linked with adverse human health response. $PM_{2.5}$ can be emitted directly from industrial facilities or can be formed in the atmosphere from precursor emissions.
	Project effect on O_3	Ozone (O_3) can affect the respiratory system. O_3 is not emitted directly. In fact, NO_X will reduce ambient O_3 levels due to reactions with nitrogen oxide emissions. Given the northerly latitude location, the photochemical production of O_3 due to the Project will be negligible and therefore is not addressed.
	Project effects on fugitive dust and metal deposition	Fugitive sources of TSP and metals will include mining, processing, handling, and storage of iron ore. The metal concentration of the ore concentrate will be higher than natural background levels. The ambient concentrations and deposition of metal compounds are therefore evaluated in addition to dust.
	Project effects on greenhouse gas emissions	Combustion of hydrocarbons produces carbon dioxide (CO_2), a greenhouse gas. Given the interest in greenhouse gases relative to potential global warming and climate change, estimates of greenhouse gas emissions are required.
Closure	Dust concentration and deposition	Vehicle emissions will occur from transportation of materials and workers to the site. Fugitive emissions will result from earthworks related to closure.

2.2 NOISE AND VIBRATION

High levels of environmental noise and vibrations can affect people by impairing their enjoyment of using the land. High noise and vibration levels can also affect wildlife, causing changes in behaviour or avoidance of affected areas, for at least temporary periods. Environmental noise and vibration levels are therefore the VEC selected for mitigation and monitoring.

2.2.1 BASELINE NOISE LEVELS

Pre-development background atmospheric noise levels are low, ranging from 25 to 35 dBA (refer to Attachment 3). Noise recorded at all three sites consisted mainly of wind, insect, and small animal or bird sounds; at the coastal sites, noises associated with flowing water and waves were also recorded. Differences between daytime and night time were small, and attributed mainly to noise from nearby human activities that couldn't be screened out.

Measured ambient noise levels at all three sites (2007 campaign) were lower than those typically found in remote rural areas, likely because of the lower noise contribution from wind in vegetation for the three sites as opposed to more southerly areas with higher-profile vegetation which is more likely to generate wind-related noise.

2.2.2 KEY ISSUES AND CONCERNS FOR NOISE AND VIBRATION

Key issues and concerns for noise and vibration are presented in Table 2.

TABLE 2: SUMMARY OF KEY ISSUES AND CONCERNS FOR NOISE AND VIBRATION

VEC	Issue Identified and Reason for Selection of VEC	Indicator
Environmental sound levels	• Minimize disturbance of natural terrestrial wildlife use patterns in the region • Minimize impacts on seasonal human dwellings in the area of Milne Inlet	• A-Weighted Sound Levels (L_{eq} dBA)
Environmental vibration levels	• Minimize disturbance of natural terrestrial wildlife use patterns in the region	• Peak vibration levels (mm/s)

2.3 CLIMATE CHANGE AND GREENHOUSE GAS

"Controlling emissions must be done in ways that carefully consider Nunavut's developing economy by minimizing the negative impacts to the economy and, where possible, identify economic opportunities" (Nunavut Climate Change Strategy, October 2003).

At present, arctic-grade diesel fuel is the only economically viable source of energy for the Project. Baffinland is committed, however, to continuing investigation of alternative sources of energy to satisfy Project energy requirements.

3 MITIGATION MEASURES

3.1 LIFE OF PROJECT MITIGATION MEASURES

Mitigation measures that will be implemented over the life of the Project to minimize identified adverse impacts on air quality, noise, and vibration are outlined in this section.

Procurement Policy

Baffinland`s procurement procedures will incorporate air emissions and noise standards for the purchase of all equipment and machinery used at the Project. Emission and noise standards will be based on Nunavut or Canadian regulatory guidelines, or best available technologies.

Best Management Practices

For all Project phases, Baffinland HSE Management Framework requires application of best management practices for environmental protection.

Fuel Supply

Throughout the life of the project, Baffinland will endeavour to secure sources of fuel low in contaminants (low-sulphur fuel).

Scheduled Maintenance Program

Mobile equipment and stationary combustion equipment (generators, boilers, and waste incinerators) will be subjected to a routine maintenance schedule to ensure that emissions are in line with emission criteria and vendor`s specifications on emissions.

Occupational Health and Safety

At all times, workplace conditions will be in compliance with OSHA standards for workplace ambient air quality and noise. When and where necessary, employees will be provided with hearing protection and respiratory masks for work in dusty environments. Health and safety procedures and standards will be strictly enforced throughout the life of the Project.

Waste Segregation for Incinerator Operation

Diversion of waste streams such as paper, glass, and plastic recyclables will be assessed for feasibility. Open-air burning will be limited and will only involve paper and chemical (i.e. glue, paint, etc.) free, untreated wood products.

Vehicle Traffic

Vehicle traffic at the Mine Site and the Tote Road to Milne Port is expected to be the major contributor to dust generation. Dust generation will be more pronounced during summer months and is not likely to

be an issue during winter or the freshet period. To minimize dust generated by vehicular traffic during the summer, Baffinland will:

- Use granular material for road construction and maintenance
- Limit speed of vehicles on all roads
- Use dust suppressant as required, and,

3.2 CONSTRUCTION AND CLOSURE PHASES

For the construction and closure phases, emissions sources include mobile equipment used for construction and the earthwork activities involved in preparing sites for Project infrastructure, roads, borrow pits, and quarry operations.

Activity-specific mitigation measures are outlined in the following management plans:

- Environmental Protection Plan (EPP)
- Borrow Pit and Quarry Management Plan
- Road Management Plan

The potential air quality impacts resulting from construction, operation, and closure activities are as follows:

- SO_2 and NO_2 levels from mobile equipment are expected to be lower than indicator thresholds during construction and closure activities.
- Elevated dust deposition levels are expected in the immediate vicinity of construction. These levels could occasionally exceed indicator thresholds.

3.2.1 MITIGATION MEASURES FOR CONSTRUCTION AND CLOSURE PHASES

Best management practices for dust control will be implemented throughout the construction and closure phases. These best management practices include:

- The use of coarse granular material for road construction
- Watering roads, as necessary, to reduce visible plumes when it is practical to do so (e.g., when temperatures are above freezing)
- Using other dust suppressants (i.e $CaCl_2$) as appropriate
- Using well-defined haul routes to minimize disturbed surfaces
- Limiting traffic to essential use over construction areas
- Limiting speed over construction areas

- Minimizing drop distances (i.e., using adjustable stackers) for stockpiling activities.

Implementation of these measures will reduce the magnitude and extent of dust deposition.

3.2.1.1 ANTICIPATED EFFECTIVENESS OF MITIGATION MEASURES

Dust emissions will primarily derive from traffic onsite and the Tote Road. These sources can be readily controlled because of ease of access. Enforcing strict speed limit for vehicles is expected to minimize dust generation from traffic.

3.2.1.2 EFFECTS OF MITIGATION FAILURE OR MALFUNCTION

Dust-suppression measures are not prone to failure, as such, but to relative degrees of success. All materials from which dust could be generated are non-reactive and low in contained heavy metals, such that there is no chemical risk to the environment. Dusting of vegetation surfaces has the potential to reduce plant growth rates, but most dust from Project activities will fall in close proximity to roads and well within construction site boundaries.

3.2.1.3 CONTINGENCIES

Principal contingencies for dust control are increased frequency of water spraying, and selection of a more effective dust suppressant in the case of road dust.

3.2.2 CONCLUSIONS FOR CONSTRUCTION AND CLOSURE PHASE

Elevated dust concentrations and deposition levels may occur in the immediate vicinity of roads and construction sites. Implementing best management practices for dust control will limit the magnitude and extent of impacts on air quality. Refer to the Dust Management Protocol (Attachment 7) for dust suppressant application procedures.

Given the localized nature of air emissions (mostly from mobile and construction equipment), the construction and closure phases are not expected to have significant impacts on air quality.

3.3 OPERATION PHASE

The ERP phase is currently limited to the production and shipment of 4.2 Mtpa. The ore will be transported over the Tote Road to Milne Port by 140 tonnes trucks. Up to 4.2 Mt of ore will be stockpiled at Milne Port and shipped during the open water season.

On October 29, 2014, Baffinland submitted to regulators and stakeholders a proposed amendment, Phase 2 of the ERP, which would increase the annual ore production and shipment from 4.2 Mtpa to 7.8 Mtpa. The proposed “Phase 2” is currently under review by the Nunavut Planning Commission (NPC) and the Nunavut Impact Review Board (NIRB).

3.3.1 MINE SITE AIR QUALITY

3.3.1.1 SOURCES OF AIR EMISSIONS

Activities likely to have an impact on air quality are:

- Mining activity (blasting)
- Mobile engine operation in and around the mine pit, including shovels, drills, loaders, and trucks
- Mine haul roads
- Ore crushing
- Ores stockpiles (lumps and fines) including stackers
- Loading of trucks for haulage of ore to Milne Port
- Waste incinerators' exhaust.

As with the construction phase, potential air quality impacts resulting from operation activities include the following:

- SO_2 and NO_2 levels from mobile equipment and power generators are expected to be lower than indicator thresholds during the operation phase.
- Elevated dust deposition levels are expected in the immediate vicinity of the mine, crushing, and stockpile areas. These levels could occasionally exceed indicator thresholds. Since the baseline level is even lower than the indicator thresholds (less than 1 g/m2/year), the predicted dust deposition, although falls within the indicator threshold (55 g/m2/year), but is above the baseline levels over a distance. An impact zone at a distance of 14 km from the potential mine development was adopted based on data from Ekati.

3.3.1.2 MITIGATION MEASURES FOR THE MINE SITE

Mitigation measures incorporated in the design include:

- Exhaust stacks for power generators will be clustered within one to two stack diameters of each other to enhance plume rise, thereby reducing ground-level concentration of air contaminants.

In addition to these design features, the following will be considered:

- Reducing drop distances to stockpiles
- Where possible, limiting speed on roads
- Dust suppression on roads; and

3.3.1.3 EXPECTED AMBIENT AIR CONTAMINANT CONCENTRATIONS FOR MINE SITE

Airborne contaminant dispersion modelling was carried out as part of the EIS (see EIS Volume 5). For air quality modelling, a 3-km zone was used to define the local study area (LSA) and a 1.5-km zone was used for evaluation of model results against appropriate air quality criteria.

Air quality parameter concentrations in excess of their respective thresholds are predicted, though these exceedances are generally confined to the LSAs and are fully reversible. Effects of the Project on air quality are predicted to be not significant.

3.3.2 TOTE ROAD

Ore haul traffic is expected to be the main source of dust generated along the Tote Road. Mitigation measures to minimize dust emissions will include outfitting ore haul trucks with a roll-on tarp cover, regulating speed limits, and utilizing water and dust suppressants during snow free months. No other specific mitigation measures are provided. Table 6-2 outlines the correction actions that will be implemented if higher than expected dust deposition rates along the Tote Road are observed.

3.3.3 MILNE PORT

3.3.3.1 SOURCE OF AIR EMISSIONS

Activities likely to have an impact on air quality are:

- Ore stockpiles, loaders, and conveyors
- Power generation stations, including a series of generators operating on diesel, with boilers providing emergency backup heat
- Waste incinerators
- Shipping and loading activities, specifically ship loading; and
- Tug boat and ship operation around Milne Port.

3.3.3.2 MITIGATION MEASURES

The main mitigation measures that will be used to minimize dust generation are:

- Reduced vehicle speed on roads
- Minimize drop distance from stackers.

3.3.3.3 EXPECTED AMBIENT AIR CONTAMINANT CONCENTRATIONS FOR MILNE PORT

Airborne contaminant dispersion modelling was carried out as part of the EIS for the ERP (for the larger Project as well - see EIS Volume 5). For air quality modelling, a 3-km zone was used to define the local study area (LSA) and a 1.5-km zone was used for evaluation of model results against appropriate air quality criteria.

Air quality parameter concentrations in excess of their respective thresholds are predicted, though these exceedences are generally confined to the LSAs and are fully reversible. Effects of the Project on air quality are predicted to be not significant.

3.3.4 AIRCRAFT OPERATION

Although aircraft will be a source of air emissions, dust, and noise, given the intermittent nature of this source and the short aircraft operation times in the Project area, air quality and noise impacts of aircraft use are expected to be minimal. Dust suppressant will be used on the airstrips as required. No other specific air quality or noise mitigation measures are provided for aircraft operation.

3.3.5 SHIPS OPERATION

During the open water season, up to sixty (60) Panamax ore carriers will dock at Milne Port. In addition to ore carrier operation, a total of two (2) tugs will be operating to assist the ships and resupply barges in navigation at the port.

The potential ambient air quality impacts from ship emissions were assessed in the EIS, using CALPUFF air dispersion model. The ship emissions will be infrequent and transient; and as such only short-term (1-hour) ambient concentrations of SO_2, NO_x, and NO_2 were analyzed. The emissions at the port are expected to be within applicable threshold standards.

3.4 NOISE

For all phases of the Project, the major sources of noise will be from:

- Mobile equipment and machinery used for construction and facility maintenance
- Blasting events in quarries and at the mine
- Trucks used to haul run-of-mine ore and to haul crushed ore to Milne Port
- Crushing operation
- Power plant generators

Noise modelling was carried out as part of the FEIS and Amended FEIS (see Volume 5). For noise modelling, a Local Study Area (LSA) was defined for the Mine Site, Milne Port and Steensby Inlet as an area within 3 km of the potential Project development area (PDA). Noise criteria used for the impact assessment followed ERCB Directive 038 guidelines (see Section 5). This established a limit of 40 dBA, 1.5 km from the PDA. For all sites, the predicted modelling results showed that the 40-dBA limit will not be exceeded beyond the LSA.

In terms of the 1.5-km evaluation zone:

- For Mine Site – to the southwest, the limit of 40 dBA is exceeded at the 1.5-km line by approximately 6 dB at the south end of the area; and
- For Milne Port – the limit of 40 dbA is not exceeeded at the 1.5 km line; and

For Steensby Site - the limit of 40 dBA is exceeded at the 1.5-km line, but only over water to the southwest. It should be noted that Milne Port noise levels were reassessed in 2013 due to the increased amount of

activity planned for the site during the Early Revenue Phase of the Project. The Milne Port noise modelling study followed the same methodology and criteria utilized by previous studies conducted for the Mine Site and Steensby Inlet. The study and its predicted results are presented in Section 3 of Volume 5 of the Amended FEIS.

3.4.1 MITIGATION MEASURES FOR NOISE

The primary mitigation measure for noise is to ensure that all mobile equipment is equipped with mufflers and that all mobile equipment and machinery are well-maintained.

3.5 GREENHOUSE GAS EMISSIONS REDUCTION PROGRAM

Once the facilities are in operation and a baseline for GHG emission is established, Baffinland will bench-mark its operation against other similar mining operations and implement a Greenhouse Gas Emission Reduction Program.

4 ROLES AND RESPONSIBILITIES

4.1 ORGANIZATIONAL CHARTS

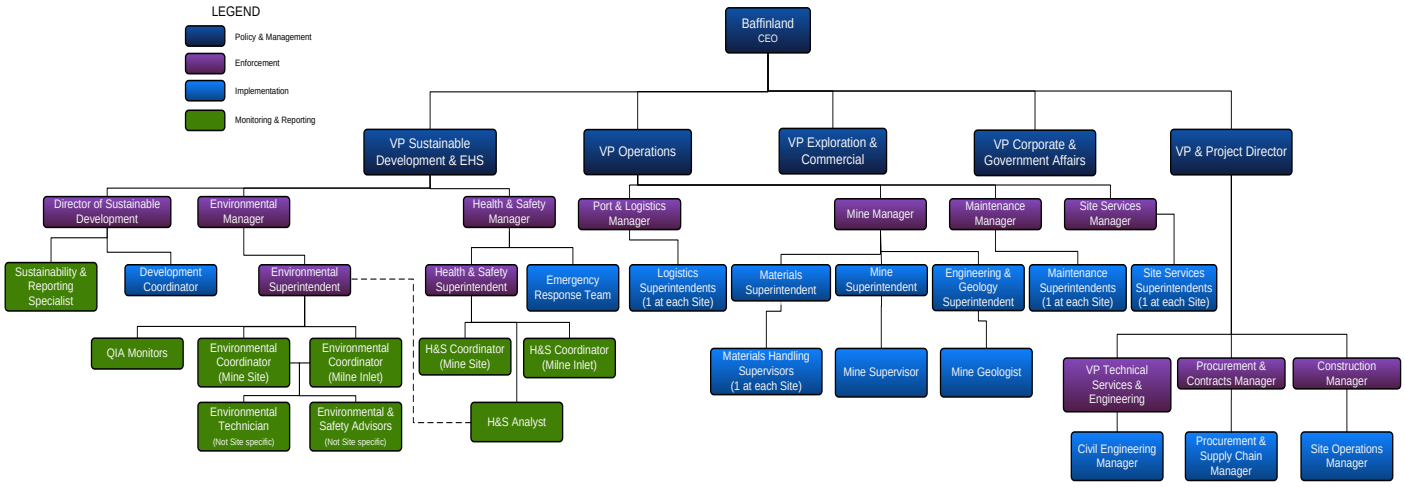

FIGURE 4-1 presents the organization structure for both the construction and operation periods.

4.2 ROLES AND RESPONSIBILITIES

4.2.1 BAFFINLAND ENVIRONMENTAL TEAM

Baffinland Iron Mines Corporation Senior Management	
Position	**Responsibilities and Accountabilities**
VP Operations	- Reports to Baffinland's CEO - Overall accountability for the operation of the Project - Allocation of resources (human and financial) for the implementation of Baffinland's commitments and objectives related to health, safety and environment during operation - Accountable for on-site environmental, health and safety performance during operation
VP Sustainable Development, Health, Safety and Environment	- Reports to Baffinland's CEO - Establish corporate environmental policies and objectives - Monitors and reports on Baffinland's performance related to environmental, health and safety policies and objectives - Community liaison - Liaise with regulatory authorities - Obtains necessary permits and authorizations - Monitors compliance with terms and conditions of permits and licences - Routine EHS audit of contractor performance while on site
Manager Purchasing and Contract	- Reports to Baffinland's Project Director - Accountable for procurement and purchasing

Baffinland Iron Mines Corporation Senior Management	
Position	**Responsibilities and Accountabilities**
	- Ensure that environmental commitments, policies and objectives are included in all contract documents
VP Corporate Affairs	- Reports to Baffinland's CEO - Accountable for external communication (Governments, media, NGO, others) related to Baffinland's press release and overall communication of site incidents/events

4.3 ROLES AND RESPONSIBILITIES

The Baffinland Environmental Team is organised into two parts, on site as well as off site. The organisational structure for the Mary River Project in relation to the environment discipline is shown in the Table 3 below. Communication channels are described as liaisons in the tables outlining the responsibilities and accountabilities in the following sections.

4.3.1 ENVIRONMENTAL PROJECT TEAM

4.3.1.1 THE BAFFINLAND ENVIRONMENTAL TEAM

The Baffinland Environmental Team will oversee all environmental and community works on and off site. The Baffinland Corporate Environmental Team responsibilities are summarized in Table 3.

TABLE 3: BAFFINLAND IRON MINES CORPORATION SENIOR MANAGEMENT

Baffinland Iron Mines Corporation Senior Management	
Position	**Responsibilities and Accountabilities**
VP Operations	- Reports to Baffinland's CEO - Overall accountability for the operation of the Project - Allocation of resources (human and financial) for the implementation of Baffinland's commitments and objectives related to health, safety and environment during operation - Accountable for on-site environmental, health and safety performance during operation

Baffinland Iron Mines Corporation Senior Management	
Position	**Responsibilities and Accountabilities**
VP Sustainable Development, Health, Safety and Environment	- Reports to Baffinland's CEO - Establish corporate environmental policies and objectives - Monitors and reports on Baffinland's performance related to environmental, health and safety policies and objectives - Liaise with regulatory authorities - Obtains necessary permits and authorizations - Monitors compliance with terms and conditions of permits and licences - Routine EHS audit of contractor performance while on site
Manager Purchasing and Contract	- Reports to Baffinland's VP Operations - Accountable for procurement and purchasing - Ensure that environmental commitments, policies and objectives are included in all contract documents
VP Corporate and Government Affairs	- Reports to Baffinland's CEO - Accountable for external communication (Governments, media, NGO, others) related to Baffinland's press release and overall communication of site incidents/events - Community liaisons report to position

The Baffinland on-site Environmental Team will oversee all environmental activities on site. These responsibilities on site are outlined in Table 4.

TABLE 4: BAFFINLAND IRON MINES CORPORATION ON-SITE MANAGEMENT TEAM

Baffinland Iron Mines Corporation On-Site Environmental Team	
Position	**Responsibilities and Accountabilities**
Environmental Manager	- Reports directly to VP Sustainable Development, Health, Safety and Environment and Indirect reporting and coordination with Operations VP and Director Environment - Overall accountability for environmental staff and performance at site - Coordinates implementation and monitors the performance of the Environmental Management System at site - Liaises with the senior management, regulators and stakeholders - Ensures effective monitoring and auditing of environmental performance of departments and contractors on site and identifies opportunities for improvement - Monitors compliance with permits, licenses and authorizations - Ensures all regulatory environmental monitoring and reporting requirements (monthly, annual) are met - Leads and coordinates site permitting requirements. - Initiates and oversees environmental studies

Baffinland Iron Mines Corporation On-Site Environmental Team	
Position	**Responsibilities and Accountabilities**
	- Oversees investigations and reporting of environmental incidents to regulatory bodies, stakeholders and senior management - Reviews and updates environmental management plans
Environmental Superintendent	- Reports to Environmental Manager - Specific accountabilities for environmental monitoring and reporting - Leads investigations and reporting of environmental incidents onsite - Serves as the liaison for regulators during onsite inspections and visits - Provides ongoing environmental education and environmental awareness training to all employees and contract workers - Oversees environmental database management - Prepares updates for management plans
Environmental Coordinator	- Reports to the Environmental Superintendent and Manager - Specific accountabilities for environmental monitoring and reporting - Provides day to day direction to Environmental staff onsite - Serves as a liaison for regulators during onsite inspections and visits. - Provides ongoing environmental education and environmental awareness training to all employees and contract workers - Assists with environmental database management
Environmental Advisor	- Reports to the Environmental Superintendent and Manager - Specific accountabilities for environmental monitoring and reporting - Assists with environmental database management - Prepare updates for management plans
Environmental Monitor and Technician	- Reports to the Environmental Superintendent or designate - Assists with environmental database management - Assists with monitoring and sampling activities as per the Project's management plans
QIA Monitor	- Works alongside the Baffinland Environment Department to ensure the proper implementation of all environmental management and monitoring plans - Acts as the QIA liaison for onsite environmental matters
Environmental Support Groups (Consultants, etc.)	- Assists with sampling, monitoring and reporting activities as required by permits, licenses and environmental management plans - Provides technical expertise to various environmental studies

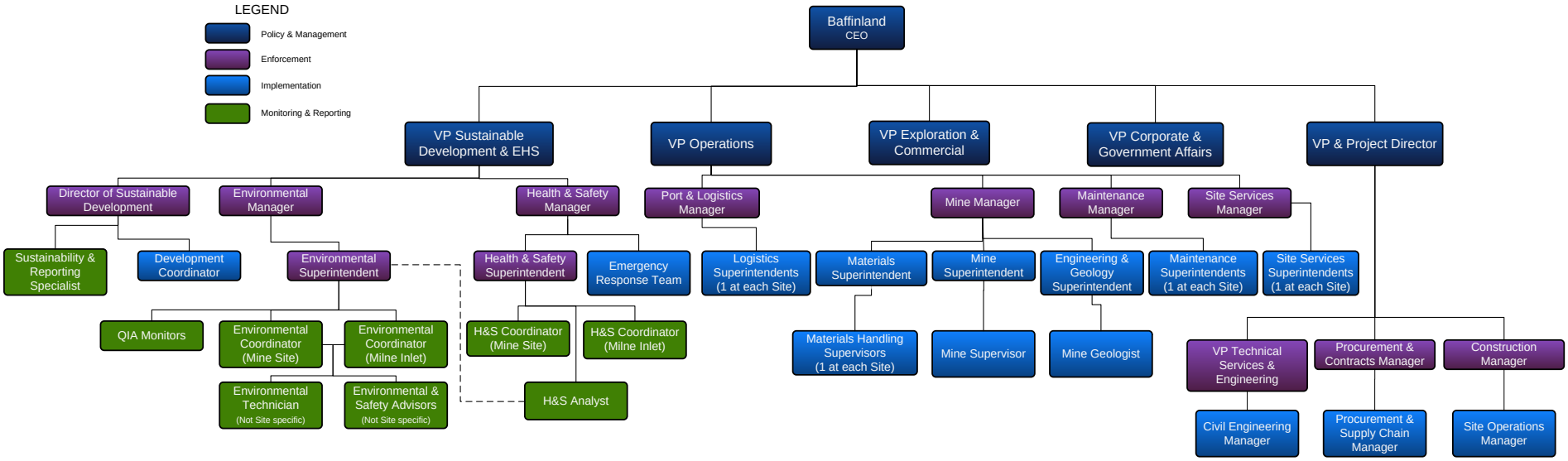

FIGURE 4-1: MARY RIVER PROJECT ORGANIZATION CHART

4.3.2 ENVIRONMENTAL DEPARTMENT

The Environmental Department will oversee all environmental activities on site. These responsibilities on site are outlined below.

Baffinland Iron Mines Corporation On-Site Environmental Team	
Position	**Responsibilities and Accountabilities**
Environmental Manager	• Reports directly to VP Sustainable Development, Health, Safety and Environment and Indirect reporting and coordination with Operations VP and Director Environment • Overall accountability for environmental staff and performance at site • Coordinates implementation and monitors the performance of the Environmental Management System at site • Liaises with the senior management, regulators and stakeholders • Ensures effective monitoring and auditing of environmental performance of departments and contractors on site and identifies opportunities for improvement • Monitors compliance with permits, licenses and authorizations • Ensures all regulatory environmental monitoring and reporting requirements (monthly, annual) are met • Leads and coordinates site permitting requirements. • Initiates and oversees environmental studies • Oversees investigations and reporting of environmental incidents to regulatory bodies, stakeholders and senior management • Reviews and updates environmental management plans
Environmental Superintendent	• Reports to Environmental Manager • Specific accountabilities for environmental monitoring and reporting • Leads investigations and reporting of environmental incidents onsite • Serves as the liaison for regulators during onsite inspections and visits • Provides ongoing environmental education and environmental awareness training to all employees and contract workers • Oversees environmental database management • Prepares updates for management plans
Environmental Coordinator	• Reports to the Environmental Superintendent and Manager • Specific accountabilities for environmental monitoring and reporting • Provides day to day direction to Environmental staff onsite • Serves as a liaison for regulators during onsite inspections and visits. • Provides ongoing environmental education and environmental awareness training to all employees and contract workers • Assists with environmental database management
Environmental Advisor	• Reports to the Environmental Superintendent and Manager • Specific accountabilities for environmental monitoring and reporting • Assists with environmental database management • Prepare updates for management plans
Environmental Monitor and Technician	• Reports to the Environmental Superintendent or designate • Assists with environmental database management • Assists with monitoring and sampling activities as per the Project's management plans

Baffinland Iron Mines Corporation On-Site Environmental Team	
Position	**Responsibilities and Accountabilities**
QIA Monitor	• Works alongside the Baffinland Environment Department to ensure the proper implementation of all environmental management and monitoring plans • Acts as the QIA liaison for onsite environmental matters
Environmental Support Groups (Consultants, etc.)	• Assists with sampling, monitoring and reporting activities as required by permits, licenses and environmental management plans • Provides technical expertise to various environmental studies

4.4 TRAINING AND AWARENESS

Employees and Contractors working onsite will receive environmental training as part of the Site Orientation, to achieve a basic level of environmental awareness and understanding of their obligations regarding compliance with regulatory requirements, commitments and best practices.

The Environmental and Safety Leads and contractor supervisors will be provided with this Air Quality and Noise Abatement Management Plan, and will receive additional orientation with respect to the requirements outlined in this Plan. In addition, all supervisor level Employees and Contractors will be required to attend an Environmental Protection Plan (EPP) training session and will be provided with the EPP as a written guidance for their work.

Targeted environmental awareness training will be provided to both individuals and groups of workers assuming a specific authority or responsibility for environmental management or those undertaking an activity with an elevated high risk of environmental impact. Training will be delivered in the form of toolbox/tailgate meetings or other means as appropriate.

Content of the environmental component of the site induction will include, at a minimum:

- Location of environmental sensitivities
- Location of additional information on environmental matters
- Due diligence responsibilities
- Responsibilities related to waste management, spill reporting, noise management and road traffic rules
- Principles and necessary steps to avoid encounters with bears or other wildlife and what to do if one such encounter occurs.

With respect to this Air Quality and Noise Abatement Management Plan, Baffinland may contract out all or part of its air monitoring and noise survey programs. If contracted out, a well-defined scope of work will be developed that will identify:

- Specific locations for sampling

- Duration of the sampling campaign
- Analysis required
- Reporting format and requirement.

A call for tender will be sent to competent contractors, requesting the following:

- Qualification and expertise of the contractor
- Experience in northern climate
- Details of QA/QC for sampling and analysis
- Client references.

4.5 COMMUNICATION

Types of communications for which members of the team will participate include:

- Meetings and formal written correspondence with stakeholders and regulatory bodies.
- Site visits by community representatives
- Design, construction, and planning meetings
- Field inspections and monitoring reports disseminated by the Environmental Lead
- Electronic communication
- Tailgate/toolbox meetings
- Formal environmental awareness training.

Communication will be appropriately recorded and filed for future reference. Where appropriate, copies of communication will be forwarded to the Health, Safety and Environmental Leads as well as and the Vice President of Sustainable Development and HSE.

4.6 EXTERNAL COMMUNICATIONS

Effective forms of communication include the proactive notification to external stakeholders of Project activity. Project activity updates will be provided to the communities of North Baffin through various means, including regular meetings, public notices, and radio announcements as appropriate.

Baffinland will endeavour to maintain Community Liaison Offices to assist in this regard. Information on air quality and noise monitoring will be integral to this external communication effort.

4.7 AIR QUALITY

Regulatory agencies have identified ambient air quality criteria for the identified indicator contaminants, specifying maximum concentration levels in the atmosphere. In general, these criteria are based on the lowest-observed-level-of-effect and incorporate a safety factor. For this assessment, these criteria were used to define thresholds for the indicator contaminants that, if exceeded, would be considered to be of potential concern.

There are ambient air quality guidelines for Nunavut for TSP, NO_2 and SO_2 (Department of Sustainable Development, 2002). National Air Quality Objectives, CWS, and criteria from other Canadian jurisdictions were selected as the thresholds for the remaining contaminants.

The national objectives are divided into three categories, described as follows (Health Canada, 2005):

- "Maximum desirable level is the long-term goal for air quality and provides a basis for an anti-degradation policy for the unpolluted parts of the country, and for continuing development of control technology."
- "Maximum acceptable level is intended to provide adequate protection against effects on soil, water, vegetation, materials, visibility, personal comfort, and well-being."
- "Maximum tolerable level denotes time-based concentrations of air contaminants beyond which, due to a diminishing margin of safety, appropriate action is required without delay to protect the health of the general public."

Table 5 presents a comparison of federal objectives, NWT criteria, Nunavut guidelines, and CWS. The criteria refer to different averaging periods to account for potential short-term acute exposures and long-term chronic exposures. Based on the precautionary principle, the most stringent criteria were selected as the threshold for each contaminant indicator.

TABLE 5: PERFORMANCE INDICATORS AND THRESHOLDS FOR AIR QUALITY

Contaminant (µg/m³)	Averaging Time	Federal Air Quality Objectives			Canada Wide Standard	Nunavut	NWT	Indicator Threshold
		Desirable	Acceptable	Tolerable				
TSP	24 hr	-	120	400	-	120	120	120
	Annual	60	70	-	-	60	60	60
PM_{10}	24 hr	-	-	-	-	-	50*	50
$PM_{2,5}$	24 hr	-	-	-	30**	-	30	30
SO_2	1 hr	450	900		-	450	450	450
	24 hr	150	300	800	-	150	150	150
	Annual	30	60	-	-	30	30	30
NO_2	1 hr	-	400	1,000	-	400	-	400
	24 hr	-	200	300	-	200	-	200
	Annual	60	100	-	-	60	-	60
CO	1 hr	15,000	35,000	-	-	-	-	15,000
	8 hr	6,000	15,000	20,000	-	-	-	6,000
O_3	1 hr	100	160	300	-	-	-	-
	8 hr	-	-	-	127***	-	127	-
	24 hr	30	50	-	-	-	-	-
	Annual	-	30	-	-	-	-	-

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

** Annual 98th percentile 24-hour concentration, averaged over 3 years.

** Annual 4th highest 8-hour concentration, averaged over 3 years.

Table 6 presents dust-deposition criteria for Alberta and Ontario. These criteria appear to be based on nuisance considerations. The Ontario values have been recalculated to the same units as the Alberta criteria. All dust deposition criteria were used to assess the project.

TABLE 6: DUST DEPOSITION CRITERIA

Average Time	Alberta Residential and Recreational Areas	Alberta Commercial and Industrial Areas	Ontario Ambient Air Quality Criteria	Indicator Threshold
1 month	53 mg/100cm²/ 30 day	158 mg/100cm²/30 day	70 mg/100cm²/30 day	15.8mg/100cm²/30day
	5.3 g/m²/30 day	15.8 g/m²/30 day	7 g/m²/30 day	5.3 g/m²/30 day
Annual	-	-	4.6 g/m²/30 day	55 g/m²/year
	-	-	55 g/m²/year	

4.8 NOISE METRICS

Environmental sound levels vary continuously over time. To account for both daily and short-term variations in sound levels, several single numerical descriptors have been developed based on large-scale psycho-acoustic studies of annoyance with environmental noise. These allow sound monitoring to be conducted for a constantly varying sound environment over extended periods, with the results described as a single number that accurately describes the environment.

The single number descriptor commonly used in most international standards for environmental sound measurements is the energy equivalent sound level (Leq). The Leq value, expressed in dBA, is the energy-averaged, A-weighted sound level for the complete measurement interval.

It is the steady, continuous sound level over a given period that has the same acoustic energy as the actual varying sound level over a given period that has the same acoustic energy as the actual varying sound levels occurring over the same period in the measured environment. It is one of the most common and useful predictors of human response to noise, and, is also the noise descriptor used to establish environmental noise criteria. The A-weighting accounts for the frequency content of measured sound based on a frequency response similar to that heard by the human ear.

The noise descriptors specific to this Air Quality and Noise Abatement Management Plan are:

- 24-h A-weighted energy equivalent sound level Leq(24), referred to as daily sound level
- 15-h A-weighted energy equivalent sound level LeqDay or Leq(15), referred to as daytime sound level
- 9-h A-weighted energy equivalent sound level LeqNight or Leq(9), referred to as night time sound level
- 1-h A-weighted energy equivalent sound level Leq (1), referred to as hourly sound level.

4.8.1 NOISE GUIDELINES

There are no regulations or guidelines in Nunavut that address environmental noise levels. However, noise has been addressed in recent EISs developed for other mining projects in Nunavut (i.e., Meadowbank Gold Project, Doris North Gold Project, High Lake Project). These projects and other projects in the NWT have adopted ERCB Directive 038 Guidelines (ERCB, 2007) as indicative of what is generally considered acceptable with respect to noise levels from industrial activities in remote areas. Directive D038 guidelines have been adopted for the Mary River Project. For an overview of Directive 038, see Table 5-3 Energy Resources Conservation Board Directive 038 Guideline.

4.8.2 NOISE LIMIT AT FENCELINE FOR THE MINE SITE

The fenceline is not defined for facilities such as those at the Baffinland sites, where there is no fence or other fixed facility boundary. For this management plan, the mine area surface lease boundary was used as a proxy for the fenceline. Thus the PSL for the Mine Site is 40 dBA 1.5 km from the mine lease boundary.

4.8.3 NOISE LIMIT AT MILNE PORT

The seasonal hunt camp located at Milne Inlet site has been considered a dwelling with respect to Directive D038. The PSL for this camp is 40 dBA 1.5 km from the exploration license boundary in all other directions (away from the hunt camp).

4.8.4 NOISE LIMIT FOR WORK CAMPS

Work camps such as those associated with the Project are specifically excluded from the requirements of Directive D038. These dwellings were considered, however, as it is important for worker health to maintain an adequate sleep environment. Interior noise can be characterized using balance noise criteria (NCB) curves. For sleeping areas in larger complexes, NCB ratings of NCB 28 to NCB 33 are generally accepted. A NCB rating of 33 has been adopted for the Project.

TABLE 7: ENERGY RESOURCES CONSERVATION BOARD DIRECTIVE 038 GUIDELINES

General Format of Directive D038	Directive D038 sets out permissible sound levels (PSLs), which must be met at all dwellings surrounding the Project development. These limits apply to operational noise only. The cumulative sound level from all energy-related (in this case Baffinland-related) development in the area is measured or predicted. This is called the comprehensive sound level (CSL) and is compared against the PSL. The CSL includes background ambient sound levels. The base PSL value is 40 dBA, which is based on a typical rural or remote ambient sound level (ASL) of 35 dBA, plus 5 dBA allowance for the industrial activity (Alberta Environment research showed that in general, people tolerate sound from energy facilities of up to 5 dBA above the ambient sound environment). The PSL can be increased to account for the presence of other industrial or transportation noise sources, such as road and rail traffic, and for the population density of developed areas. In remote pristine areas, an ASL adjustment, based on measured existing sound levels, can be applied, which might reduce PSL at these locations. For areas where there are no dwellings, a sound level limit of 40 dBA 1.5 km from the facility fence is applied.
Dwellings	A dwelling is defined in Directive D038 as a permanently or seasonally occupied residence, including trailer parks and campgrounds in regular consistent use. For assessment, the only dwelling near Baffinland-related activities is a seasonally occupied hunt camp at Milne Inlet. Worker residences, dormitories, and construction camps are specifically excluded as dwellings under Directive D038.
Noise Limit for Remote Area	Where no noise-sensitive receptors are located within 1.5 km of the facility, the CSL from the facility (facility noise plus ambient) must meet a PSL of 40 dBA Leq (night) measured at 1.5 km from the facility fenceline.

If required, mitigation measures such as the following can be adopted:

- Berms or barriers near dwellings

- Upgraded windows and mandatory air conditioning.

4.8.5 ROADS

Noise from these sources will be intermittent, occurring only when vehicles or heavy equipment pass by. They will be remote from all human receptors.

4.8.6 AIR TRAFFIC

Directive D038 provides no guidance on noise from air traffic sources. Aircraft are subject to federal regulations for noise emissions. Noise from aircraft will be intermittent, occurring when aircraft fly by. They will be remote from all human receptors. In addition, where possible, the aircraft is advised to maintain a minimum flying altitude of 2,000 feet when in the air space over the park; except for approach to land, take-off, or for safety reasons.

4.9 VIBRATION METRICS

Vibration impacts can be broken down into two zones: terrestrial (above ground, on land) and underwater.

4.9.1 TERRESTRIAL

Human perception of ground-borne vibration can be ranked as follows (Bender, 1996):

- Barely to distinctly perceptible - 0.5 to 2.5 mm/s ppv
- Distinctly to strongly perceptible - 2.5 to 6.25 mm/s ppv
- Strongly perceptible to mildly unpleasant – 6.25 to 25.4 mm/s ppv
- Increased potential for structural damage - 12.5 to 25.4 mm/s ppv.

The potential for structural damage increases for airborne vibration overpressure in excess of 120 dB (MOE, 1997).

4.9.2 UNDERWATER

Fisheries and Oceans Canada (DFO) has produced *Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters* to protect marine wildlife, including fish and marine mammals from underwater vibrations (DFO, 1998).

Highlights of the guideline include the following:

- No explosive is to be knowingly detonated within 500 m of any marine mammal (or no visual contact from an observer using 7 x 35 power binocular).
- No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa in the swim bladder of a fish.

- No explosive is to be detonated that produces, or is likely to produce, a peak particle velocity greater than 13 mm/s in a spawning bed during the period of egg incubation.

The guideline also presents tables of weight of explosive change versus distance and other estimation methods are provided to determine the potential impacts.

This guideline is relevant mostly for the construction phase of the Project (construction of docking facilities, creek/river crossings).

5 MONITORING

5.1 METEOROLOGY

Three meteorological stations have been established, at the Mine Site, Milne Port and Steensby Camp. The stations record air temperature, relative humidity, precipitation, barometric pressure, wind direction, and wind speed. Data collected from the meteorological stations are establishing a climatic record in key project areas. Details of the auto-stations are presented in Attachment 4 of this Management Plan.

During 2009, each station was retrofitted with new research technology being tested to determine its ability to transfer data remotely in real time.

Tide gauges will also be installed at Milne Port to monitor relative sea level and storm surge (Refer to Attachment 2, Table 11 – Project Certificate commitments).

5.2 AIR QUALITY MONITORING

Potential sources of project-related effects on air quality include exhaust emissions from vehicles, mining activities, aircraft, generators and other equipment, emissions from camp incinerators, and fugitive dust emissions from road traffic during snow-free periods.

Daily inspection of facilities will ensure compliance with this Air Quality and Noise Abatement Management Plan.

Scheduled maintenance on mobile equipment and stationary equipment will ensure that emissions are in line with vendors` specifications and emission criteria.

The Dust Management Protocol (Attachment 7) discusses the procedures for applying dust-suppressants. Training/instruction on the use of dust suppressants will be provided to all employees and Contractors, as required.

5.2.1 AMBIENT AIR QUALITY MONITORING

Passive and active air quality monitoring will be conducted at specified locations outside the Potential Development Areas (PDA). Active monitoring will involve measuring TSP in areas of activity at the Mine Site and Milne Port, as per Terms and Condition #8 (Attachment 2). Passive sampling will include collecting SO_2, NO_2, O_3, and dustfall samples simultaneously. During both construction and operation, the monitoring program will focus on TSP and dust deposition.

Air quality data will be collected via active (TSP) and passive sampling methods (SO_2, NO_2, O_3, and dustfall, including metal deposition). Snow-core sampling will be used to determine dustfall at specified locations.

The initial dust (TSP) sampling locations and frequency were established at the Mine Site, Milne Port and along the Tote Road in the summer of 2013 to monitor dust deposition rates and verify predictions of its

potential impacts (Refer to Attachment 6- Dust Fall Monitoring Program for details). Sampling locations and frequency associated with the Dust Fall Monitoring Program will be reassessed and revised/updated as required.

Along with dust monitoring, Baffinland commits to a minimum of three (3) years of continuous monitoring for SO_2 and NO_x at the Mine Site and Milne Port following the start of shipment of ore and will review the continuation of this program based on the results of the monitoring and through consultation with Environment Canada. To address this commitment, continuous air quality monitoring systems were installed at the Mine Site and Milne Port during late 2014 to monitor SO_2 and NO_x. Baffinland commits to re-visit this monitoring program should the Project change significantly.

Table 8 and Table 9 present an overview of the indicators and corrective action to be taken should thresholds be exceeded.

TABLE 8: AIR QUALITY PERFORMANCE INDICATORS AND THRESHOLD

Location	Frequency	Indicator	Threshold	Corrective Action
Mine Site	Number of sampling locations and frequency to be determined.	SO2 NO2 PM2.5 TSP	Refer to Table 5.1	Review mitigation measures in place. Review specification on equipment. Review maintenance schedule for combustion equipment.
Milne Port	Number of sampling locations and frequency to be determined.	SO2 NO2 PM2.5 TSP	Refer to Table 5.1	Review mitigation measures in place. Review specification on equipment. Review maintenance schedule for combustion equipment.

TABLE 9: DUSTFALL PERFORMANCE INDICATORS AND THRESHOLDS

Location	Frequency	Indicator	Threshold	Corrective Action
Mine Site		Dustfall	4.6 g/m^2/yr	Use dust suppressant. Review mitigation measures in place. Review specification on equipment. Review maintenance schedule for combustion equipment.
Tote Road		Dust fall	4.6 g/m^2/yr	Construction of road bed (coarse material) Use of dust suppressant Speed limit for vehicles Ore trucks equipped with roll-on tarp covers
Milne Port		Dustfall	4.6 g/m^2/yr	Use dust suppressant. Review mitigation measures in place. Review specification on equipment. Review maintenance schedule for combustion equipment.

5.2.2 INCINERATOR EMISSION TESTING

Non-hazardous combustible camp waste is disposed of in camp incinerators. Incinerated waste is typically generated from the kitchen and personnel accommodations. All waste sent to the incinerator will be sorted as per the Waste Sorting Guidelines (BAF-PH1-830-P25-0001) described in the Waste Management Plan (BAF-PH1-830-P16-0028). Initial stack tests were conducted upon commissioning all camp incinerators to confirm conformance with all applicable Air Quality regulations based on a 'typical' waste stream'. Camp incinerators are currently installed at Milne Port and the Mine Site. Each incinerator uses dual-chamber, variable-airflow design technology and is specifically designed for remote camp operations. The operation of incinerators will be monitored using on-line instruments capable of continuous temperature monitoring of the combustion process in both chambers and stack emissions. Temperature readings outside of the normal range can warn the operator that the system is not working properly.

Incinerators onsite are capable of meeting the Canadian Council of Ministers of the Environment (CCME), CWS for mercury emissions, and the CCME-CWS for dioxins and furans. The incinerators are operated as required, using the Incinerator Operation Procedure (BAF-PH1-320-PRO-0002) which has been developed in accordance with the manufacturers' recommendations. All incinerator operators receive training by experienced supervisory personnel.

5.2.3 EXPANDED REGIONAL STUDY

As per Term and Condition # 7, once the rail project becomes operational, similar land-based monitoring stations will be installed along Foxe Basin and along Hudson Strait.

The purpose of these land-based stations is to provide an expanded study area to capture emissions related to shipping traffic.

5.3 NOISE

The purpose of the monitoring program is to assess the magnitude of noise impacts from Project activities. The main activities expected to cause noise impacts include mining, crushing, generators, aircraft activities and transportation activities related to ore, overburden, and waste rock.

Field activities will be conducted in accordance with the EPP to minimize potential effects on people and wildlife. More specifically, equipment will be operated with modern mufflers, and subjected to regular maintenance. In remote areas, drilling and other site activities will be guided by the presence and response of wildlife.

Table 10 presents performance indicators, thresholds, and corresponding corrective action. The site management will also need to ensure certification of noise compliance is current, where applicable.

TABLE 10: NOISE PERFORMANCE INDICATORS AND THRESHOLDS

Location	Frequency	Indicator	Threshold	Corrective Action
Mine Site	To be determined	Noise level at fenceline.	40 dBA	Review mitigation measures in place.
Milne Port	To be determined	Noise level at fenceline.	40 dBA	Review mitigation measures in place.

6 REPORTING REQUIREMENTS

6.1 REPORTING

Information collected on air quality and noise via the monitoring programs described in Section 6 will be reported annually to the NIRB as per the Terms and Conditions of the Project Certificate. GHGs will also be reported to Environment Canada as described below in Section 7.1.3.

Specifically, reporting will address:

6.1.1 AIR QUALITY

- Report on incinerator testing (as per requirements of Attachment 2, Table 11 – T&C # 11 and 12)
- Results of passive air quality measurements at the Mine Site and Milne Port (Attachment 2, Table 12 commitment # 61)
- Results of dust deposition monitoring at the Mine Site, along Tote Road, and, Milne Port (Attachment 2, Table 12 commitment #60).
- Report on land-based monitoring stations.
- Report on exceedances to FEIS predicted air quality predictions.

In accordance with T&C # 8 (Attachment 2, Table 11), in cases where exceedances are manifested, Baffinland will provide an explanation for the exceedance, a description of planned mitigation, and shall conduct additional monitoring to evaluate the effectiveness of mitigative measures.

6.1.2 NOISE

- Report on noise monitoring at camp sites (Attachment 2, Table 11 T&C #14)

6.1.3 GREENHOUSE GAS

As per the Notice with respect to reporting of greenhouse gases (GHGs) for 2014 (EC, 2014a), if Baffinland meets or exceeds the 50,000 tonnes CO_2 eq threshold, it will be required to report emissions for each of the following gases or groups of gases:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Sulphur hexafluoride (SF_6)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)

Total quantity in tonnes of direct emissions of CO_2, CH_4, and N_2O must be reported for the following source categories:

- Stationary Fuel Combustion
- Venting
- Flaring
- Fugitive
- On-site Transportation
- Waste
- Wastewater

Baffinland will estimate its emissions according to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). These guidelines describe the various approaches to estimate GHG emissions per category.

Additionally, the following will be reported annually to the NIRB as per the Terms and Conditions of the Project Certificate:

- Quantity of fuel consumed during the year
- Calculation of greenhouse gas emissions for the site (Attachment 2, Table 11 T&C # 9)
- Provide interested parties with evidence of continued initiatives undertaken to reduce greenhouse gas emissions (Attachment 2 – Table 11 T&C # 3)
- And estimate of marine shipping vessels emissions (refer to Attachment 2, Table 12 Commitment #62)
- Report on efforts made with shipping partners to reduce fuel consumption (refer to Attachment 2, Table 12 Commitment #63).

6.1.4 METEOROLOGICAL DATA

In accordance with Project Certificate Terms and Conditions and other Baffinland commitments (refer to Attachment 2), the following information will also be made available to regulatory agencies (Environment Canada, NRCan, others):

- Tidal information at Milne Port (Attachment 2, Table 11 T&C #1).
- Weather related information (Attachment 2, Table 11 T&C #5, Table 12 Commitments #58 and 59).

6.2 DOCUMENTATION AND DATA CONTROL

Baffinland's Environmental Manager will oversee the preparation, review, and distribution, as appropriate, of the data and reports required for regulatory purposes.

Execution of some of the monitoring programs detailed in the Air Quality and Noise Abatement Management Plan will be conducted by, or supported by consultants and contractors to Baffinland. Data and reports will be prepared and delivered to Baffinland by its consultants for internal and external distribution and use, as appropriate.

All formalized documents and reports will follow data-control procedures, with revision numbers and revision tracking. Documents and data that are to be issued and liable to change will be controlled to ensure they are approved before issue and that the current issue or revision is known to and available to those requiring them.

6.3 INTERNAL AND EXTERNAL REPORTING

Implementation of monitoring under the Air Quality and Noise Abatement Management Plan results in collection of data and generation of various reports. Whereas there are regulatory requirements for formal monthly and annual reports, including disclosure of issues of non-conformance, internal reporting is used to provide direction to personnel and to provide operational updates to site and corporate management. Internal reporting mechanisms might include weekly environment reports, weekly operations reports, and routine inspection reports. Site-based toolbox and management meetings are also an important internal reporting tool commonly used.

Parks Canada has requested to be provided with regular flight and shipping schedules that can be used to brief visitors to the park. Any changes to the regular schedule that is substantially different will need to be notified to the Parks Canada so that appropriate mitigations can be explored.

7 QA/QC

As per the requirements of Baffinland's EHS Framework (SD-STE-001), regular audits will be undertaken to ensure compliance with the current Air Quality and Noise Abatement Management Plan and that best management practices are implemented. The result of this audit will form the basis for an annual written statement of assurance by management on effectiveness of the Air Quality and Noise Abatement Management Plan.

In terms of the physical sampling, maintenance of sampling station, and analytical services that may be performed by consultants or contractors, Baffinland's procurement procedures for these services will ensure that the consultant or contractor retained to execute the work has the necessary accreditation, calibration and QA/QC procedures in place.

8 ADAPTIVE STRATEGIES

Baffinland is committed to continuous improvement in its work activities in the aim of reducing risks to the environment and improving operational effectiveness. The strategy employed at Baffinland is regular monitoring supported by operational change and adoption of other mitigating measures if warranted.

As per the requirements of Baffinland's HSE Management Framework (SD-STD-001), the company will conduct and document management reviews of its Air Quality and Noise Abatement Management Plan on a regular basis. Such reviews will ensure the integration of monitoring results for the Waste Management Plan are integrated with other aspects of the Project and that necessary adjustments are implemented as required. These reviews also provide a formal mechanism to assess the effectiveness of the management in achieving the company's objectives and maintaining ongoing compliance with Project permits and authorizations.

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Attachment 1: Sustainable Development Policy

SUSTAINABLE DEVELOPMENT POLICY

At Baffinland Iron Mines Corporation, we are committed to conducting all aspects of our business in accordance with the principles of sustainable corporate responsibility and always with the needs of future generations in mind. Everything we do is underpinned by our responsibility to protect the environment, to operate safely and fiscally responsibly and to create authentic relationships. We expect each and every employee, contractor, and visitor to demonstrate a personal commitment to this policy through their actions. We will communicate the Sustainable Corporate Policy to the public, all employees and contractors and it will be reviewed and revised as necessary on an annual basis.
These four pillars form the foundation of our corporate responsibility strategy:

1. Health and Safety
2. Environment
3. Investing in our Communities and People
4. Transparent Governance

1.0 HEALTH AND SAFETY

- We strive to achieve the safest workplace for our employees and contractors; free from occupational injury and illness from the very earliest of planning stages. Why? Because our people are our greatest asset. Nothing is as important as their health and safety.
- We report, manage and learn from injuries, illnesses and high potential incidents to foster a workplace culture focused on safety and the prevention of incidents.
- We foster and maintain a positive culture of shared responsibility based on participation, behaviour and awareness. We allow our workers and contractors the right to stop any work if and when they see something that is not safe.

2.0 ENVIRONMENT

- We employ a balance of the best scientific and traditional Inuit knowledge to safeguard the environment.
- We apply the principles of pollution prevention and continuous improvement to minimize ecosystem impacts, and facilitate biodiversity conservation.
- We continuously seek to use energy, raw materials and natural resources more efficiently and effectively. We strive to develop pioneering new processes and more sustainable practices.
- We understand the importance of closure planning. We ensure that an effective closure strategy is in place at all stages of project development and that progressive reclamation is undertaken as early as possible to reduce potential long-term environmental and community impacts.

3.0 INVESTING IN OUR COMMUNITIES AND PEOPLE

- We respect human rights and the dignity of others. We honour and respect the unique culture, values and traditions of the Inuit people.
- We contribute to the social, cultural and economic development of sustainable communities adjacent to our operations.
- We honour our commitments by being sensitive to local needs and priorities through engagement with local communities, governments, employees and the public. We work in active partnership to create a shared understanding of relevant social, economic and environmental issues, and take their views into consideration when making decisions.

4.0 TRANSPARENT GOVERNANCE

- We will take steps to understand, evaluate and manage risks on a continuing basis, including those that impact the environment, employees, contractors, local communities, customers and shareholders.
- We ensure that adequate resources are available and that systems are in place to implement risk-based management systems, including defined standards and objectives for continuous improvement.
- We measure and review performance with respect to our environmental, safety, health, socio-economic commitments and set annual targets and objectives.
- We conduct all activities in compliance with the highest applicable legal requirements and internal standards
- We strive to employ our shareholder's capital effectively and efficiently. We demonstrate honesty and integrity by applying the highest standards of ethical conduct.

Tom Paddon
President and Chief Executive Officer
September 2011

Attachment 2: Amended Project Certificate Terms and Conditions

Below are Concordance Tables of this management plan with amended NIRB Project Certificate No. 005, May 2014 (main text) and Appendix A to NIRB Decision Report

TABLE 11: CONCORDANCE TABLE WITH NIRB PROJECT CERTIFICATE NO 005 AMENDMENT 1, TERMS & CONDITION

No.	Term and Condition	Comments
Meteorology and Climate (including Climate Change)		
1	The Proponent shall use GPS monitoring or a similar means of monitoring at both Steensby Port and Milne Port, with tidal gauges to monitor the relative sea levels and storm surges at these sites.	A tide gauge will be installed at Milne Port. Refer to Section 7 for Reporting.
2	The Proponent shall provide the results of any new or revised assessments and studies done to validate and update climate change impact predictions for the Project and the effects of the Project on climate change in the Local Study Area and Regional Study Area as defined in the Proponent's Final Environmental Impact Statement.	Ongoing
3	The Proponent shall provide interested parties with evidence of continued initiatives undertaken to reduce greenhouse gas emissions.	Refer to Section 7 for Reporting
4	The Proponent shall endeavour to include the participation of Inuit from affected communities and other communities in Nunavut when undertaking climate-change related studies and research.	Ongoing
5	The Proponent shall endeavour to explore and implement reasonable measures to ensure that weather-related information for the various Project sites is readily accessable to the public on a continual basis throughout the life of the Project	Refer to Section 7 for Reporting
Air Quality		
6	The Proponent shall provide the results of any emissions calculations conducted to determine the level of sulphur dioxide (SO_2) emissions, nitrogen oxide (NO_x) emissions and greenhouse gases generated by the Project using fuel consumption or other relevant criteria as a basis.	Refer to Section 7 for Reporting.
7	The Proponent shall update its Air Quality and Noise Abatement Management Plan to provide for continuous monitoring at land-based monitoring stations designed to capture operations phase ship-generated SO_2 and NO_2 emissions at Steensby Port and Milne Port. Continuous monitoring is to be carried out through several shipping seasons at each port as required to determine that emissions are at acceptable levels.	Refer to Section 6 for Monitoring and Section 7 for Reporting

No.	Term and Condition	Comments
8	The Proponent shall demonstrate through monitoring of air quality at the mine site and at the Steensby Inlet and Milne Inlet port sites that SO_2 and NO_2 emissions remain within predicted levels and, where applicable, within limits established by all applicable guidelines and regulations. In cases where exceedances are manifested, the Proponent shall provide an explanation for the exceedance, a description of planned mitigation, and shall conduct additional monitoring to evaluate the effectiveness of mitigative measures.	Refer to Section 7 for Reporting.
9	The Proponent shall provide calculations of greenhouse gas emissions generated by activities at the Steensby Inlet and Milne Inlet port sites and other Project sources including aircraft associated with the Project. Calculations shall take into consideration, fuel consumption as measured by Baffinland's purchase and use as well as the fuel use of its contractors and sub-contractors.	Refer to Section 7 for Reporting.
10	9.1.1.1 The Proponent shall update its Dust Management and Monitoring Plan to address and/or include the following additional items: 9.1.1.2 a) Outline the specific plans for monitoring dust along the first few kilometres of the rail corridor leaving the Mary River mine site. 9.1.1.3 b) Identify the specific adaptive management measures to be considered should monitoring indicate that dust deposition from trains transporting along the rail route is greater than initially predicted. 9.1.1.4 c) Outline specific plans for monitoring dustfall at intervals along and in the vicinity of the Milne Inlet Tote Road to determine the amount and extent of dustfall. 9.1.1.5 d) Identify the specific adaptive management measures to be considered if monitoring indicates that dust deposition from traffic on the Milne Inlet Tote Road is greater than initially predicted.	Section 3 presents Mitigation measures Section 6 presents Monitoring Section 7 presents Reporting
11	The Proponent shall develop and implement an Incineration Management Plan that takes into consideration the recommendations provided in Environment Canada's Technical Document for Batch Waste Incineration (2010).	Refer to Section 6
12	Prior to commencing any incineration of on-site Project wastes, the Proponent shall conduct at least one stack test immediately following the commissioning of each temporary and permanent incinerator.	Refer to Section 6
Noise and Vibration		
13	The Proponent is encouraged to work with Fisheries and Oceans Canada at the regulatory phase and to take a precautionary approach when selecting the overpressure threshold to be applied to explosives use for the	Refer to the Blasting Management Plan (Type A Water Licence). This plan was developed in consultation with the DFO.

No.	Term and Condition	Comments
	protection of fish and aquatic life.	
14(a)	The Proponent, through coordination with the MEWG as may be appropriate, shall demonstrate appropriate adaptive management for construction activities at Milne Inlet that have the potential to disrupt marine mammal species, including pile driving and ore dock construction, are undertaken.	Refer to the Shipping and Marine Wildlife Management Plan
14(b)	The Proponent, through coordination with the TEWG as may be appropriate, shall demonstrate appropriate adaptive management for project activities during operations which have the potential to produce noise and sensory disturbance to wildlife and other users of project areas.	This condition is in progress in consultation with the Terrestrial Environment Working Group (TEWG).
15	The Proponent shall collaborate to the extent possible with the Qikiqtani Inuit Association and local Hamlet organizations when undertaking consultation with all affected communities regarding railway, tote road and marine shipping operations. During these consultations, it is recommended that the Proponent provide information including video, audio, and photographic representation as well as any other aids (i.e. models) that may enhance the general public's understanding of railway, tote road and marine shipping operations, as well as all safety considerations for members of the public who may be travelling around the project area.	Baffinland continues to work with Hamlet and QIA regarding safety considerations for travel and interaction with project for those travelling in the area. In support of this, Baffinland established the Pond Inlet Community Advisory Group (which includes HTO and Hamlet representation) and continues to work with the Marine and Terrestrial working groups, of which QIA is a member.

TABLE 12: APPENDIX A TO NIRB DECISION REPORT

No.	Subject	Commitment	Action
2	Design (Fugitive Dust)	Baffinland is committed to developing and implementing mitigation measures which control fugitive dust emissions.	Refer to Section 3 of this Management Plan
3	Operations (Ore Processing and Tailings)	Baffinland will undertake only the physical crushing and screening processing of the ore generated from the Mary River Project within the project area.	Crushing and screening is limited to the Mine Site.
18	Railway (Locomotives)	Baffinland is committed to purchasing the highest tier (per the USA's EPA standards) of locomotive available for use at the Mary River project.	Deferred until approved Project gets under way
32	Marine (Noise)	Baffinland is committed to providing the QIA with a copy of the frequency-noise distribution graph for sound generated by ore ship propellers travelling through ice.	Addressed in Shipping and Marine Mammals Management Plan
40	Monitoring (Abandonment and Restoration)	Baffinland is committed to undertaking environmental effects monitoring during the mine life mine as well as after closure.	Addressed in Abandonment and Reclamation Plan
57	Management Plans	Baffinland is committed to updating its management plans to reflect new information, new practices and changes to operating conditions.	Refer to page 1 for date of update. Refer to Section 9 for commitment to Adaptive Strategies
58	Meteorology and Climate (Reporting)	Baffinland is committed to contributing to regional monitoring and information gathering.	Refer to Section 7 - Reporting
59	Meteorology and Climate (Reporting)	Baffinland is committed to giving consideration to the sharing of weather data collected for the Mary River Project with Environment Canada to post on its public weather network.	Refer to Section 7 - Reporting
60	Air Quality (Fugitive Dust from Railway Shipping)	Baffinland is committed to monitoring fugitive dust emissions on vegetation along the first few kilometres of the Railway leaving both terminals (Mary River and Steensby Inlet). This monitoring will be extended if it is identified that other areas of the project site are also being impacted by fugitive dust emissions.	Refer to Section 6 of this Plan – this commitment is applied to dust monitoring along the Tote Road Attachment 6 of this p/an.
61	Air Quality (SO_2 Emissions)	Baffinland is committed to conducting passive monitoring of SO_2 at the Steensby Inlet camp.	Refer to Section 6 of this Plan – this commitment is applied to passive monitoring at Milne Port.
62	Project Design (Marine Shipping Air Emissions)	Baffinland is committed to estimating marine shipping vessel emissions associated with the Mary River Project.	Refer to Section 7 for reporting
63	Project Design (Greenhouse Gas)	Baffinland and its shipping partners are committed to working with shipyards to reduce fuel consumption by 20% or more.	Refer to Section 7 for reporting
66	Monitoring	Baffinland is committed to the development and implementation of a monitoring program during the construction and other phases of the Mary River Project.	This management plan addressed the air quality and noise components.

Attachment 3: Baseline Project Conditions

TABLE 1: MEASURED CONATAINMENT CONCENTRATIONS FOR THE MARY RIVER PROJECT

Parameter	Baseline Concentration ($\mu g/m^3$)
24-hour TSP	7.0
24-hour PM_{10}	3.8
30-day SO_2	0.262
30-day NO_2	0.188
30-day O_3	52.8

TABLE 2: BASELINE DUSTFALL DEPOSITION RATES

Parameter	Baseline Deposition Rate ($mg/100cm^2/30$ days)
Total Dustfall	0.398

TABLE 3: BASELINE METAL DEPOSITION RATES FOR SELECTED METALS

Parameter	Baseline Deposition Rate ($\mu g/100cm^2/30$ days)
Al	26.9
Co	0.5
Cr	0.3
Fe	30.6
Mg	23.9
Mn	1.7

Data obtained from the 2007 sampling program were compared with federal and other provincial air quality criteria (see Section 1.2) and with data from other air quality monitoring stations in the Canadian Arctic. Results are shown in Table 4 Baseline Ambient Air Quality Monitoring Results, and indicate that concentrations of both TSP and PM10 were well below applicable indicator thresholds.

TABLE 4: BASELINE AMBIENT AIR QUALITY MONITORING RESULTS

Air Quality Parameter	24-h Indicator Threshold	Mary River Sampling Locations			
		1A	1B	2A	2B
Maximum TSP (µg/m³)[1]	120	3.5	3.0	**7.0**	5.5
Maximum 24-h PM_{10}, (µg/m³)[2]	50	3.0	1.5	1.8	**3.8**
Total dustfall deposition rate (30-day average) (µg/100cm²/30d) [3]					
SO_2 (30-day average) (µg/m³)[3]	450 (1-h) 150 (24-h) 30 (annual)				
NO_2 (30-day average) (µg/m³)[3]	400 (1-h) 200 (24-h) 60 (annual)				
O_3 (30-day average) (µg/m³)[3]	100 (1-h) 127 (8-h) 30 (24-h) 30 (annual)				
Metal deposition rates (30-day average) µg/100cm²/30d (3)					

NOTES:
[1] – based on 15 samples
[2] – based on 12 days of sampling
[3] – based on 50 days of sampling.
Bold values indicate maximum values selected as baseline concentrations.

TABLE 5: BASELINE AMBIENT NOISE MONITORING RESULTS

Site	Leq (24 h) (dBA)	Leq (Day, 15 h) (dBA)	Leq (Night, 9 h) (dBA)	Minimum Leq (1 h) (dBA)	Maximum Leq (1 h)(dBA)
Mary River	25	25	26	20	34
Milne Inlet	30	31	29	21	35
Steensby Inlet	29	31	26	23	35

Attachment 4: Weather Stations at Project Sites

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

CANADA

Baffinland Iron Mines Corporation Annual Report

2014 Met Station Monitoring and Maintenance

Presented to:

Trevor Meyer
Baffinland Iron Mines Corporation
December 22, 2014

Prepared by:

Shannon Green
Campbell Scientific (Canada) Corp.
T: 780.454.2505 | Direct: 780.733.8225
E: shannon.green@campbellsci.ca

Overview

New meteorological stations were installed at Mary River, Milne and Steensby locations on Baffin Island, NU in August 2013 by Campbell Scientific Canada (CSC). These met stations were intended to replace existing Symboticware met stations that were previously installed and had become non-functional. The CSC stations contain new, calibrated rugged sensors and dataloggers in order to provide consistent, accurate and reliable data. These features are particularly important given the remote locations of these stations, where access is a challenge. Some existing hardware, such as enclosures, towers, and power supplies have been repurposed for use with these stations.

Campbell Scientific is also providing both Field and Data Services for all three stations, which include active network and data management.

Field Services includes an annual maintenance trip by a CSC technician. This trip involves field calibrating or swapping of sensors to minimize station downtime, general station maintenance and inspection, and addressing any hardware and/or troubleshooting concerns.

Data Services includes the remote collection of data once a week using each of the stations iridium satellite communications hardware. The data is collected to a CSC server and synced to an FTP site which is accessible by Baffinland Iron Mine Inc. Basic QA/QC is performed on the data in order to monitor station health and identify any abnormalities with a specific parameter/sensor.

This report includes an outline of the work completed by CSC Technician, Mike Ryder, during the September 2014 maintenance trip. A summary is also included of the station health and data overview from each station starting from the installation date in August 2013 up until the date of the maintenance trip in September 2014.

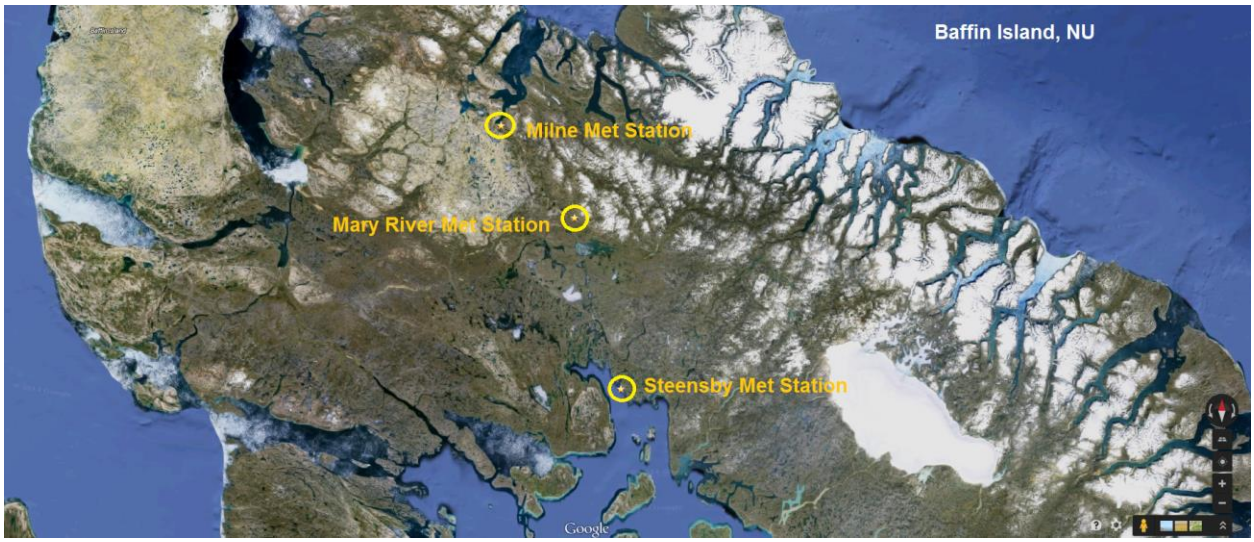


Figure 1: Map of Baffinland met stations installed on Baffin Island, NU as of August 2013

Station Health

Campbell Scientific Canada has been collecting data from the Milne, Mary River and Steensby met stations starting as of late August 2013. The data is collected remotely to a CSC server on a weekly schedule via iridium communication hardware. Once data is collected, it is then synced in near real time to a password protected, secure FTP site accessible by Baffinland end users.

Data QA/QC

A basic QA/QC check of all data is performed in order to monitor station health and flag any suspect or invalid data. Initially, QA/QC checking of data was performed manually on a weekly basis. As of July 2014 all data from each station is being imported into our WISKI database which now provides automated data QA/QC and validation. The automated QA/QC occurs within several minutes after data is collected from each station and imported into the WISKI database. Below are events that occurred and were flagged during the past year:

October-November 2013 – CSC observed battery voltages consistently dropping at all three stations. Steensby station in particular was most concerning as the station power had dropped to voltages below 11.5 V. Baffinland was notified of the issue and upon approval, CSC reduced the collection schedule from weekly to bi-weekly in order to continue data collection during winter months. Once the battery voltages recovered and increased to a sustainable level, scheduled collections were changed back to a weekly interval. Graphs 1 to 3 included below show battery voltage trends at the Milne, Mary River and Steensby stations from August 2013 to August 2014.

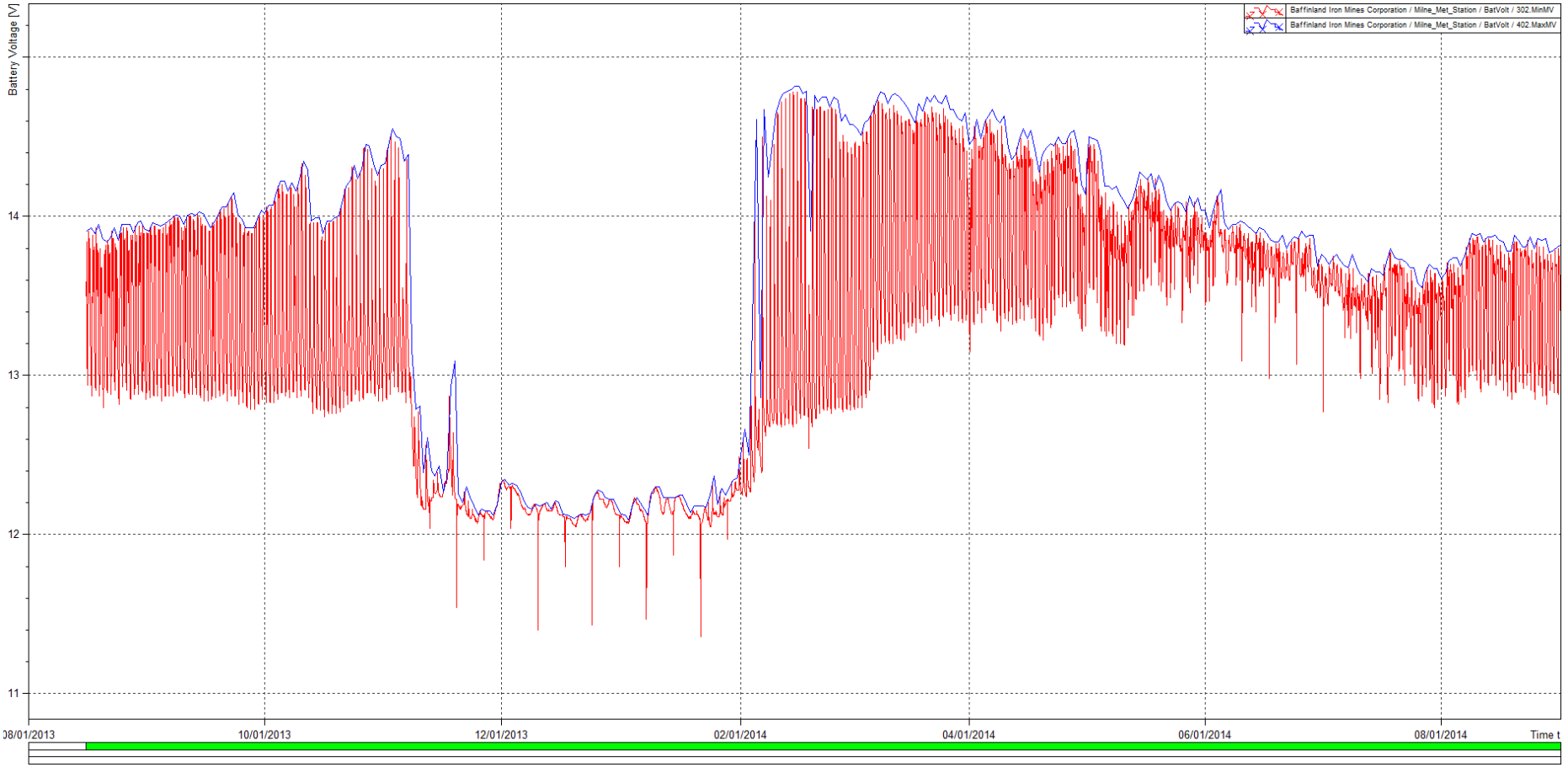
October 2013 – Relative Humidity data was flagged as suspect from the Mary River station starting in October 2013. Baffinland was notified regarding concerns with the RH sensor and that a site visit would be required to replace this HC2-S3 probe. Once notified, the client decided to wait until the upcoming 2014 fall maintenance trip to replace this sensor. Suspect data values were recorded from this sensor until it was replaced during the September 2014 maintenance site visit at this station. The HC2-S3 sensors from the Milne and Steensby met stations were also replaced as a precaution during the 2014 maintenance trip.

It was suspected that the HC2-S3 sensor at the Mary River station had been affected by an issue where if condensation were to come in contact with the RH chip it could begin to show erratic behavior. The erratic behavior is typically manifested by spikes to high and low RH values outside of normal operating conditions. These spikes tend to last over a time period of a few milliseconds to several seconds. In the majority of cases the unstable readings will appear in raw data as rapid swings between 0% and 100% RH or greater over a narrow period creating a “saw tooth” trend when graphed. The presence of the erroneous values in a data set will bias the accuracy of the output. To date our records indicate that this concern has occurred in a very small percentage of probes deployed.

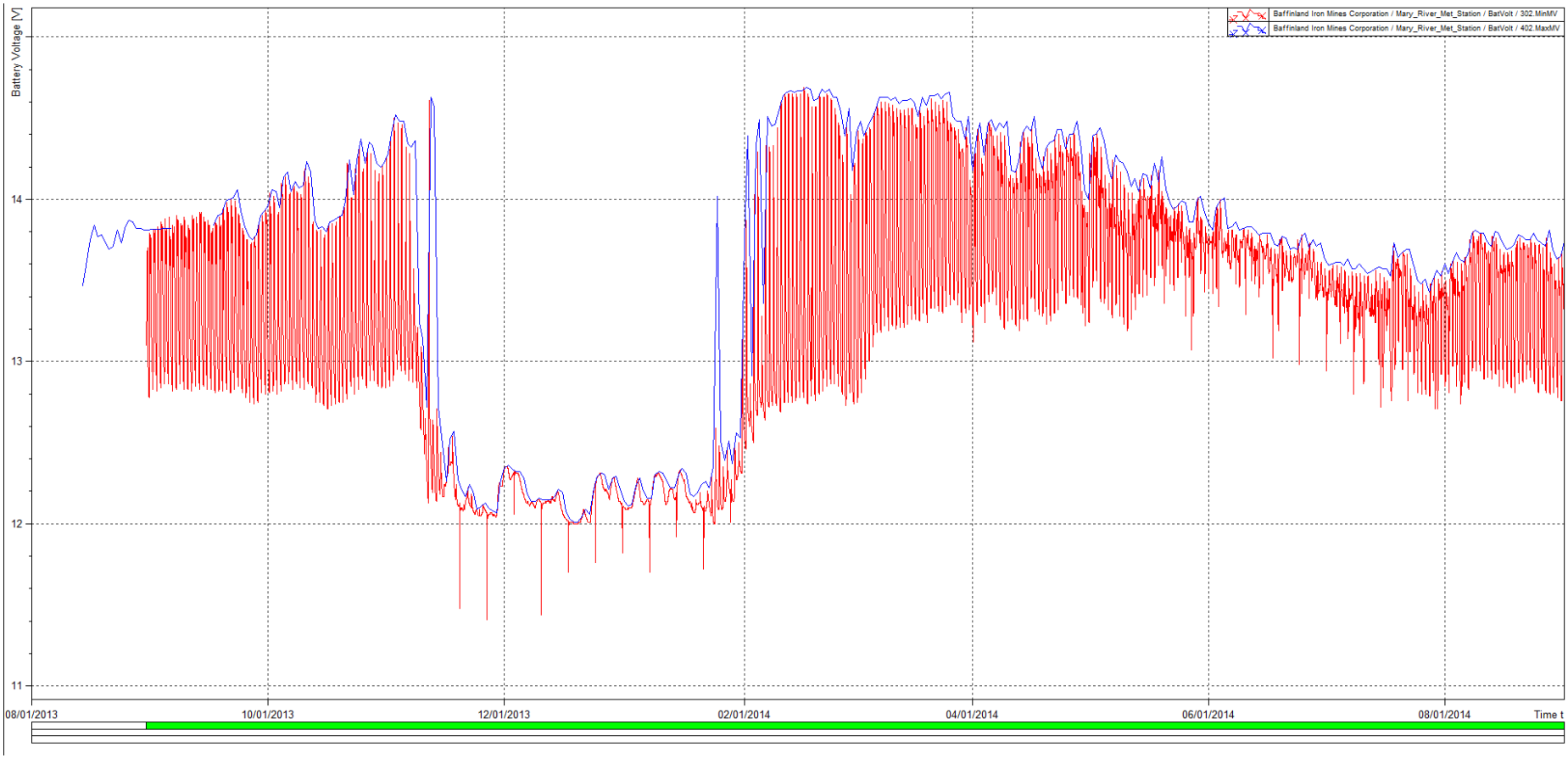
Graphs 4 included below show the suspect RH values from the Mary River HC2-S3 Temp/RH probe. Graphs 5 and 6 include RH data from August and September 2014 to show data values prior to and after replacement of the Temp/RH sensor.

Data Retrieval

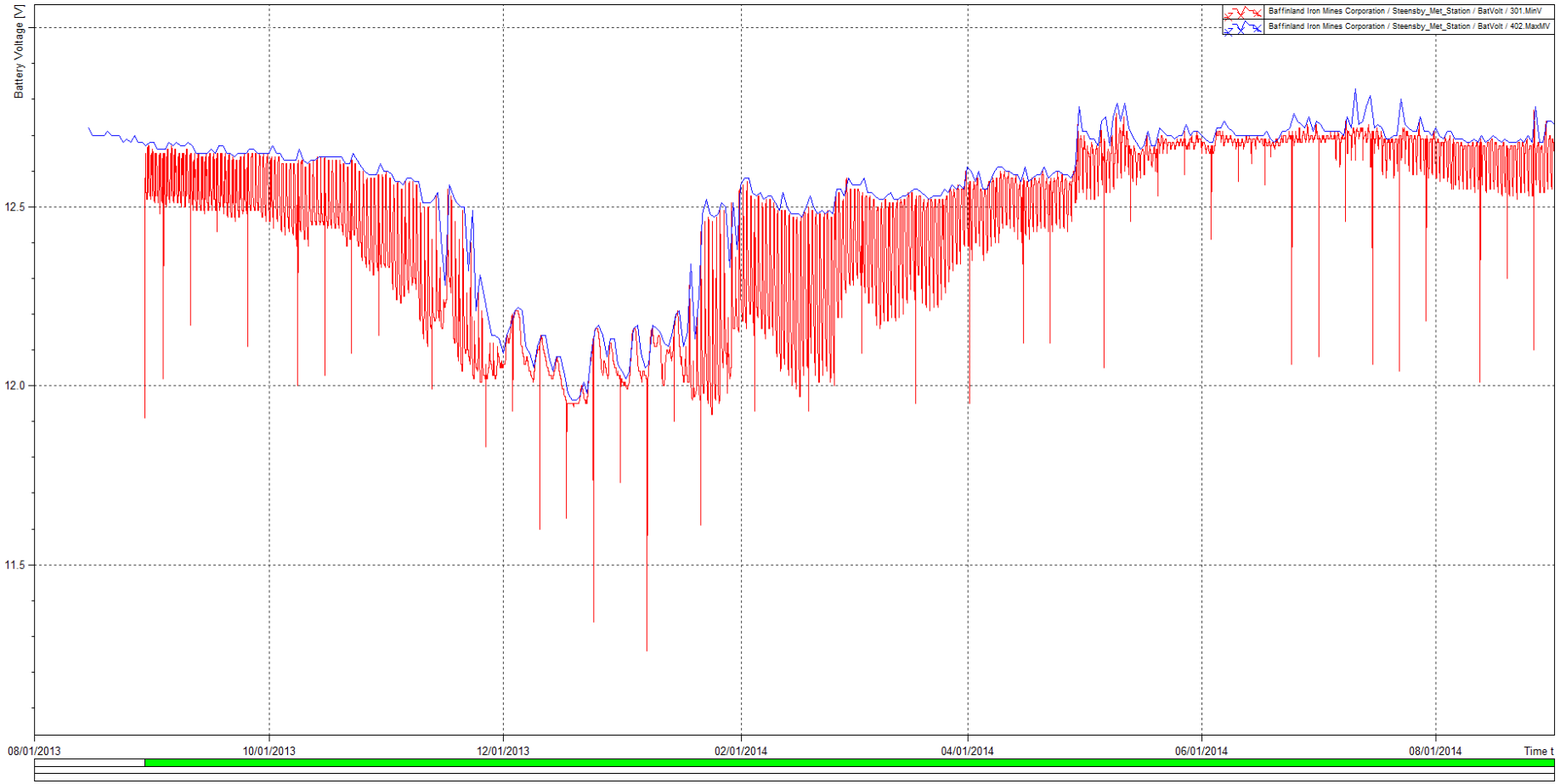
Despite battery concerns during winter months, all three stations remained operational over the entire year. A complete set of data files for all station tables has been collected and is stored on the CSC server as well as synced to the FTP folders for each station. There were no recorded data gaps.



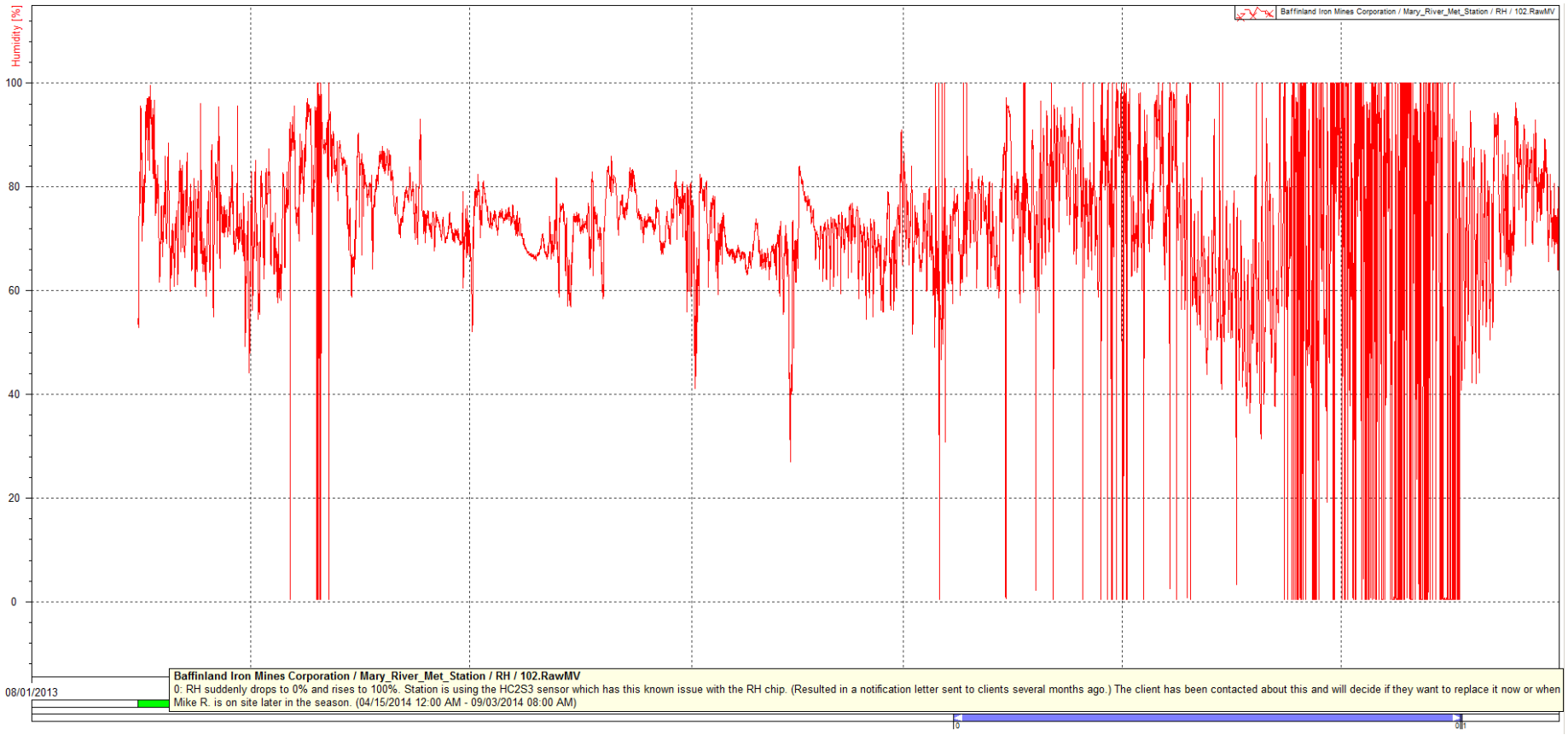
Graph 1: Milne station power – Aug 2013 to Aug 2014



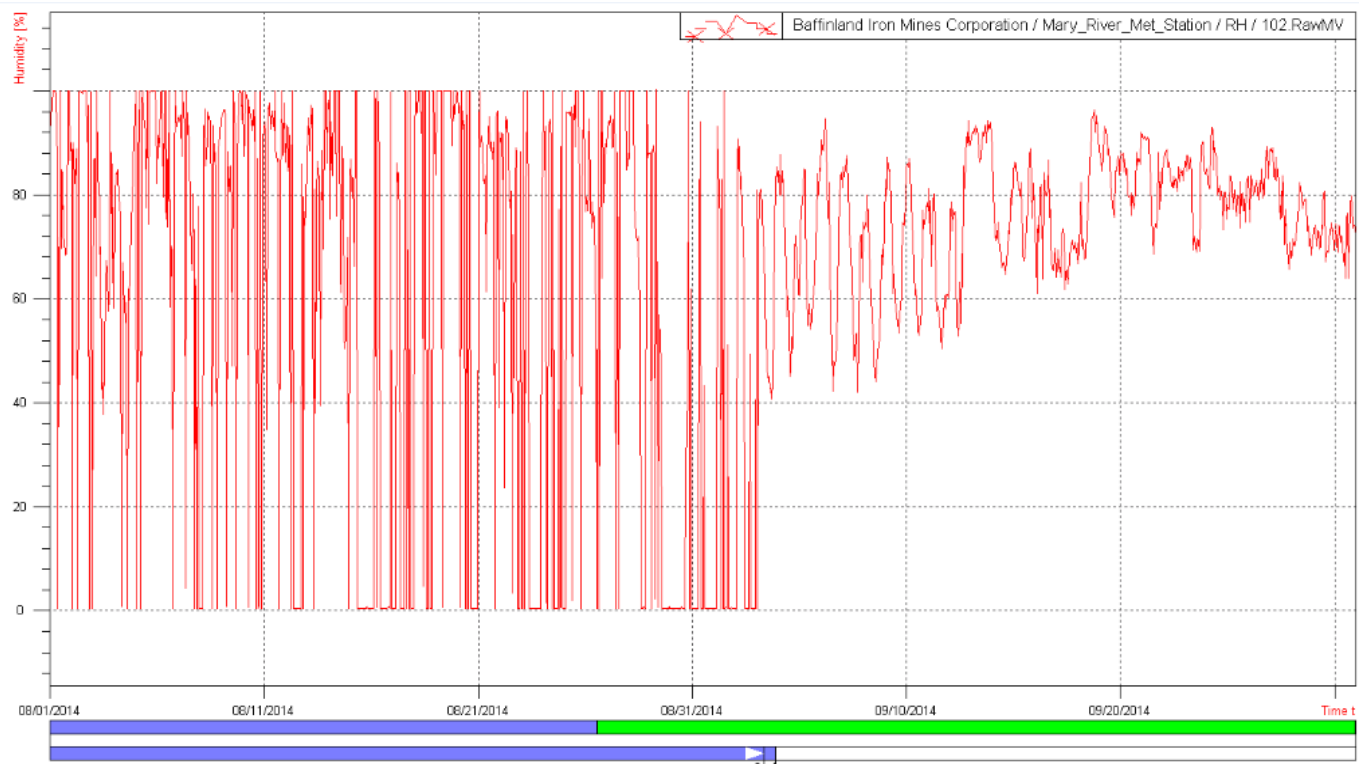
Graph 2: Mary River station power – Aug 2013 to Aug 2014



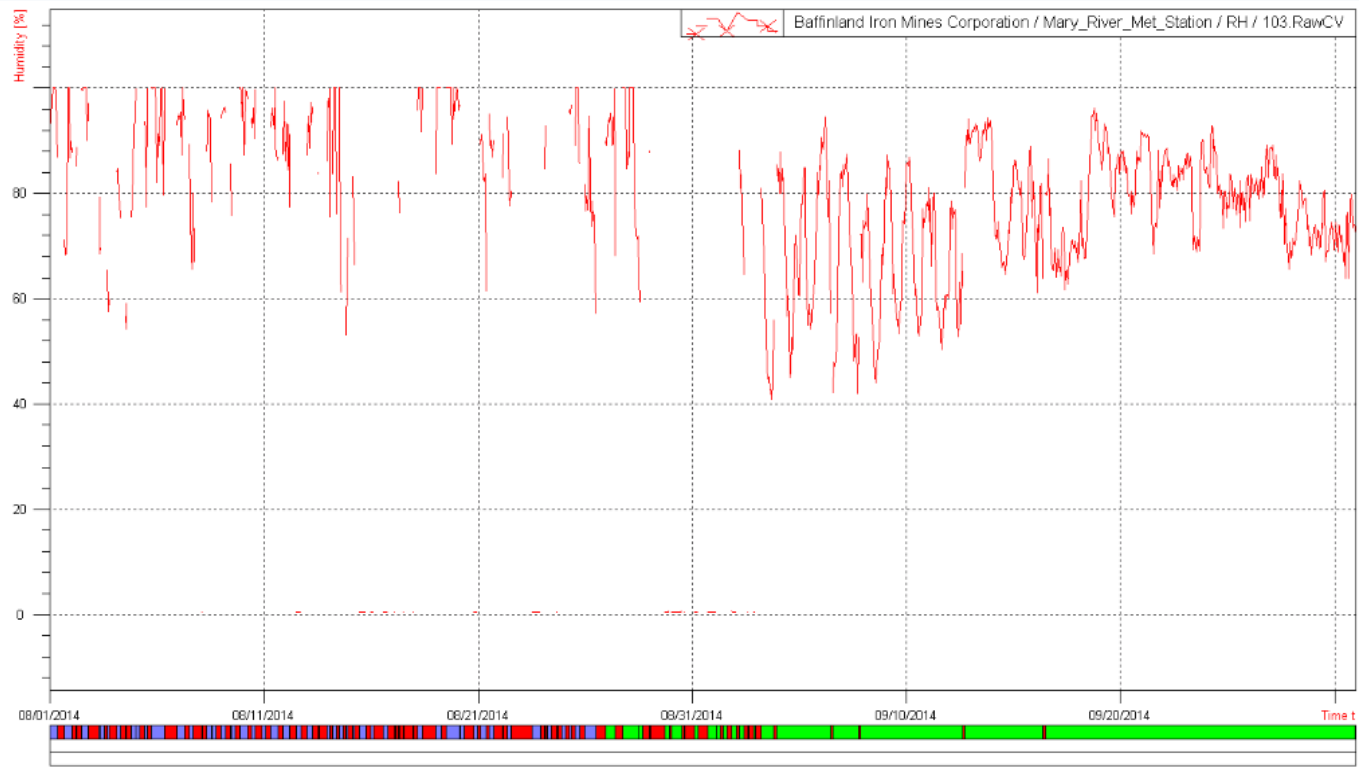
Graph 3: Steensby station power – Aug 2013 to Aug 2014



Graph 4: Mary River Suspect RH Readings from Aug 2013 to Aug 2014 with QA/QC comment



Graph 5: Mary River Suspect RH Readings – Aug-Sept 2014



Graph 6: Mary River Suspect RH Readings – Aug-Sept 2014 with invalid data spikes removed

Station Details and Maintenance Summaries

Milne Met Station

71°52'38.9"N 80°49'55.4"W

The Milne weather station equipment was installed by CSC Technician, Mike Ryder, in August 2013. This station is using an existing power supply from the Symboticware met station previously installed at this location.

Datalogger:

CR1000 -55 - s/n 56192

Power Supply:

2 X 85 W solar panels

12V 115 AHr Battery

CH100 charger/regulator

Communications:

9522B Iridium satellite modem - s/n 300025010034330

COM9522B Satellite modem interface – s/n 1031

SC932A CS I/O to 9 Pin RS-232 DCE Interface (with L10873 and SC12 cables)

Sensors:

HC2-S3 Rotronics Temp/RH probe – s/n 61081042

05108 RM Young Wind Monitor – s/n 1278320

SP Lite2 Kipp&Zonen Solar radiation sensor – s/n136645

TE525M Texas Electronics Tipping Bucket Rain Gauge (existing from Symboticware station)

Housing:

ENC 16/18 fiberglass waterproof enclosure (datalogger, iridium modem hardware, and charger/regulator)

ENC BATT (12V 115 AHr battery)

Mounting Structure:

UT30 Universal Towers 10M tower with guy wire kit

Milne Maintenance Summary

Site Visit Date – Sept 5, 2014 CSC Technician: Mike Ryder

Datalogger:

Prior to any maintenance performed at this station, all existing data stored on the datalogger was downloaded. Due to the age of this CR1000 datalogger calibration was not required. The datalogger lithium battery was recorded at 3.39 Volts, which indicates an acceptable voltage. The lithium battery requires replacement when reading 2.9 Volts or lower.

Enclosure desiccant was replaced and the enclosure port was re-sealed with the existing putty prior to leaving site.

Chicken wire had been installed at this station to help prevent animals chewing on and damaging exposed cables; however only a small amount of chicken wire had remained at the station over time. A bucket was installed underneath the enclosure as a temporary solution to prevent animals from chewing on cables leading into the enclosure port.

Power Supply:

Due to power supply issues at this station, the existing CH100 charger/regulator was removed from this station enclosure. The CH100 has charging capacity of 1.8 Amps and was not able to charge the large battery efficiently enough. This is likely what caused the power issues documented for this station. To correct this a SunSaver20 regulator from the previous Symbyoticware station was installed as a replacement charger/regulator. The SunSaver20 has charging capacity of 20 Amps. After installation of the SunSaver20 the battery voltage increased from 13.76 to 14.46 Volts.

Sensors:

A functional test and visual inspection were performed on each sensor. Most real time data values were verified using an on-site handheld unit. The station public table was also collected to verify proper functionality of all sensors. Below is a breakdown of maintenance performed on each sensor:

Temp/RH - The existing HC2-S3 Temp/RH probe (SN 61081042) from this station was removed and a new, calibrated replacement HC-S3-XT Temp/RH probe (SN 6122440) was installed. This replacement probe was installed in order to keep the sensor network consistent at each of the three existing met stations, as well as to proactively minimize possible output issues with this sensor.

Precipitation - Due to time constraints at this site the TE525M tipping bucket rain gauge was not calibrated. This sensor requires calibration prior to or during the next scheduled maintenance site visit. The tipping bucket was visually inspected and it was noted that the mounting bracket on the tipping bucket rain gauge (as shown in Figure 3) was damaged at some point between August 2013 and prior to this site visit. To resolve the mounting issue, electrical tape was used to secure the bottom side of the tipping bucket where the mount was damaged (As shown in Figure 4). The rain gauge was checked for level once the mounting issues resolved, and re-levelled as required.

Figure 3: Milne TE525M with Broken mounting bracket

Figure 4: Milne TE525M showing repair of mounting bracket using electrical tape

Wind Speed/Direction - The 05108-10 wind monitor contains long lasting ceramic bearings to reduce maintenance requirements of this sensor. Therefore calibration/maintenance was not required for this sensor during this site visit. The wind monitor housing and cable were visually inspected and confirmed to be in excellent condition.

Solar Radiation – A functional check was performed on the SP Lite2 global solar radiation sensor. This sensor was not calibrated as it requires factory calibration. Due to its mounting location the sensor level could not be checked or re-adjusted. The sensor and cable were visually inspected and confirmed to be in good condition.

Communications:

A successful remote iridium communications test was performed by CSC Data Services representative once station maintenance was completed prior to leaving site. The communications remains on the existing power control schedule, turning on once a week.

Figure 5: Milne met station (looking towards the West)

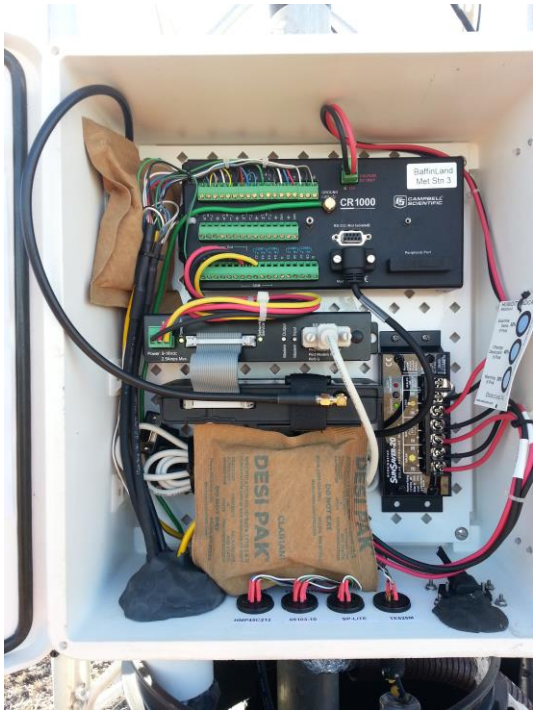


Figure 6: Inside Milne datalogger enclosure

Mary River Met Station

71°19'27.4"N 79°22'27.5"W

The Mary River weather station equipment was installed by Campbell Scientific Canada Technician, Mike Ryder, in August 2013. This station is using an existing power supply from the Symboticware met station previously installed at this location.

Datalogger:

CR1000 -55 - s/n 56190

Power Supply:

2 X 85 W solar panels

12V 115 AHr Battery

CH100 charger/regulator

Communications:

9522B Iridium satellite modem - s/n 300025010334310

COM9522B Satellite modem interface – s/n 1029

SC932A CS I/O interface (with L10873 and SC12 cables)

Sensors:

HC2-S3 Rotronics Temp/RH probe – s/n 61052990

05108 RM Young Wind Monitor – s/n 1278318

SP Lite2 Kipp&Zonen Solar radiation sensor – s/n 114315

TE525M Texas Electronics Tipping Bucket Rain Gauge (existing from Symboticware station)

Housing:

ENC 16/18 fiberglass waterproof enclosure (datalogger, iridium modem hardware, and charger/regulator)

ENC BATT (12V 115 AHr battery)

Mounting Structure:

UT30 Universal Towers 10M tower with guy wire kit

Mary River Maintenance Summary

Site Visit Date – Sept 3, 2014 CSC Technician: Mike Ryder

Datalogger:

Prior to any maintenance performed at this station, all existing data stored on the datalogger was downloaded. Due to the age of this CR1000 datalogger calibration was not required. The datalogger lithium battery was recorded at 3.38 Volts, which indicates an acceptable voltage. The lithium battery requires replacement when reading 2.9 Volts or lower.

Enclosure desiccant was replaced and the enclosure port was re-sealed with the existing putty prior to leaving site.

Power Supply:

Due to power supply issues at this station, the existing CH100 charger/regulator was removed from this station enclosure. The CH100 has charging capacity of 1.8 Amps and was not able to charge the large battery efficiently enough. This is likely what caused the power issues documented for this station. To correct this a SunSaver20 regulator from the previous Symbyoticware station was installed as a replacement charger/regulator. The SunSaver20 has charging capacity of 20 Amps. After installation of the SunSaver20 the battery voltage increased from 13.50 to 14.65 Volts.

Sensors:

A functional test and visual inspection were performed on each sensor. Most real time data values were verified using an on-site handheld unit. The station public table was also collected to verify proper functionality of all sensors. Below is a breakdown of maintenance performed on each sensor:

Temp/RH - The existing HC2-S3 Temp/RH probe (SN 61052990) from this station was removed and a new, calibrated replacement HC-S3-XT Temp/RH probe (SN 61224394) was installed. This replacement probe was installed due to RH output issues with the existing HC2-S3 probe, which was addressed in October 2013.

Precipitation - Due to time constraints at this site the TE525M tipping bucket rain gauge was not calibrated. This sensor requires calibration prior to or during the next scheduled maintenance site visit. The rain gauge was cleaned of debris as required, checked for level and adjusted as required.

Wind Speed/Direction - The 05108-10 wind monitor contains long lasting ceramic bearings to reduce maintenance requirements of this sensor. Therefore calibration/maintenance was not required for this sensor during this site visit. The wind monitor housing and cable were visually inspected and confirmed to be in excellent condition.

Solar Radiation – A functional check was performed on the SP Lite2 global solar radiation sensor. This sensor was not calibrated as it requires factory calibration. Due to its mounting location the sensor level could not be checked or re-adjusted. The sensor and cable were visually inspected and confirmed to be in good condition.

Communications:

A successful remote iridium communications test was performed by CSC Data Services representative once station maintenance was completed prior to leaving site. The communications remains on the existing power control schedule, turning on once a week.

Figure 7: Mary River met station (looking towards the North)

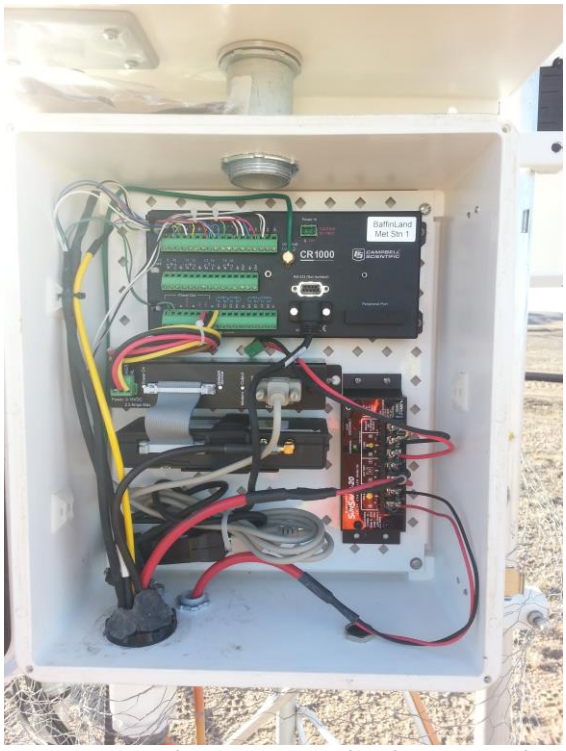


Figure 8: Inside Mary River datalogger enclosure

Steensby Met Station

70°16'36.4"N 78°31'37.4"W

The Steensby weather station equipment was installed by Campbell Scientific Canada Technician, Mike Ryder, in August 2013. This station is using an existing power supply from the Symboticware met station previously installed at this location.

Datalogger:

CR1000 -55 - s/n 56191

Power Supply:

2 X 85 W solar panels

12V 115 AHr Battery

CH100 charger/regulator

Communications:

9522B Iridium satellite modem - s/n 300025010037320

COM9522B Satellite modem interface – s/n 1030

SC932A CS I/O to 9 Pin RS-232 DCE Interface (with L10873 and SC12 cables)

Sensors:

HC2-S3 Rotronics Temp/RH probe – s/n 61053025

05108 RM Young Wind Monitor – s/n 1278319

SP Lite2 Kipp&Zonen Solar radiation sensor – s/n 136644

TE525M Texas Electronics Tipping Bucket Rain Gauge (existing from Symboticware station)

Housing:

ENC 16/18 Fiberglass waterproof enclosure (datalogger, iridium modem hardware, and charger/regulator)

ENC BATT (12V 115 AHr battery)

Mounting Structure:

UT30 Universal Towers 10M tower with guy wire kit

Steensby Maintenance Summary

Site Visit Date – Sept 3, 2014 CSC Technician: Mike Ryder

Datalogger:

Prior to any maintenance performed at this station, all existing data stored on the datalogger was downloaded. Due to the age of this CR1000 datalogger calibration was not required. The datalogger lithium battery was recorded at 3..43 Volts, which indicates an acceptable voltage. The lithium battery requires replacement when reading 2.9 Volts or lower.

Enclosure desiccant was replaced and the enclosure port was re-sealed the existing putty prior to leaving site.

Power Supply:

Due to power supply issues at this station, the existing CH100 charger/regulator was removed from this station enclosure. The CH100 has charging capacity of 1.8 Amps and was not able to charge the large battery efficiently enough. This is likely what caused the power issues documented for this station. To correct this a SunSaver20 regulator from the previous Symbyoticware station was installed as a replacement charger/regulator. The SunSaver20 has charging capacity of 20 Amps. After installation of the SunSaver20 the battery voltage increased from 12.96 to 14.46 Volts.

A crack was found in the battery enclosure. The crack was sealed using spray foam, however the battery enclosure may need replacing in the future.

Sensors:

A functional test and visual inspection were performed on each sensor. Most real time data values were verified using an on-site handheld unit. The station public table was also collected to verify proper functionality of all sensors. Below is a breakdown of maintenance performed on each sensor:

Temp/RH - The existing HC2-S3 Temp/RH probe (SN 61053025) from this station was removed and a new, calibrated replacement HC-S3-XT Temp/RH probe (SN 61224586) was installed. This replacement probe was installed in order to keep the sensor network consistent at each of the three existing met stations, as well as to proactively minimize possible output issues with this sensor.

Precipitation - Due to time constraints at this site the TE525M tipping bucket rain gauge was not calibrated. This sensor requires calibration prior to or during the next scheduled maintenance site visit. The rain gauge was in good condition and did not require cleaning. The tipping bucket was checked for level and adjusted as required.

Wind Speed/Direction - The 05108-10 wind monitor contains long lasting ceramic bearings to reduce maintenance requirements of this sensor. Therefore calibration/maintenance was not required for this sensor during this site visit. The wind monitor housing and cable were visually inspected and confirmed to be in excellent condition.

Solar Radiation – A functional check was performed on the SP Lite2 global solar radiation sensor. This sensor was not calibrated as it requires factory calibration. Due to its mounting location the sensor level could not be checked or re-adjusted. The sensor and cable were visually inspected and confirmed to be in good condition.

Communications:

A successful remote iridium communications test was performed by CSC Data Services representative once station maintenance was completed prior to leaving site. The communications remains on the existing power control schedule, turning on once a week.

Figure 6: Steensby met station (looking towards the West)

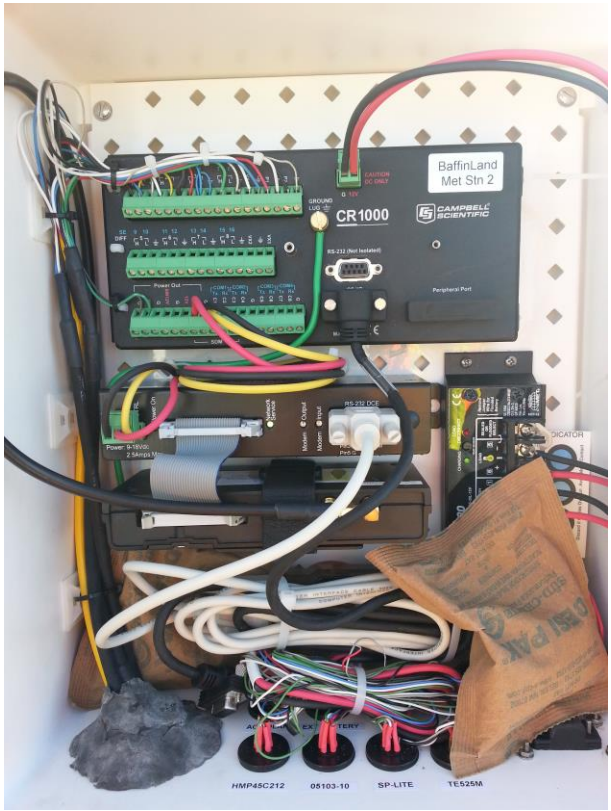


Figure 7: Inside Steensby datalogger enclosure

New Installations

During the September 2014 site visit, three new stations were also installed at the Mary River and Milne camp locations and Deposit No. 1 mine location by CSC technician, Mike Ryder. These stations were installed to allow employees to easily access and view in camp and nearby mine site weather conditions.

The data from the Milne and Mary River Camp stations are accessed and viewed via each datalogger's internal webserver using the Ethernet communications hardware. An RTMC display is uploaded to each internal webserver for easy viewing of current conditions. The Deposit No. 1 station currently does not have remote communications. Plans for Ethernet connection at this site for remote viewing of the station data via a web display have been discussed and may be implemented during the next scheduled site visit.

The real time values at all three stations were verified. The displays for the Milne and Mary River Camp station were confirmed to be functional and accessible via each station IP address prior to leaving each site.

Milne Camp

Installation – Sept 7, 2014 CSC Technician: Mike Ryder

Datalogger:

CR800

Power Supply:

PS100-8.5 Charger/regulator with rechargeable lead acid 12V battery

Z3749-ND – 120 to 24 VDC AC Adapter (Compatible for use with the WS600-UMB sensor)

Communications:

NL201-XT Ethernet interface – IP Address 10.40.2.17

Sensors:

WS600-UMB Lufft all-in-one smart weather sensor – includes Air Temp,RH, Barometric Pressure, Wind Speed/Direction and Precipitation.

Housing:

ENC 12/14 fiberglass waterproof enclosure (datalogger, Ethernet interface, and charger/regulator)

Mounting Structure:

Enclosure wall mounted inside on-site server room. WS600-UMB sensor mounted on top of user supplied pipe attached to outside of server room canister wall.

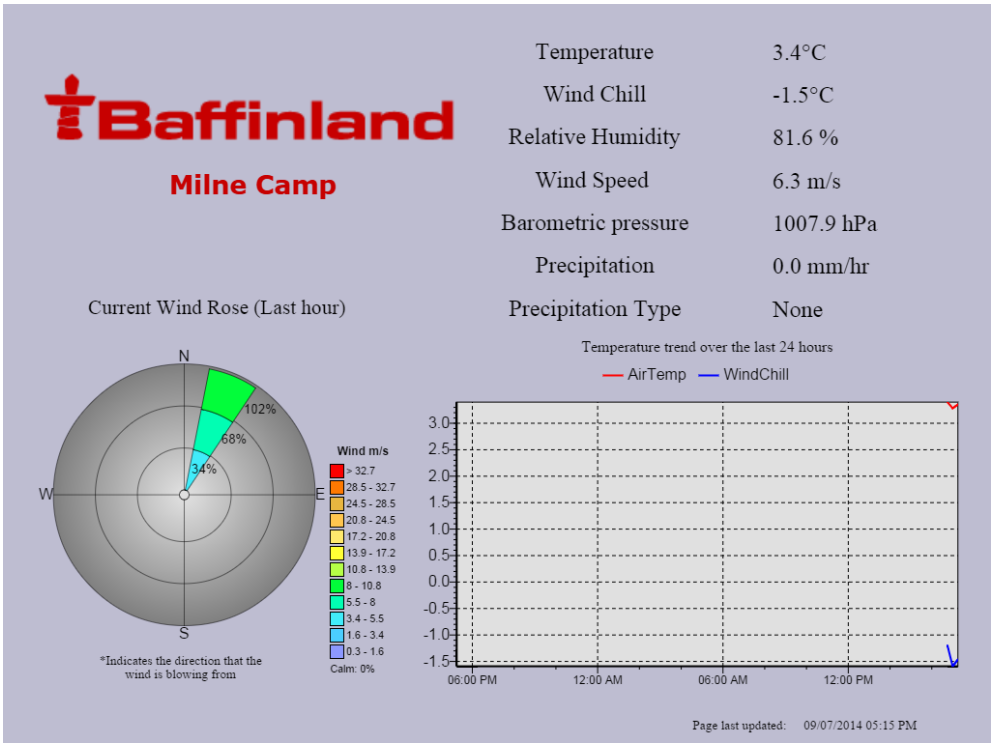


Figure 8: Real time data values shown on Milne web display screen while on site, after station was installed and operational

Figure 9: Milne camp WS600-UMB sensor installed on the outside wall of server room trailer

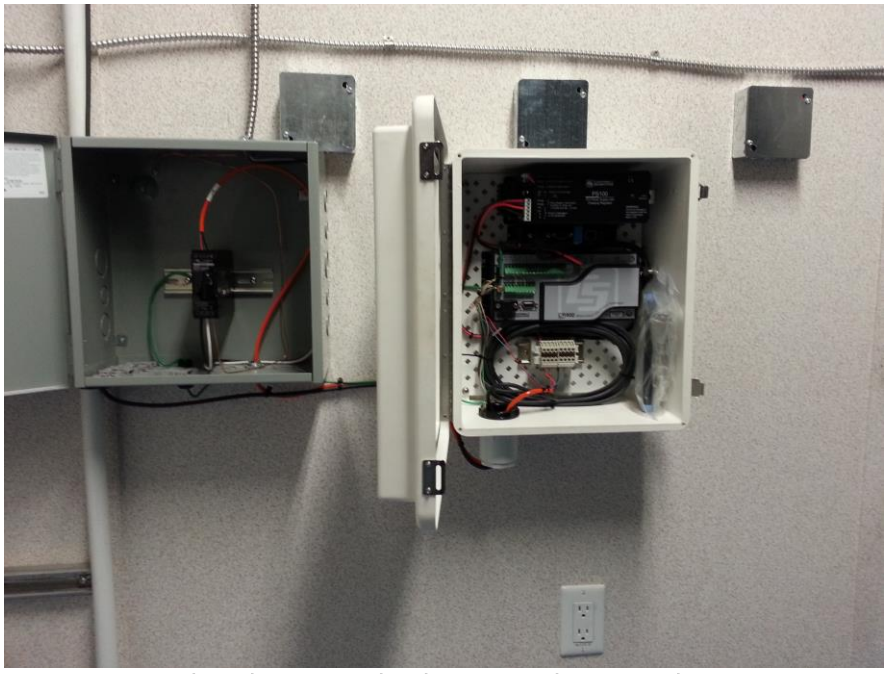


Figure 10: Inside Milne camp datalogger enclosure and sensor power supply enclosure

Mary River Camp

Installation – Sept 6, 2014 CSC Technician: Mike Ryder

Datalogger:

CR800

Power Supply:

PS100-8.5 Charger/regulator with rechargeable lead acid 12V battery

Z3749-ND – 120 to 24 VDC AC Adapter (Compatible for use with the WS600-UMB sensor)

Communications:

NL201-XT Ethernet interface – IP Address 10.20.2.17

Sensors:

WS600-UMB Lufft all-in-one smart weather sensor – includes Air Temp,RH, Barometric Pressure, Wind Speed/Direction and Precipitation.

Housing:

ENC 12/14 fiberglass waterproof enclosure (datalogger, Ethernet interface, and charger/regulator)

Mounting Structure:

Enclosure wall mounted inside on-site server room. WS600-UMB sensor mounted on top of user supplied pipe attached to outside of server room trailer wall.

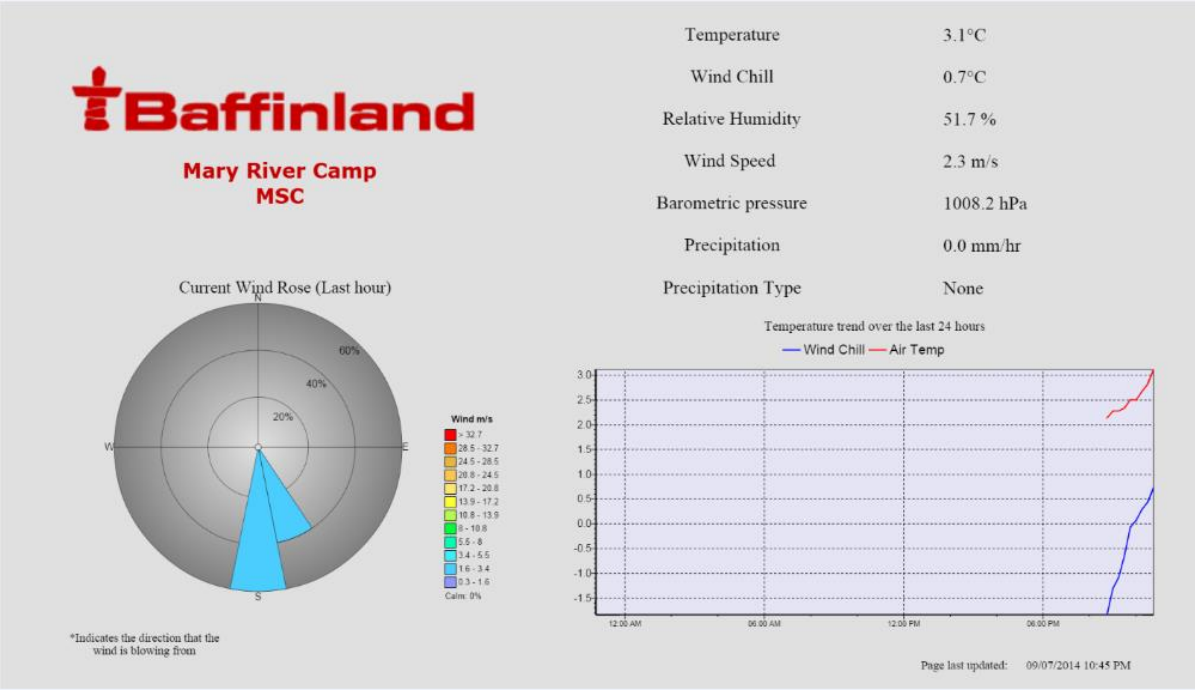


Figure 11: Real time data values shown on Mary River web display screen while on site, after station was installed and operational

Figure 12: Mary River camp WS600-UMB sensor installed on outside wall of server room trailer

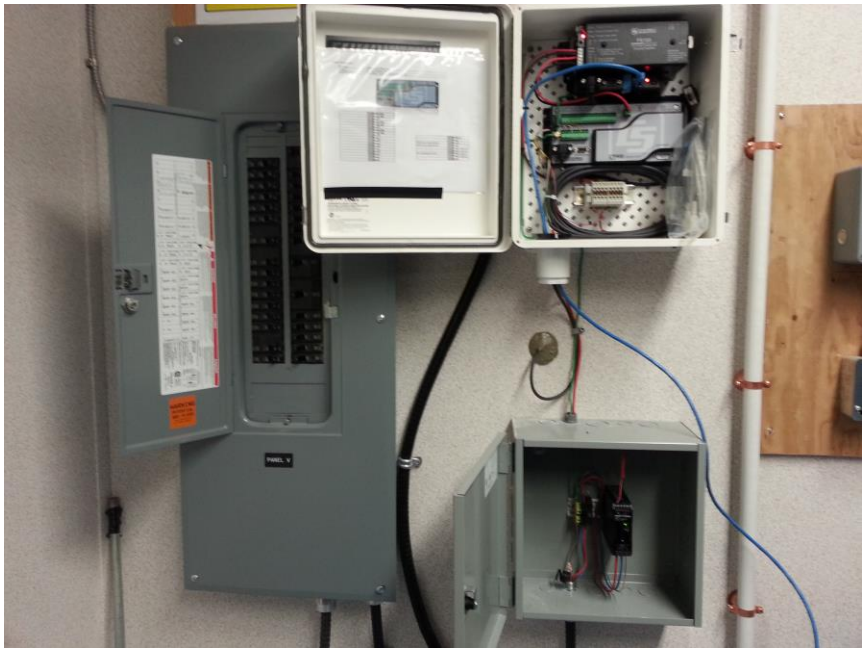


Figure 13: Inside Mary River camp datalogger enclosure and sensor power supply enclosure

Deposit No.1

Installation – Sept 4, 2014 CSC Technician: Mike Ryder

Datalogger:

CR1000

CFM100 Compact Flash Module with SD card

Power Supply:

BP 100 – 12V 100 AHr lead acid battery

Communications:

NL201-XT Ethernet interface – IP Address 10.20.2.17

Sensors:

05103-10 RM Young Wind Monitor

HC-S3 Rotronic Temp/RH Probe

Housing:

Existing Symboticware enclosure

Mounting Structure:

Existing communications repeater tower installed on top of on-site canister

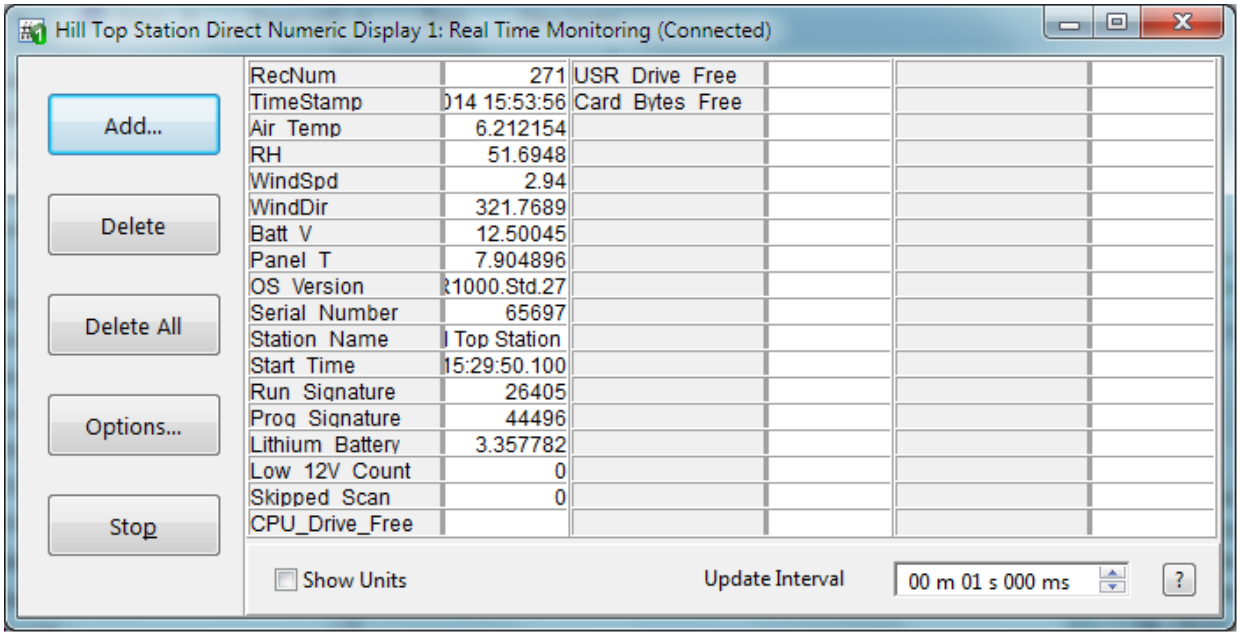


Figure 14: Real time data values shown at Deposit No. 1 station in LoggerNet software via direct connection to datalogger, after station installed and operational

Figure 15: Deposit No. 1 station installed on outside of existing site canister

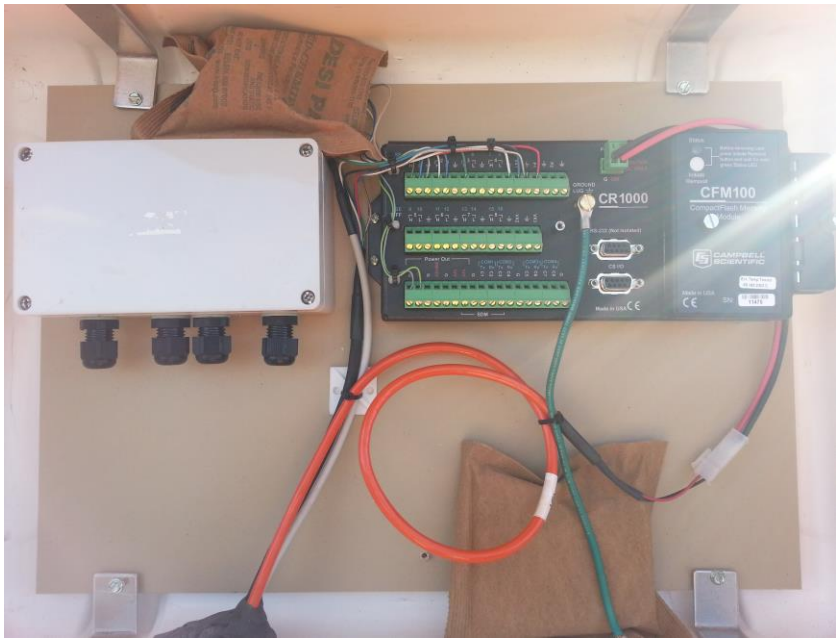


Figure 16: Inside Deposit No. 1 datalogger enclosure

Action Items/Recommendations

General:

The next recommended field maintenance/calibration site visit for all met stations (new and existing) is summer/fall 2015.

CSC will continue to monitor battery voltage levels at the Milne, Mary River and Steensby remote met stations. If battery voltages drop and continue to cause issues, CSC recommends replacing with new fully charged batteries.

Milne:

Supplementary chicken wire should be added around the bottom of this station to reinforce existing wire for better protection of station cables from damage as a result of animals.

In house calibration of the existing of the SP Lite2 is recommended during the next field maintenance trip. In order to prevent station down time and multiple site trips a replacement calibrated sensor is recommended to be installed while the existing sensor is removed for calibration.

In-house or field calibration of the TE525M tipping bucket is recommend during the next scheduled maintenance site visit. The tipping bucket mounting bracket should also be replaced and the sensor properly mounted in to the ground to improve stability.

The current old generation cable entry port causes difficulty with running the current number of sensor cables into the station enclosure. Upgrading the enclosure port to the new larger version is recommended, but not absolutely necessary.

Steensby:

Although the battery enclosure was repaired with spray foam, it is recommend to it to prevent further damage occurring and leaving the battery more exposed to animals/extreme weather.

The current old generation cable entry port causes difficulty with running the current number of sensor cables into the station enclosure. Upgrading the enclosure port to the new larger version is recommended, but not absolutely necessary.

Mary River and Milne Camp:

Annual on-site functional and visual inspection is recommended for the WS600-UMB sensors. As well, an annual calibration check of the humidity sensor by the manufacturer is recommended for these units; however, please note that this requires removing of the entire unit as the sensors cannot be removed individually.

In order to prevent station down time and multiple site trips, a replacement calibrated sensor is recommended to be installed while the existing sensor is removed for calibration.

Deposit No. 1:

This station is currently being powered only by the BP100 battery with no solar panel. The immediate plan is to recharge this battery intermittently using an on-site car battery charger. The station does not currently have any communications equipment. The data will be collected manually from the datalogger SD card which is installed in the station CFM100 module.

Future action items discussed for this station consist of upgrading to AC power with the use of a PS100-8.5 charger/regulator and compatible AC adapter, as well as potentially installing in an Ethernet connection with the use of an NL201 Ethernet interface.

If kept properly charged, the BP100 battery can then be used either as a spare battery or a replacement battery at any of the remote met stations.

Attachment 5: Long Term Meteorological Data Report

NORTH BAFFIN ISLAND INTELLIGENT MONITORING PROJECT REPORT ON LONG-TERM METEOROLOGICAL DATA

13 NOVEMBER 2009

Charles Ramcharan
Associate Professor
Dept. Biology, Laurentian University
935 Ramsey Lake Rd., Sudbury, ON P3E1W5
(705) 675-1151 x4802
cramcharan@laurentian.ca

Project Overview

Our objectives were to retrofit three existing weather stations located on a north-south transect across northern Baffin Island with equipment that would allow improved data collection and system support, as well as enable satellite communication. The three stations were located at camps operated by Baffinland Iron Mines Inc. (henceforth, Baffinland). The weather stations had been installed and maintained by an environmental consulting company, Knight-Piesold (North Bay, Ontario) in 2005. The three sites were Milne Inlet (north shore of Baffin Island), Mary River (mid Baffin Island), and Steensby Inlet (south shore of Baffin Island) (Figure 1).

FIGURE 5-1: LOCATION OF THE THREE STUDY SITES ACROSS NORTH BAFFIN ISLAND

Site Description

Two of the sites, Milne Inlet and Steensby Inlet, are rocky, coastal marine habitats and the third, Mary River, is an inland site located on rocky, post-glacial till. All three sites are on a typical tundra terrain with till and exposed bedrock. The two shoreline habitats are close enough to the ocean to be strongly affected by marine weather. The weather station at Steensby Inlet sits on a flat, rocky island about 400 m from shore. It's essentially at sea level. The station at Milne Inlet is on a ridge overlooking the ocean and is about 1 km from the shore and at an elevation of about 90 m above sea level. The Mary River station is far enough from either coast not to be strongly influenced by sea-effect weather. All three stations are far from either artificial or natural obstructions, thus all data for insolation, wind, and temperature should represent normative local conditions.

Installation of the new equipment went well (see the associated report by Symboticware, North Baffin Island Intelligent Monitoring Project – Initial Technical Report). For unknown reasons, the station at Milne Inlet failed to transmit data via satellite shortly after it was retro-fitted. Despite repeated attempts at repair, that station is not transmitting data, although it continues to collect the data. The current functioning of the weather stations does not affect this report as the focus here is on analysis of the five years of existing data that were downloaded from the three weather stations.

Meteorological Variables and Methods

All three weather stations were standard Campbell Scientific (Edmonton, AB) units. They carried sensors for (a) air temperature and humidity, (b) light radiation, (c) light energy, (d) wind speed, (e) wind direction, and (f) rainfall (Table 1). In addition to the data collected by these sensors, the data loggers in the stations (Campbell Sci. model CR10X), also monitored (g) time and date, (h) battery power, and (i) internal temperature. Depending on the variable, data may be averaged over an hour, a day, or by hour then day. Some variables such as the standard deviation of wind direction, dewpoint, and wind chill are calculated based on standard equations that were programmed into the CR10X.

Importantly, there were considerable problems with functioning of the various data probes. No station had all probes working all of the time. Moreover, data collection at the different stations was switched on and off for unknown reasons over the five year study period. As a result, the data were discontinuous and some parameters were severely affected.

The data were processed to eliminate erroneous numbers. The CR10X writes a double line of data at the end of each day (2400). The second of these data lines is incomplete and these lines were eliminated. For most of the sensors, failure was indicated by a value of zero for the measured parameter except for the temperature probe which would return a value of about -72 °C. For the most part, these erroneous temperature readings were eliminated. For Steensby Inlet in 2008 and 2009, the erroneous temperature data were retained in order to illustrate the patterns shown by a failing sensor.

The data are presented as daily values, with each day of the year being numbered from 1 (1 January) to 365 (31 December). In the cases where the raw data were already averaged hourly (e.g., wind speed) these hourly averages were again averaged for each day. For solar radiation, only the noon (1200) readings were used.

Data Analysis

As a result of restrictions caused by damaged probes and non-operation of the data loggers, it was not possible to conduct analyses of long-term trends, or even to statistically compare among the three study sites. The analyses presented below are thus largely descriptive.

Overall System Function

The recording of time of day provided a convenient means of determining when the CR10X units in the weather stations were switched on and collecting data. The data recording times are presented as high-low graphs, wherein for each day (x-axis) a line is drawn between the hour (y-axis) of the start of data collection and the hour of the last collected data point (Figure 2-4). These figures illustrate the maximum potential period of data collection. Due to sensor failures, the data available are a subset of this potential range.

The Mary River station was set up in 2005, a year before the other two. For the first year of operation, the station was switched on only from late spring to early fall, and in 2006 was operated only during the summer (Figure 2). Data collection at the other two stations began in the fall of 2006 and it appeared that those units were left on year-round. We have no explanation for the frequent data outages at all three stations. A shutdown of a few (7-10) days may represent periods when the CR10X datalogger was shut down for data retrieval. It's unclear why this would have been necessary as the unit can record continuously with the data being stored on portable solid-state drives, which can be removed at any time for data download.

In 2009, the Steensby Inlet station was experiencing frequent failure (Figure 3). Perhaps the problem was temperature-related as the unit seemed to improve with the onset of summer. Nevertheless, this station eventually failed when it was retro-fitted in August 2009.

The Milne Inlet station seemed to operate fairly well, except that it was sometimes turned off for no apparent reasons (Figure 4).

TABLE 5- 1: *Explanation of the CR10X data variables. The first number in the storage label is the "port" whereby the data are read on the CR10X.*

Final Storage Labels	*Parameter*	*Units or Format*
0,101,5855	signals a new data line	
1,Year_RTM		integer year
1,Day_RTM		integer day
1,Hour_Minute_RTM		9999.999
2,Batt_Volt_AVG		volts
3,Prog_Sig~2,17673		
4,Rain_mm_TOT	rainfall	mm
5,AirTemp_AVG	air temperature	^oC
6,RH_MAX	relative humidity	percent
7,RH_MIN	relative humidity	percent
8,Slr_W_AVG	solar radiation	Watts/m^2 (Joules/m^2/s)
9,Slr_kJ_TOT	solar radiation	kilojoules/m^2
10,WS_ms_AVG	average wind speed	m/s
11,WS_ms_MAX	maximum wind speed	m/s
12,WS_ms_MIN	minimum wind speed	m/s
13,WS_ms_S_WVT	average wind speed	m/s
13,WindDir_D1_WVT	wind direction	degrees
13,WindDir_SD1_WVT	std. dev. wind dir.	degrees
14,Tot24	total rainfall	mm
15,TdC_AVG	dew point	^oC
16,HI_C_AVG	average heat index	^oC
17,SunHrs_TOT	% hours of sunshine	99.99
18,WC_C_AVG	average wind chill	^oC
19,WC_C_MAX	maximum wind chill	^oC
20,WC_C_MIN	minimum wind chill	^oC
21,10218768	unspecified	
22,Year_RTM,19892	repeated entry	
22,Day_RTM	repeated entry	
22,Hour_Minute_RTM	repeated entry	
23,Batt_Volt_MIN~1,6731	repeated entry	
24,Prog_Sig~2,19628	repeated entry	

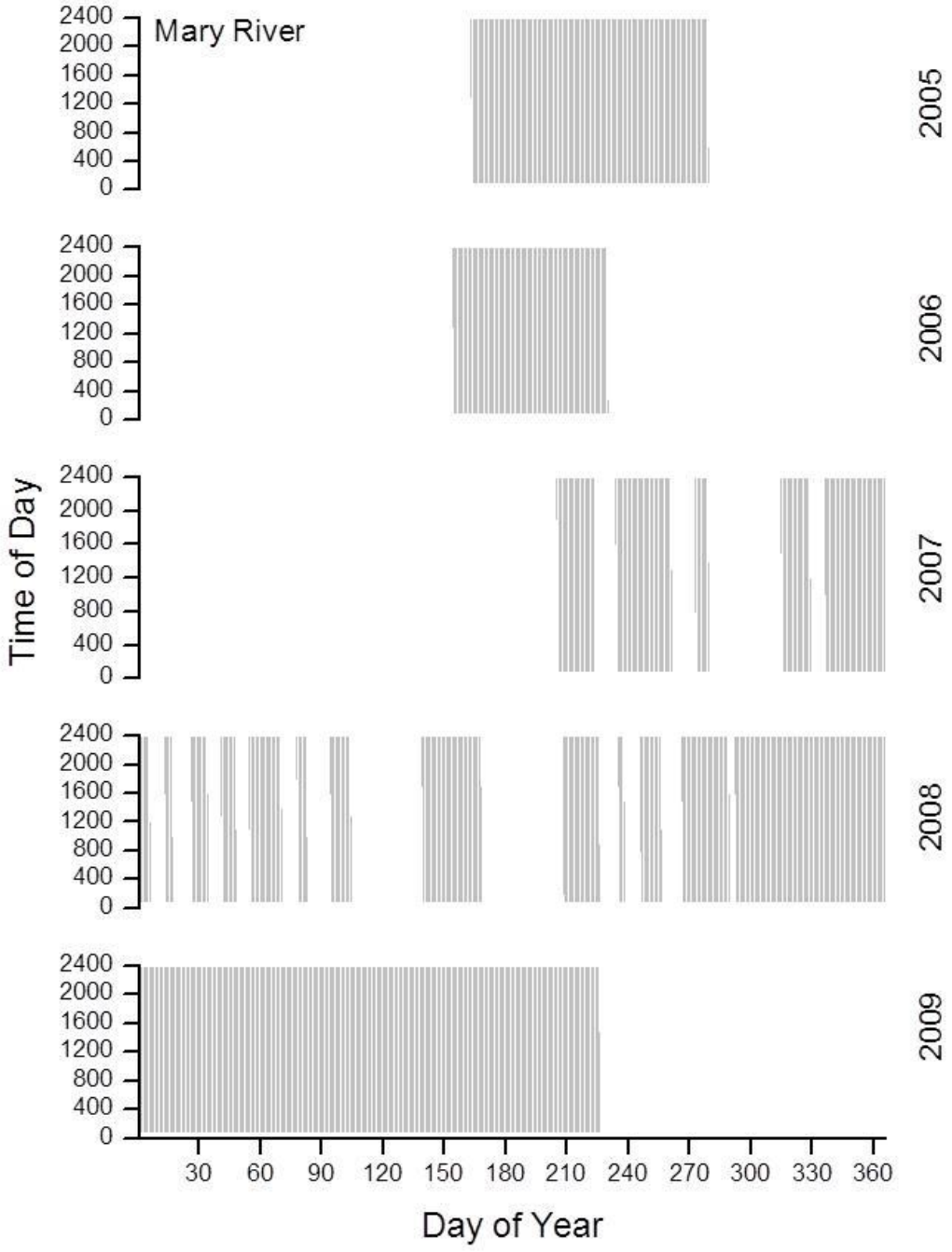


Figure 5-2: Data collection period for the Mary River station.

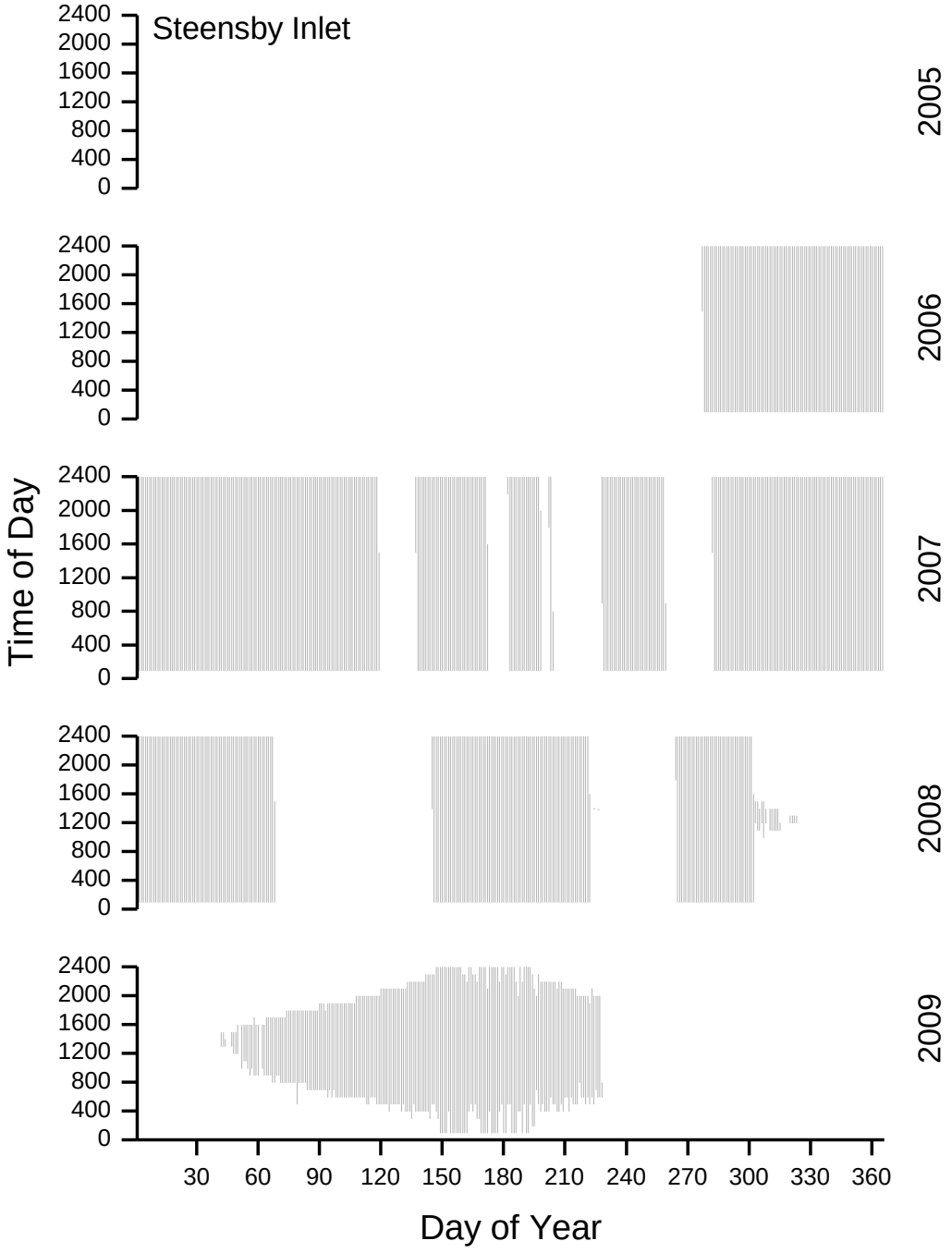


Figure 5-3: Data collection period for the Steensby Inlet station.

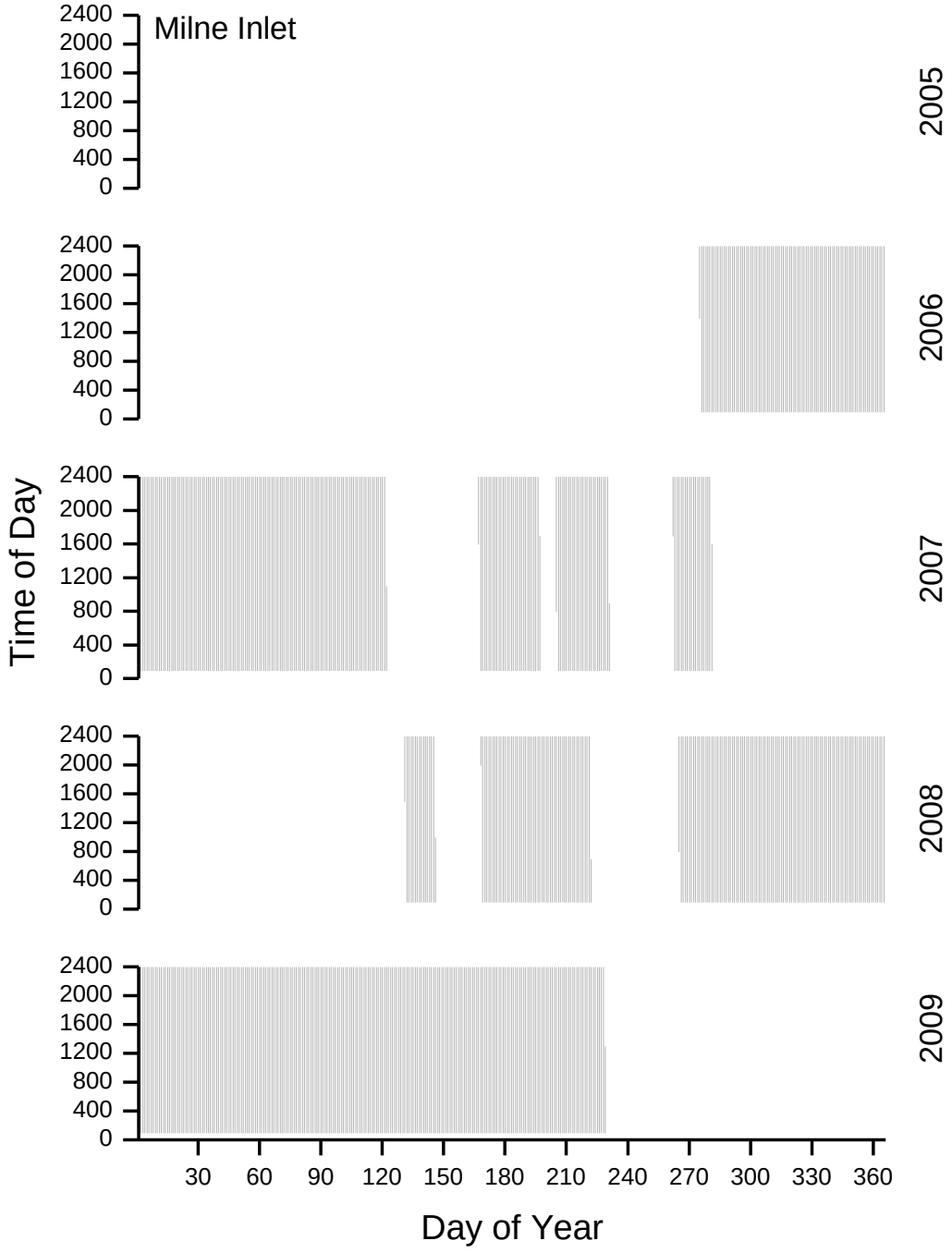


Figure 5-4: Data collection period for the Milne Inlet station.

Insolation

The weather stations record sunlight as both intensity (W/m^2) and energy ($kJ/m^2/s$), and here we report the former (Figures 5-7). Solar radiation varies with time of year and atmospheric conditions, especially cloud cover. These two factors interact. Solar levels are, of course, low to zero during the peak of winter but can be surprisingly high during a lot of the winter because cloud cover is usually low. Summer brings increased humidity thus cloud cover can reduce summer sunlight. It's mostly cloud cover that causes the high day-to-day variability in solar radiation.

At Mary River, the solar sensor operated every time the unit was turned on, but only until the fall of 2007 (Figure 5). The defective solar sensor was not replaced.

At Steensby Inlet, the solar sensor was installed only in 2007. This sensor was operational every time the unit was turned on. Since the sensor operated continuously, the seasonal pattern of rise and fall of solar radiation in the spring and fall, respectively, can clearly be seen in the 2007 to 2009 data series (Figure 6).

At Milne Inlet, similar patterns in solar radiation were evident as at Steensby Inlet (Figure 7).

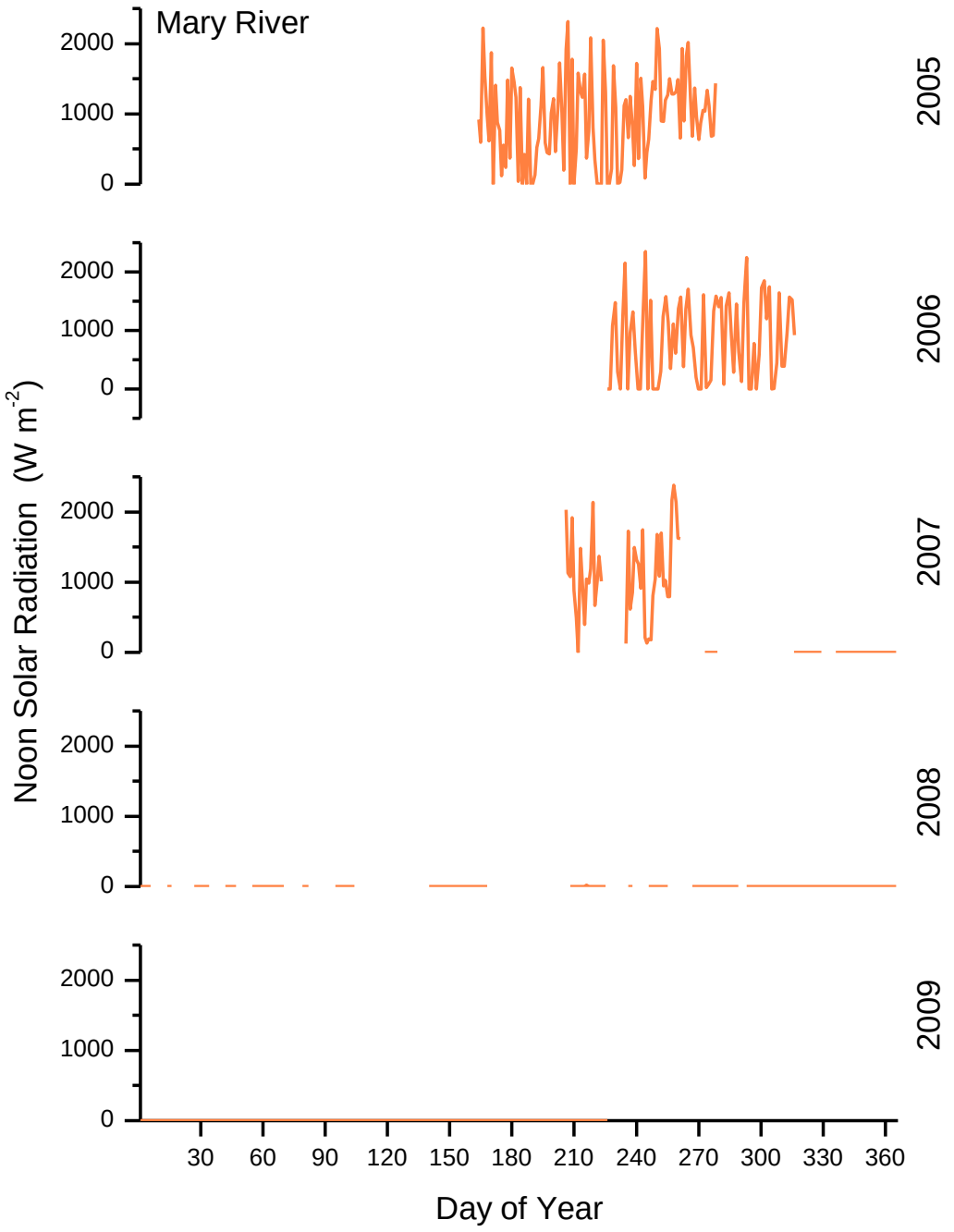


Figure 5-5: Noon solar radiation at the Mary River station

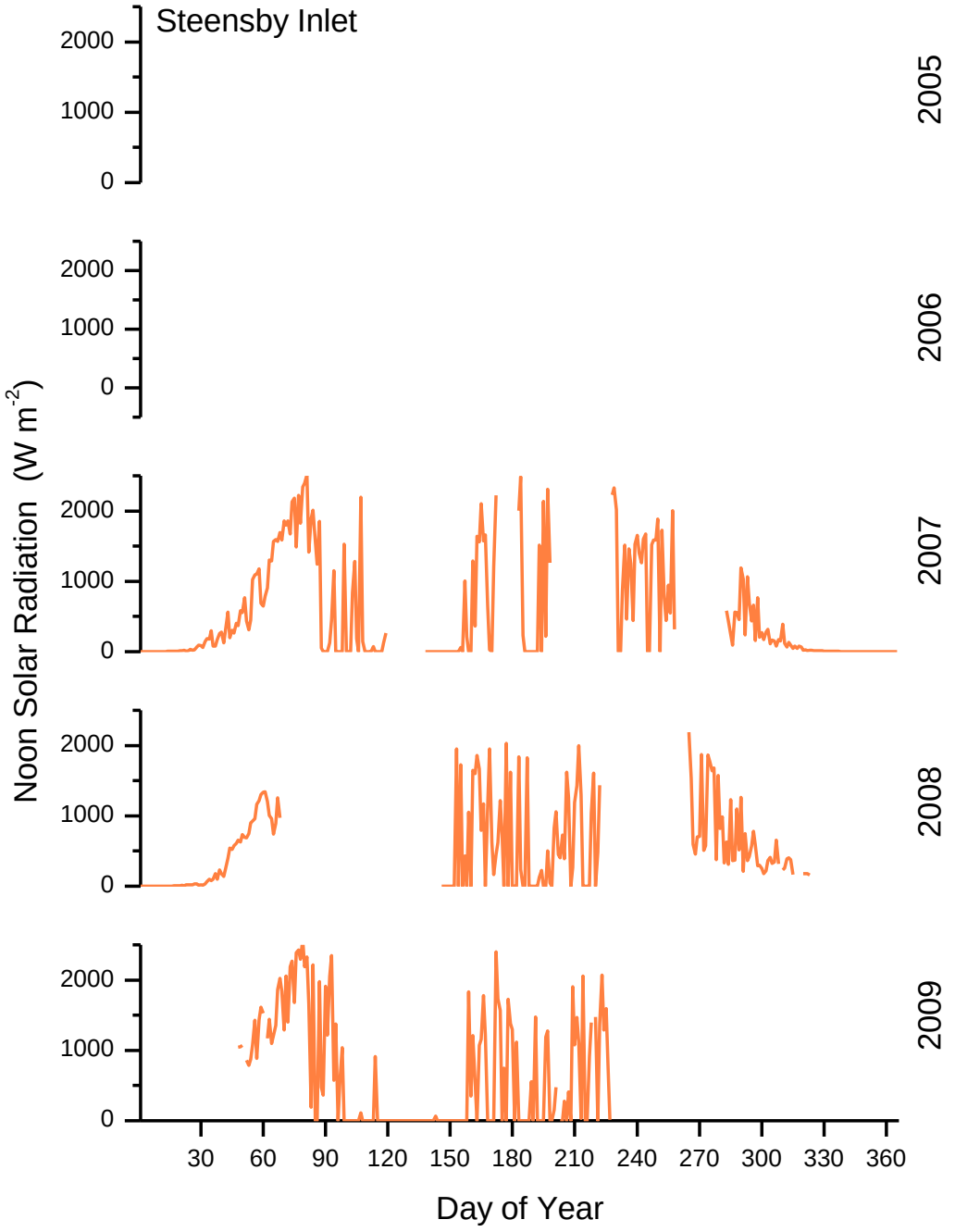


Figure 5-6: Noon solar radiation at the Steensby Inlet station.

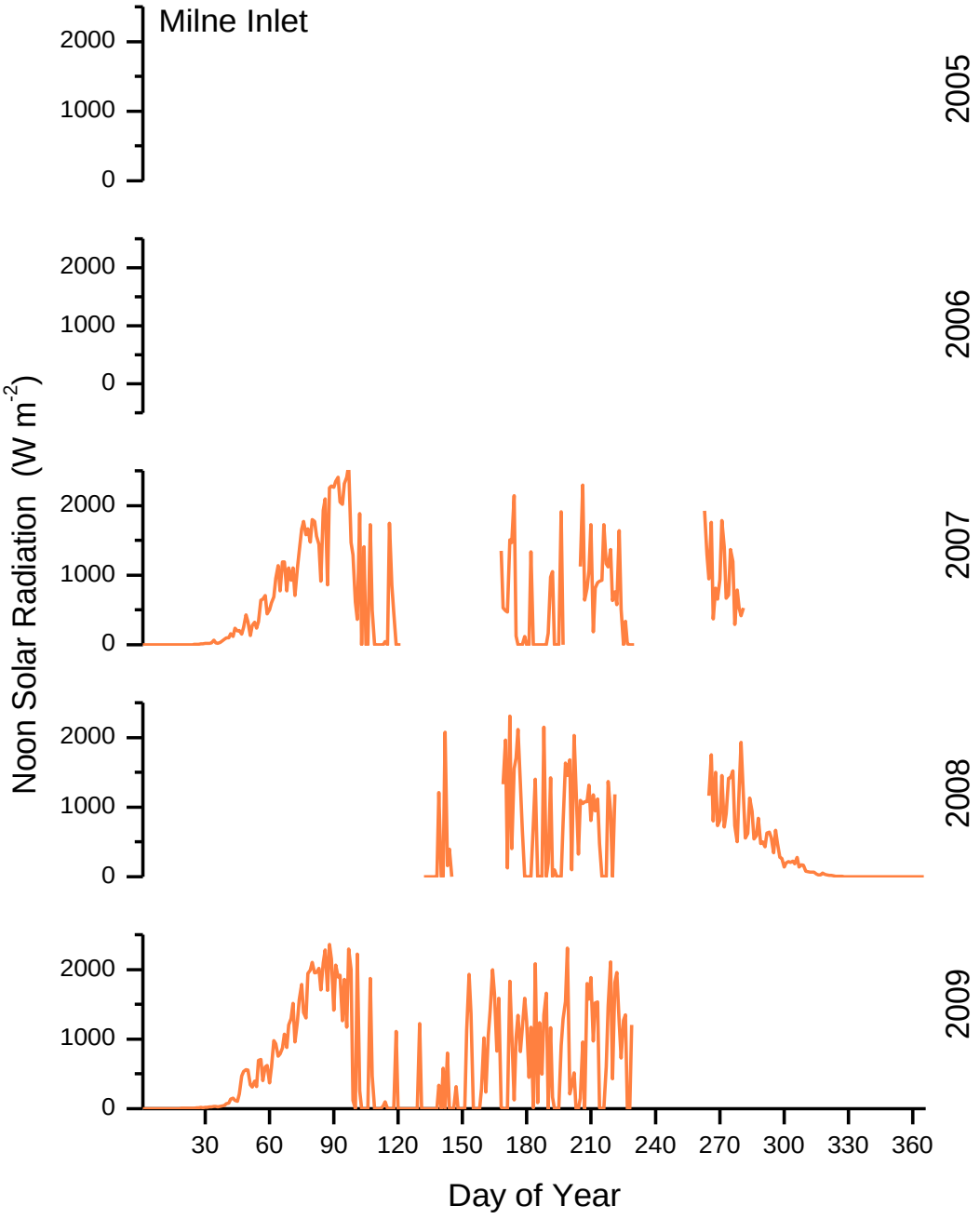


Figure 5-7: Noon solar radiation at the Milne Inlet station.

Air Temperature

Air temperature was measured by a combined temperature/humidity probe but the humidity data are not shown here. The temperature data were averaged over each day (black lines) with daily minimum (blue lines) and maximum (orange lines) values also shown (Figures 8-10).

Air temperature at the Mary River station was recorded whenever the station was turned on (Figure 8). Each year of data showed the expected seasonal pattern. It's not possible to compare the data among years because the station was too often switched off.

The Steensby Inlet station showed the same seasonality as the Mary River site (Figure 9). However, there was also some low temperature anomalies recorded as the temperature/humidity sensor began to fail in 2007 and 2008, and finally failed completely in 2009.

The Milne Inlet station also showed the seasonal patterns of the other two stations (Figure 10). In this case, the temperature/humidity probe continued to operate from 2006 to 2009. All data gaps were caused by the recording unit being switched off.

In future analyses, it would be interesting to compare temperature variability at the inland site relative to the two shoreline sites. The ocean should provide a moderating influence on air temperature at Steensby and Milne Inlets.

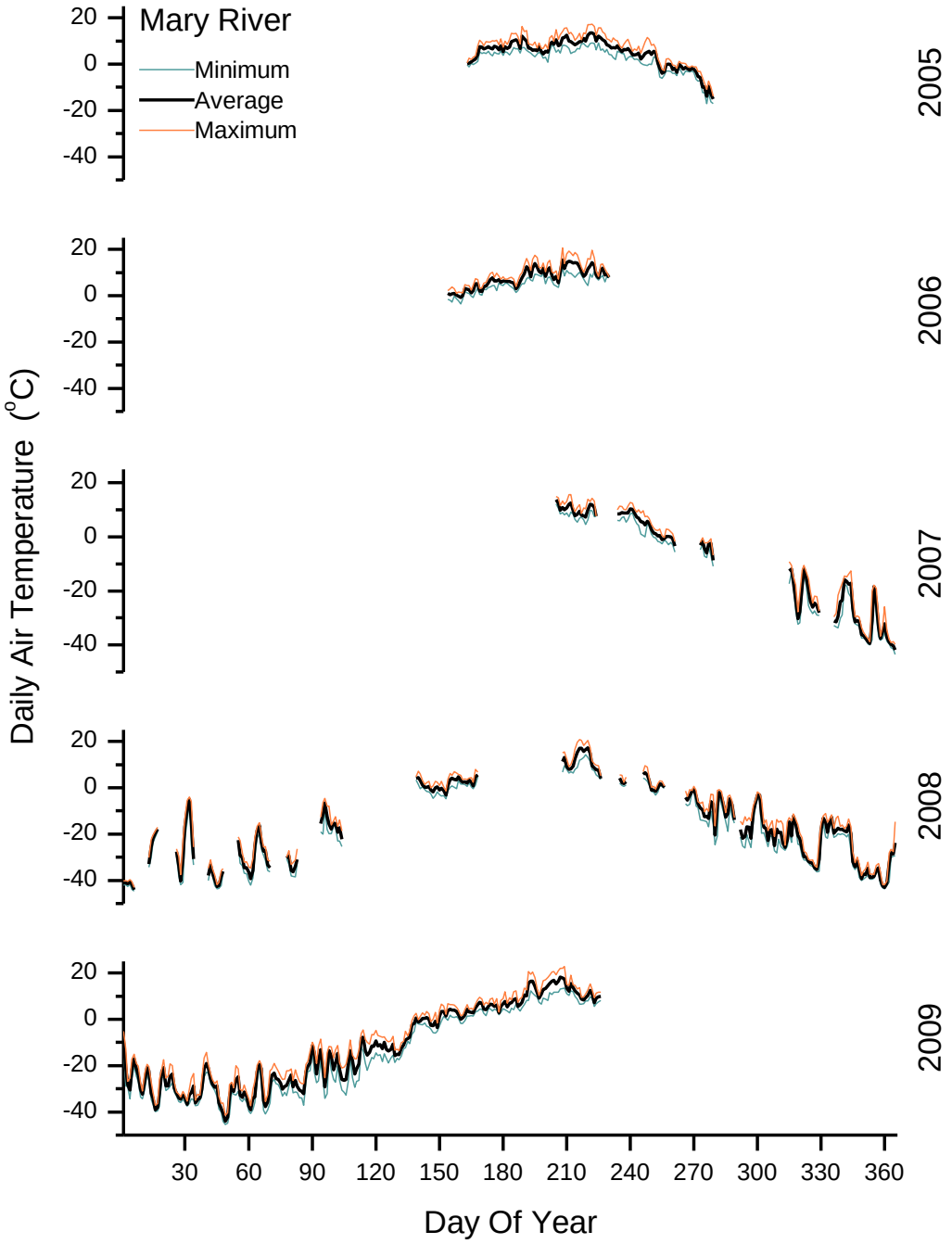


Figure 5-8: Air temperature at the Mary River station.

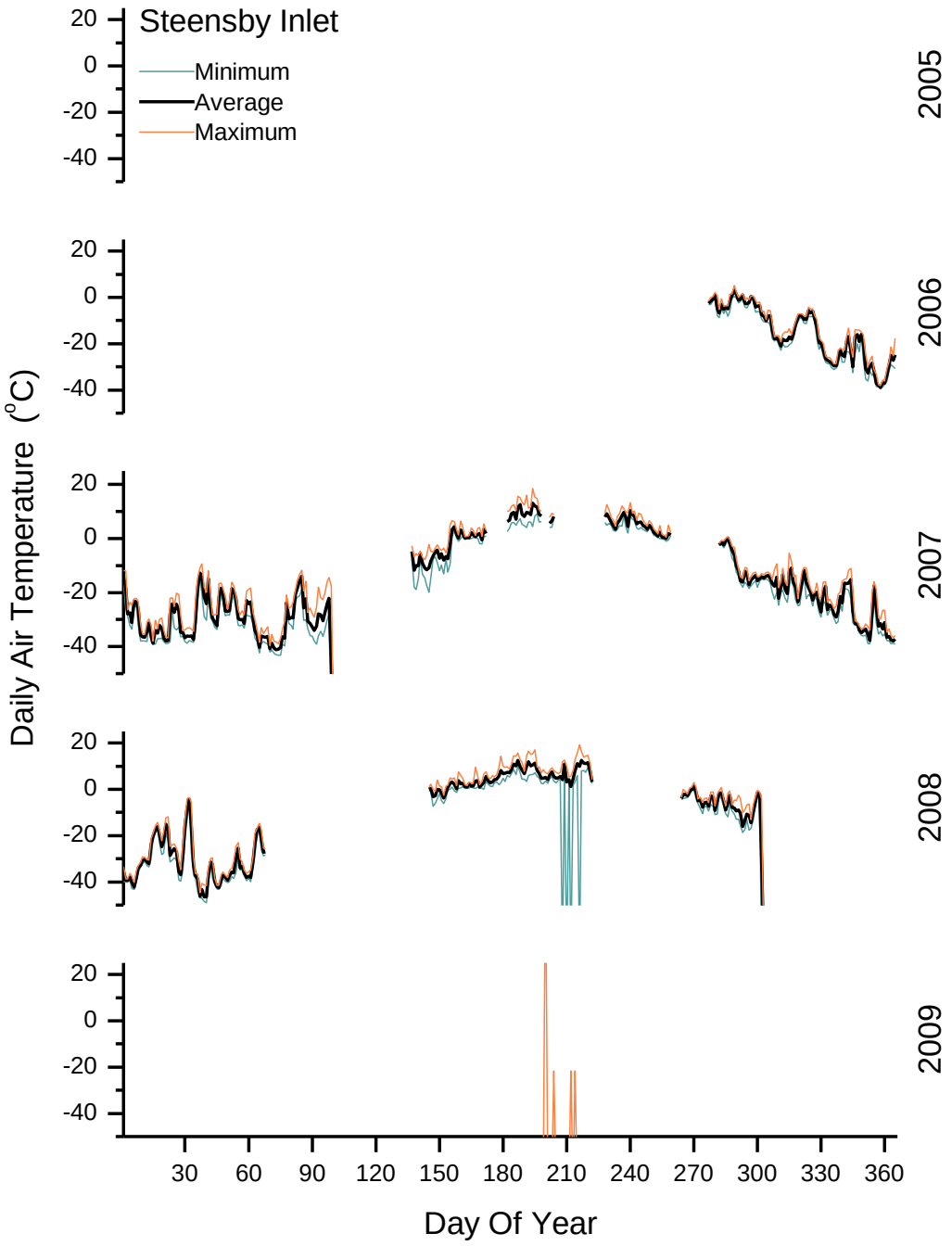


Figure 5-9: Air temperature at the Steensby station.

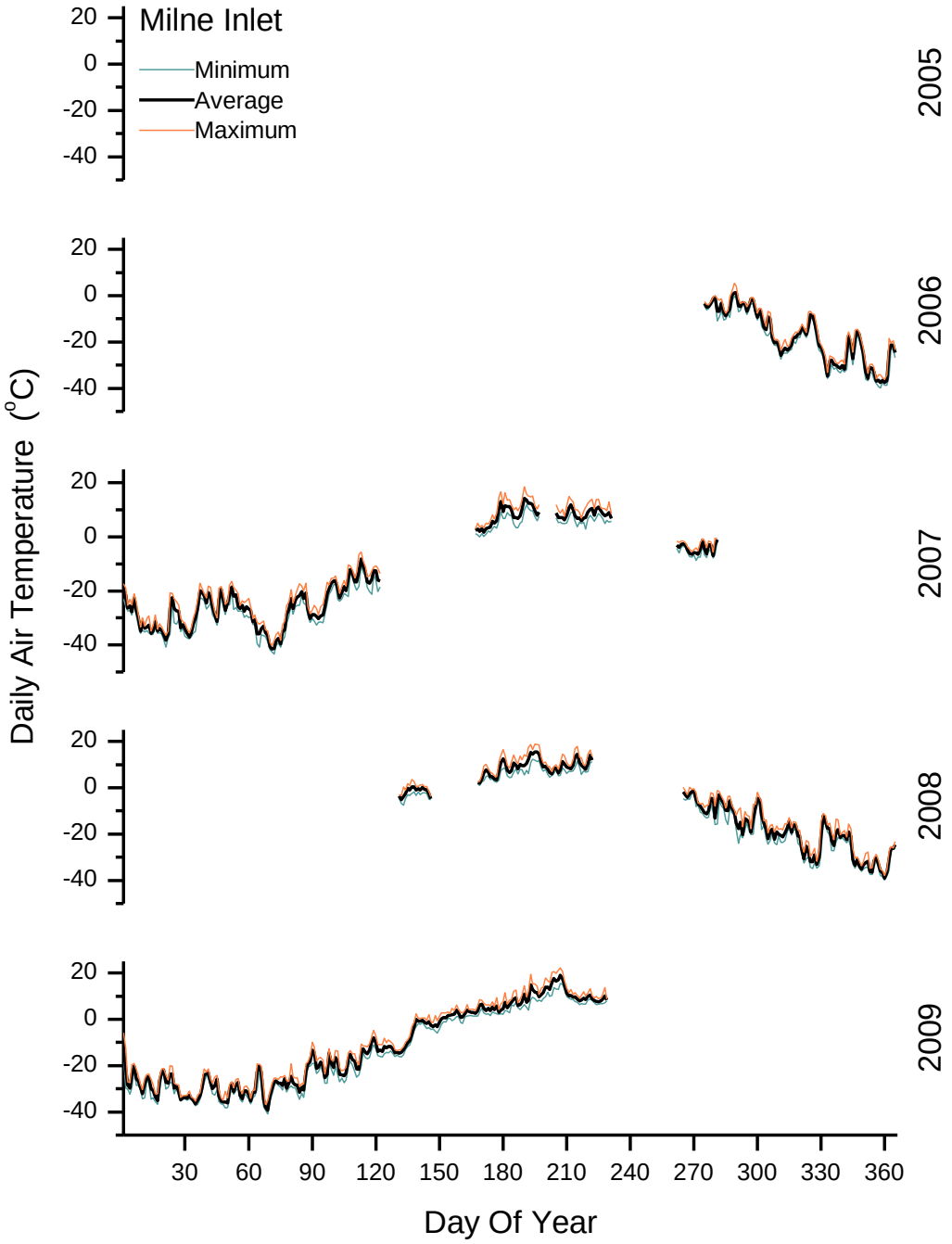


Figure 5-10: Air temperature at the Milne Inlet station.

Daily Rainfall

Rainfall was recorded by a tipping-bucket collector. This type of sensor can only record rain and is largely inoperable with any dry or semi-dry precipitation (i.e., snow and freezing rain). Thus the data on precipitation are available only from late spring to early fall (Figures 11-13).

Total daily rainfall was highly variable at the Mary River site (Figure 11). For the most part, rain seemed to occur in isolated events ("spates"), not as long-term precipitation. Overall, rainfall was not high which is expected in this fairly arid arctic region. In 2008 there were extended periods when the rain gauge reported values of zero even during the summer. Perhaps the gauge was malfunctioning during that time as the Steensby and Milne Inlets stations did record precipitation.

The Steensby Inlet station recorded much more rainfall than the other two sites (Figure 12). (Note the change in y-axis scales between Steensby Inlet and the other two sites.) This coastal, south shore site is clearly in a wetter climate than the other two sites. The temporal pattern of rain seems similar to Mary River and Milne Inlet, however. Rain seems to come at the same frequency at Steensby Inlet, it just rains much more when it does arrive. In 2009 the rain gauge at Steensby Inlet failed, likely due to damage by a polar bear.

Milne Inlet showed very little rainfall but it's unclear whether this was a real pattern or whether the rain gauge was malfunctioning (Figure 13). Comparing Figures 4 (data recording period) and 13 (rainfall) for Milne Inlet indicates that the rain gauge itself was turned off, independently of the recording unit. Where both the data logger and the rain gauge connected, the rainfall data would have shown zeros during freezing periods but we don't see this in the data stream. Eventually, the rain gauge at Milne Inlet failed completely by 2009.

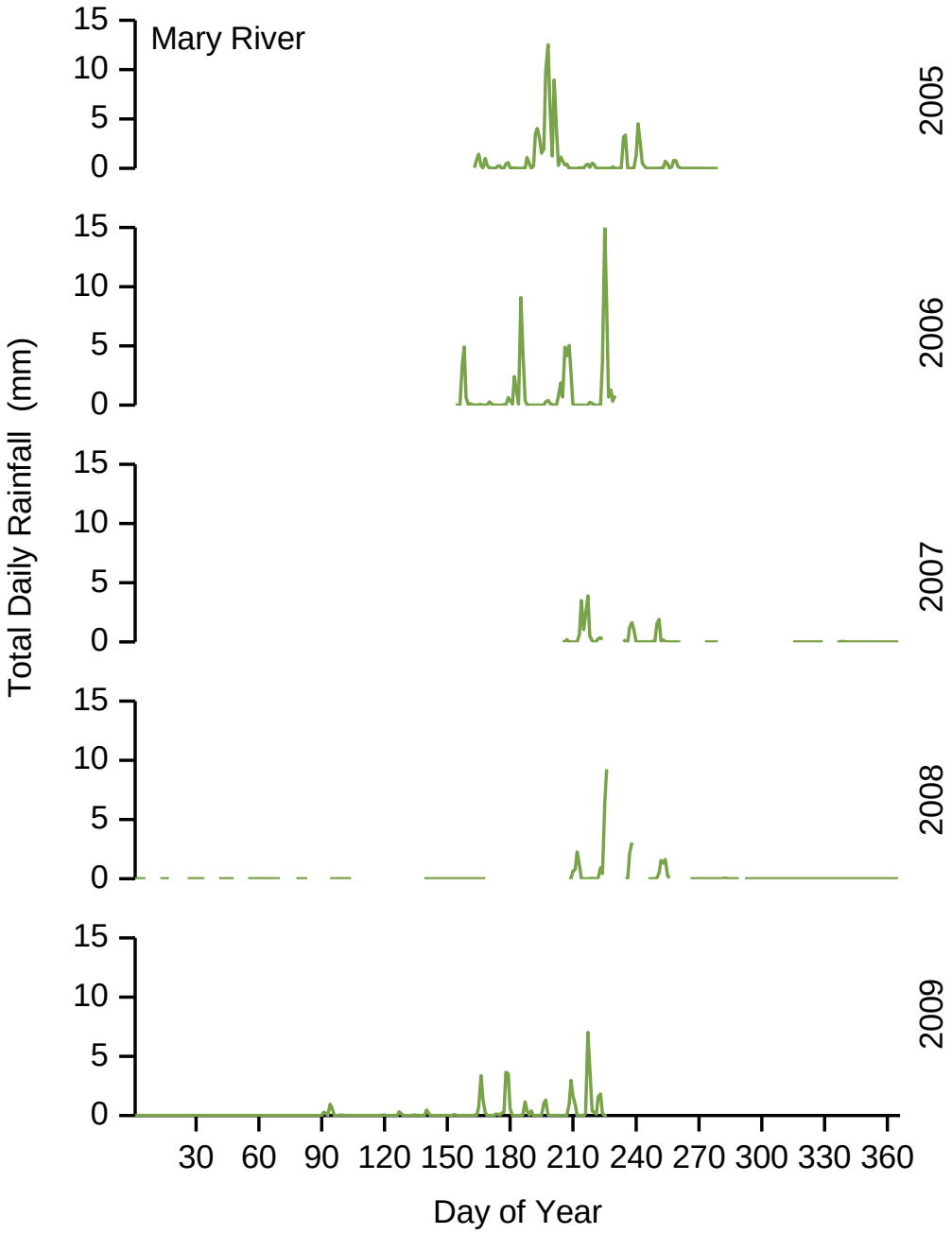


Figure 5-11: Daily rainfall at the Mary River station.

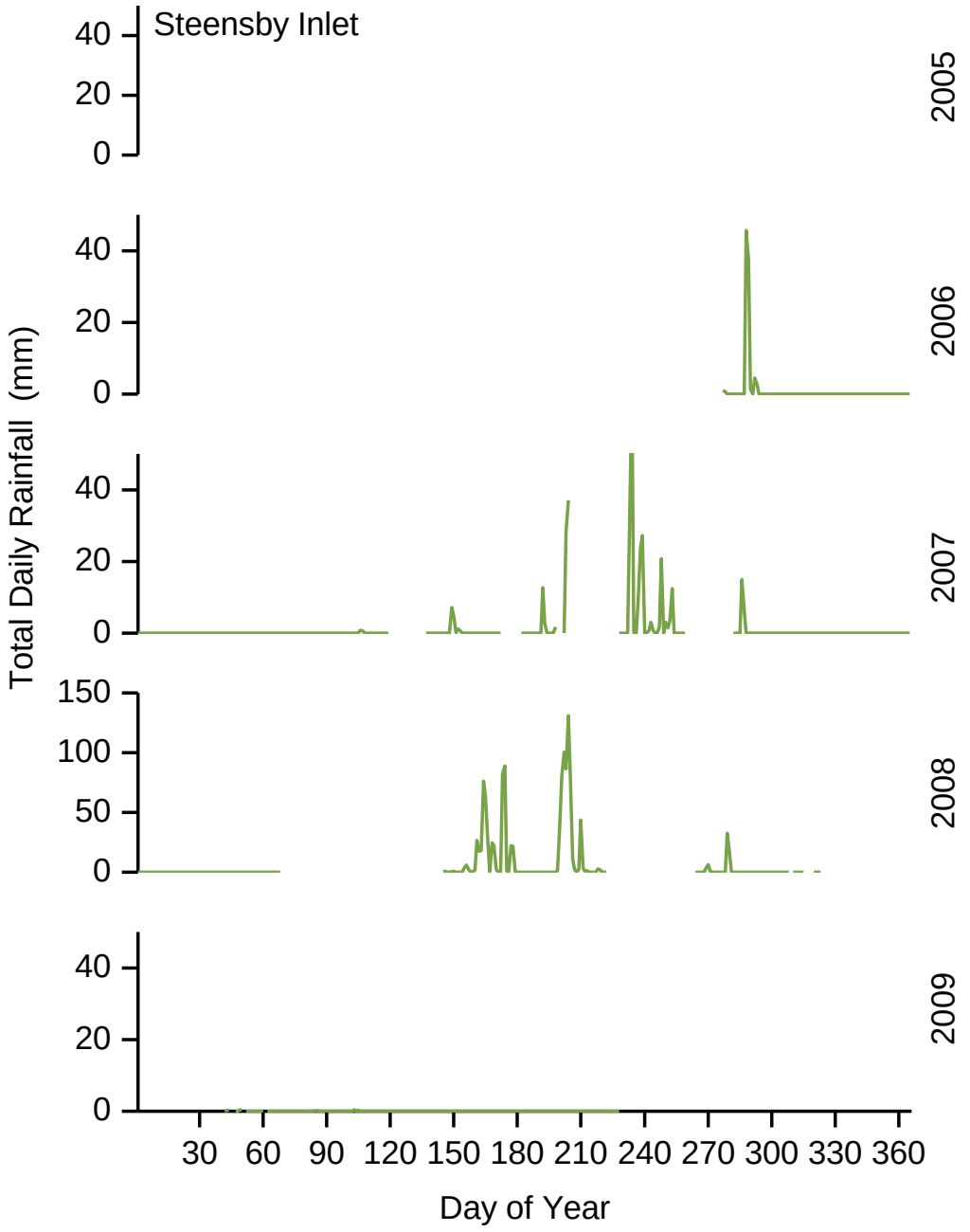


Figure 5-12: Daily rainfall at the Steensby Inlet station. Note the change in y-axis scale relative to the other figures; 2008 is on yet another scale.

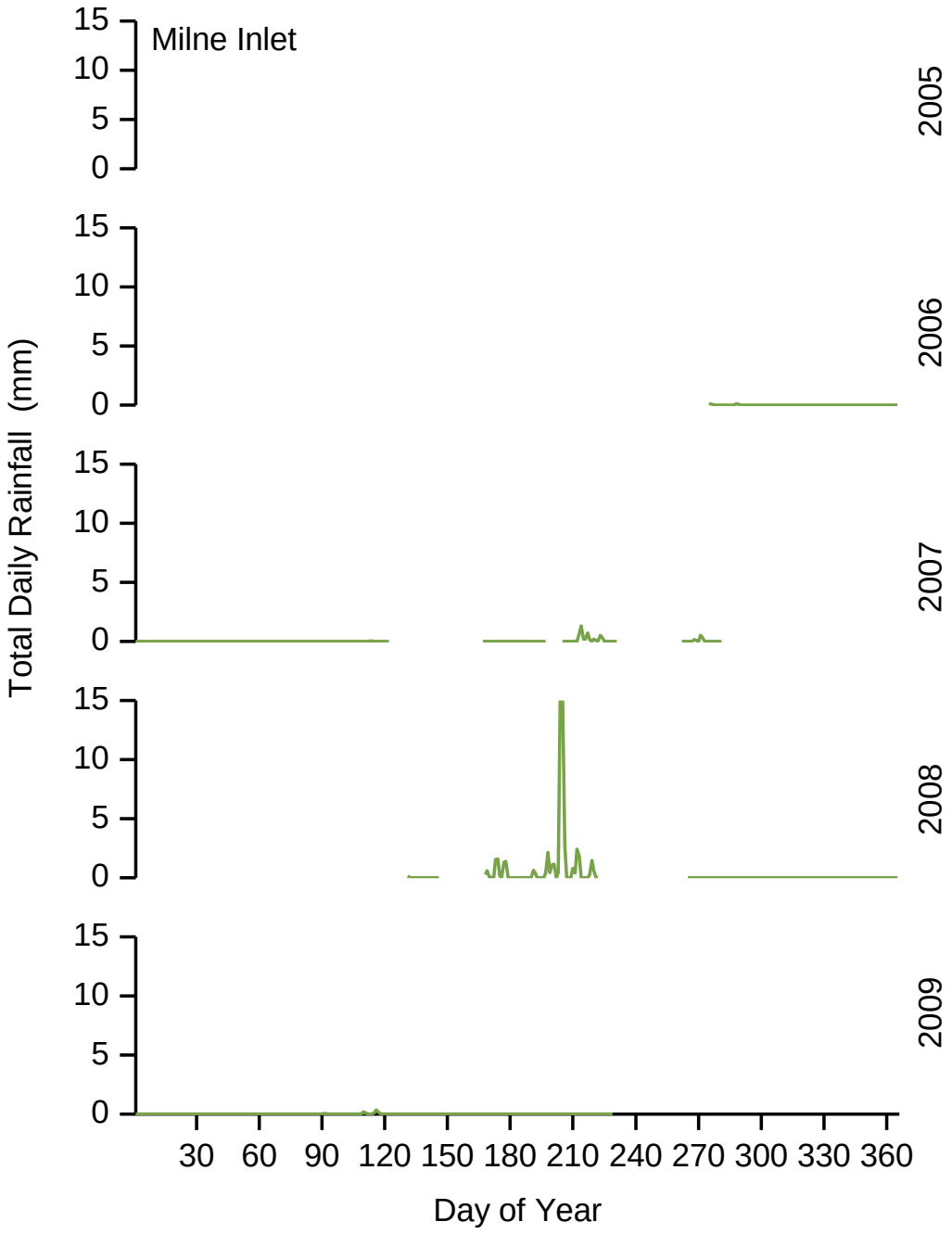


Figure 5-13: Daily rainfall at the Milne Inlet station.

Wind Speed

Wind speed was averaged over each day. Ordinarily, weather stations carry two different anemometers, one for low (cup style) and one for high (propeller style) wind speeds. The Mary Inlet station had both anemometers but only the high-speed one was connected and operational. The other sites had only high-speed sensors. The use of high-speed sensors is appropriate at these sites as wind speeds are typically high. The landscape is barren and open, thus wind is supported by a large fetch (clear landscape for building force). At all sites, wind speeds would often approach 20 m/s which is equivalent to 72 km/h.

Wind speed at Mary River showed a good data series (Figure 14) as recording occurred whenever the datalogger was switched on. Significant wind (Beaufort Scale values of 4-6) was almost always present, with frequent fluctuations that approached gale-force conditions (Beaufort 6-8).

The Steensby Inlet station also showed a very good data series for wind speed (Figure 15). At this site, wind speed was perhaps a bit more moderate than at Mary River, and did appear to also be a bit less variable.

The Milne Inlet station again had a good data series for wind speed (Figure 16) and seemed more similar to Mary River in terms of the intensity and variability in wind speed. The Milne Inlet station is located atop a high ridge and perhaps experiences higher wind than if it were located at sea level like the Steensby Inlet station.

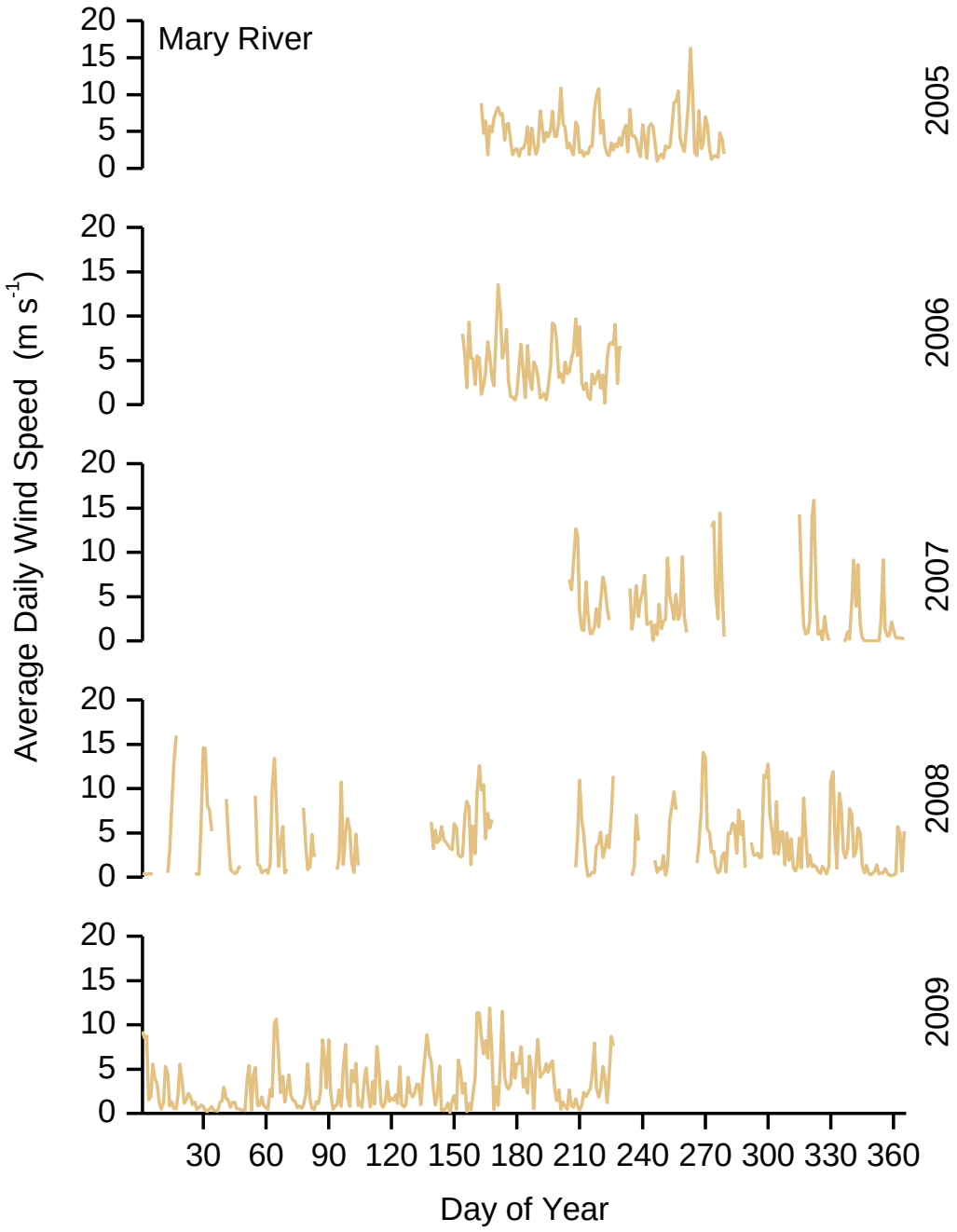


Figure 5-14: Average daily wind speed at the Mary River station.

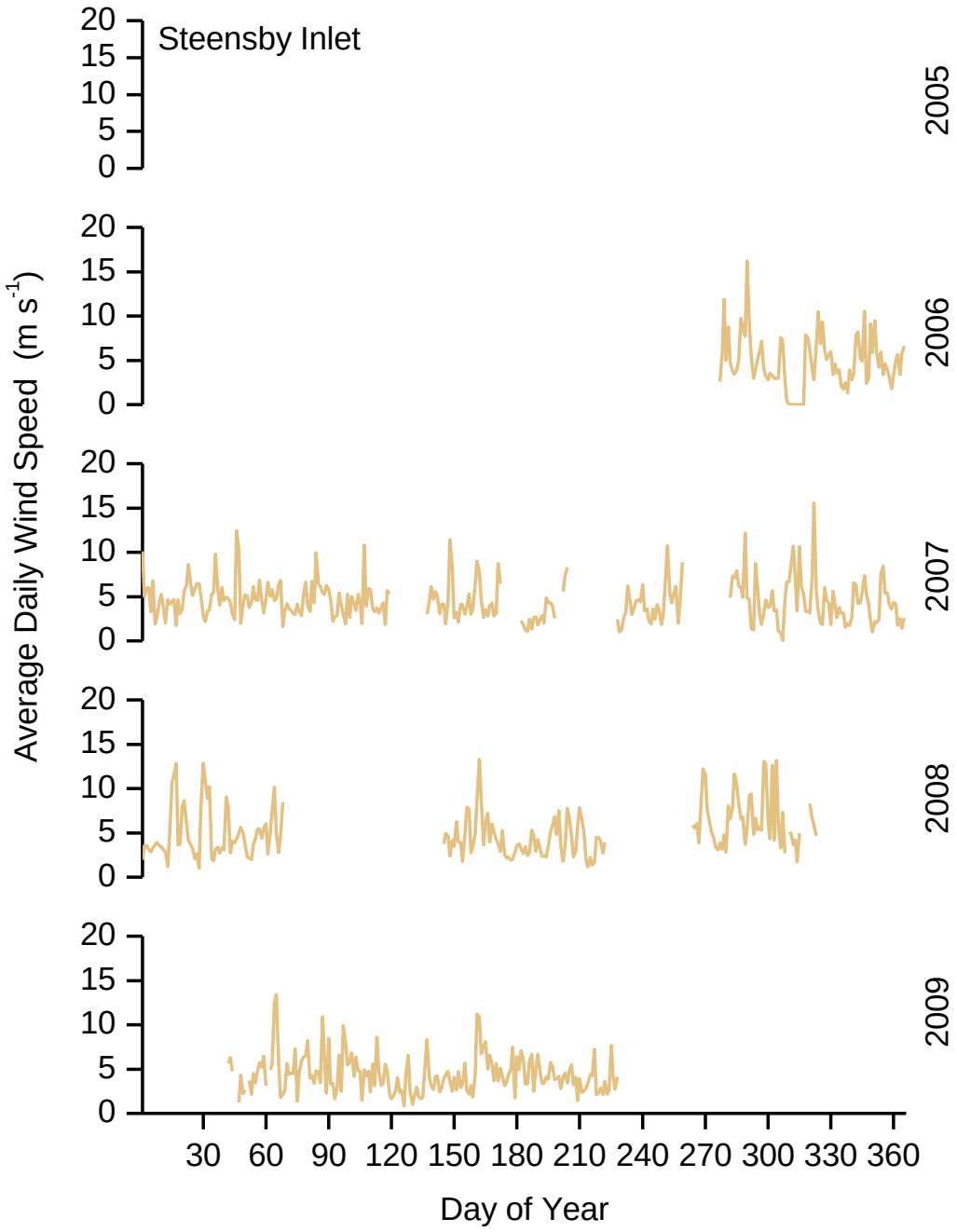


Figure 5-15: Average daily wind speed at the Steensby Inlet station.

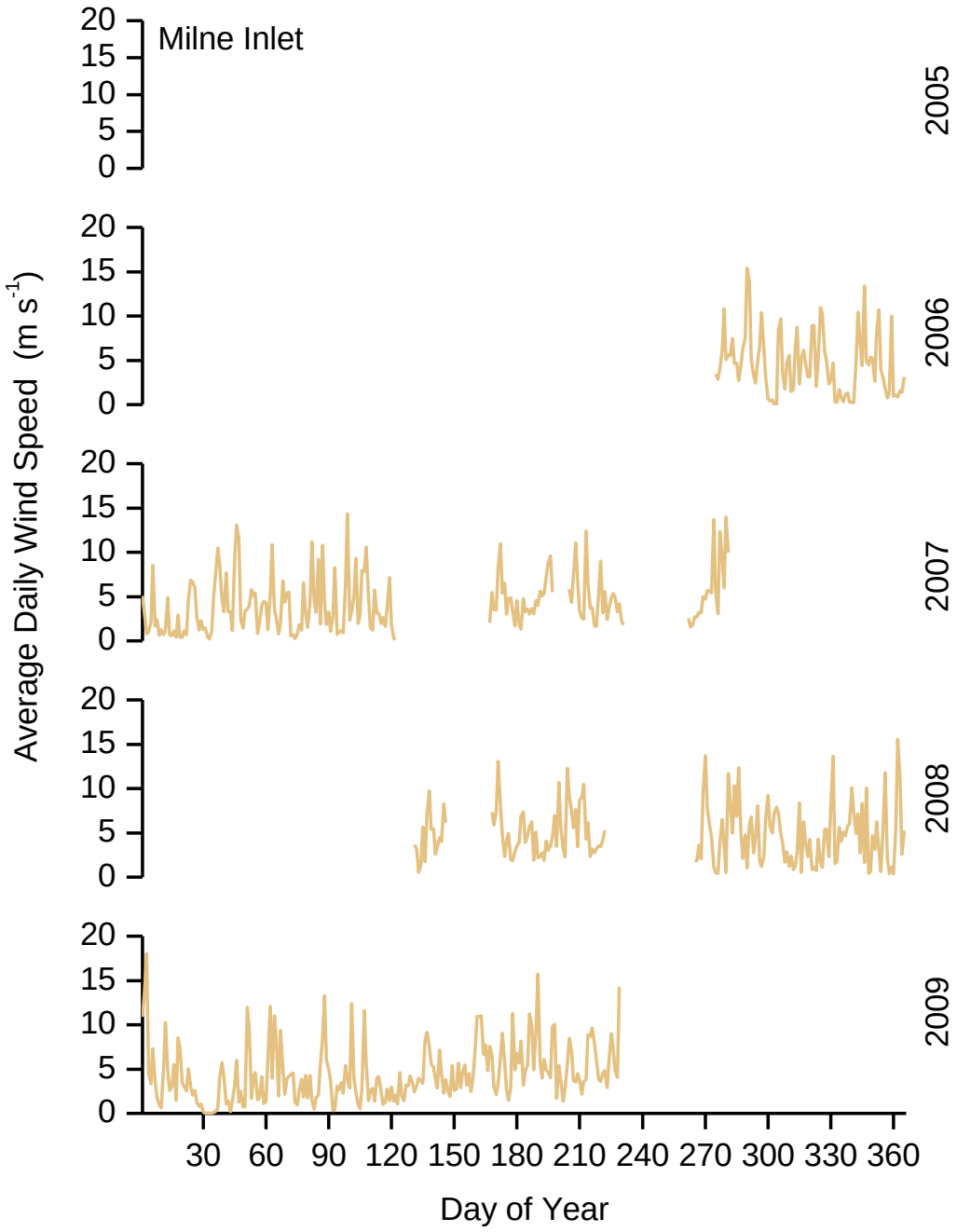


Figure 5-16: Average daily wind speed at the Milne Inlet station.

Attachment 6 - Dust Fall Monitoring

The largest amount of dustfall generated by the Mary River Project is expected to be associated with travel on the Tote Road linking the mine site with the port at Milne. However, there will also be dust fall generation from point source locations at both the mine site and the port at Milne Inlet. The dust fall monitoring program considers all potential dust fall sources, including the mine and Milne port point sources as well as the Tote Road linking the two sites.

Objectives

There are two main objectives of the dustfall monitoring program:

1. To determine the extent and magnitude of dustfall at sampling locations associated with the mine site, Milne port site, and road; and
2. To determine seasonal variations in dustfall at all sampling locations.

Methods

Passive dustfall monitoring methods are used to determine the deposition of fugitive dust from point sources and haul roads. There are a total of 34 dust fall sampling sites; the program began in 2013 with 26 sampling sites, and an additional eight were added in August 2014 (Figure 1 below):

- Nine dust fall samplers located at the Mine Site (seven within the Mine Site and two references sites; one to the northeast, and one to the south);
- Seven dust fall samplers located at Milne Port (six within the port itself, and one northeast and upwind of the port);
- 16 dust fall samplers divided between two sites along the Tote Road. These two sites are organized into transects, each composed of eight dust fall samplers distributed both north and south of the Tote Road centreline at 30 m, 100 m, 1 km, and 5 km. The prevalent wind direction is roughly parallel to the roadway as opposed to perpendicular, therefore no ‘upwind’ and ‘downwind’ directions from the road are identified; and
- Two reference dust fall samplers located 14 km southwest of the Tote Road.

Dust fall sampling is conducted year-round; however, the winter sampling program is limited to a subset of the sampling sites (14 out of 26 in the 2013/14 season) because access to remote sites is restricted. The sites not visited over the winter months were the most remote from the Mine Site, Tote Road and Milne Port. Because of their distance from disturbances, those sites are exposed to minimal project-initiated dust fall.

The sampling is conducted in accordance with methods outlined in ASTM D1739-98 (Re-approved 2010). Dust collection vessels were placed in the holder (Photo 1); these containers are pre-charged with 250 mL of algaecide in summer and 250 mL of alcohol in winter. Collection vessels are changed out approximately every month and shipped to ALS Environmental Laboratory (ALS) in Vancouver for analysis of total suspended particulates (TSP; units of mg/dm^2·day). In addition to the analysis of TSP, the 2013/14 dust fall samples were analyzed for total metal concentrations to help inform potential trends in soil and vegetation tissues, collected as part of vegetation health monitoring.

Photo 1: Dustfall collector sampling apparatus (from Rescan 2012).

The resulting data was reviewed for differences in the magnitude of dustfall from different sources (Mine, Milne Port, and Tote Road), seasonal variations, and total annual dustfall. Additionally, results are reviewed to determine the concentrations present at point sources in comparison to background sites, as well as concentrations changes with distance from the road centerline. Finally, using wind directions and strength data available through the climate monitoring program, the effect of wind on dustfall deposition can be investigated. Previous to this study, dustfall monitoring in northern Canada has been conducted during the summer months. Results from this monitoring program will allow the collection of seasonal dustfall data. Appropriate mitigation measures for the protection of caribou habitat can be determined through increased knowledge of the extent and magnitude of dustfall throughout the project area. In additional data concerning the seasonal fluctuations of dustfall can allow for the application of seasonal-specific mitigation measures.

References

Boulanger J., Poole K.G., Gunn A., and J. Wierzchowski. 2012. Estimating the zone of influence of industrial developments on wildlife: a migratory caribou *Rangifer tarandus groenlandicus* and diamond mine case study. Wildlife Biology 18:2.

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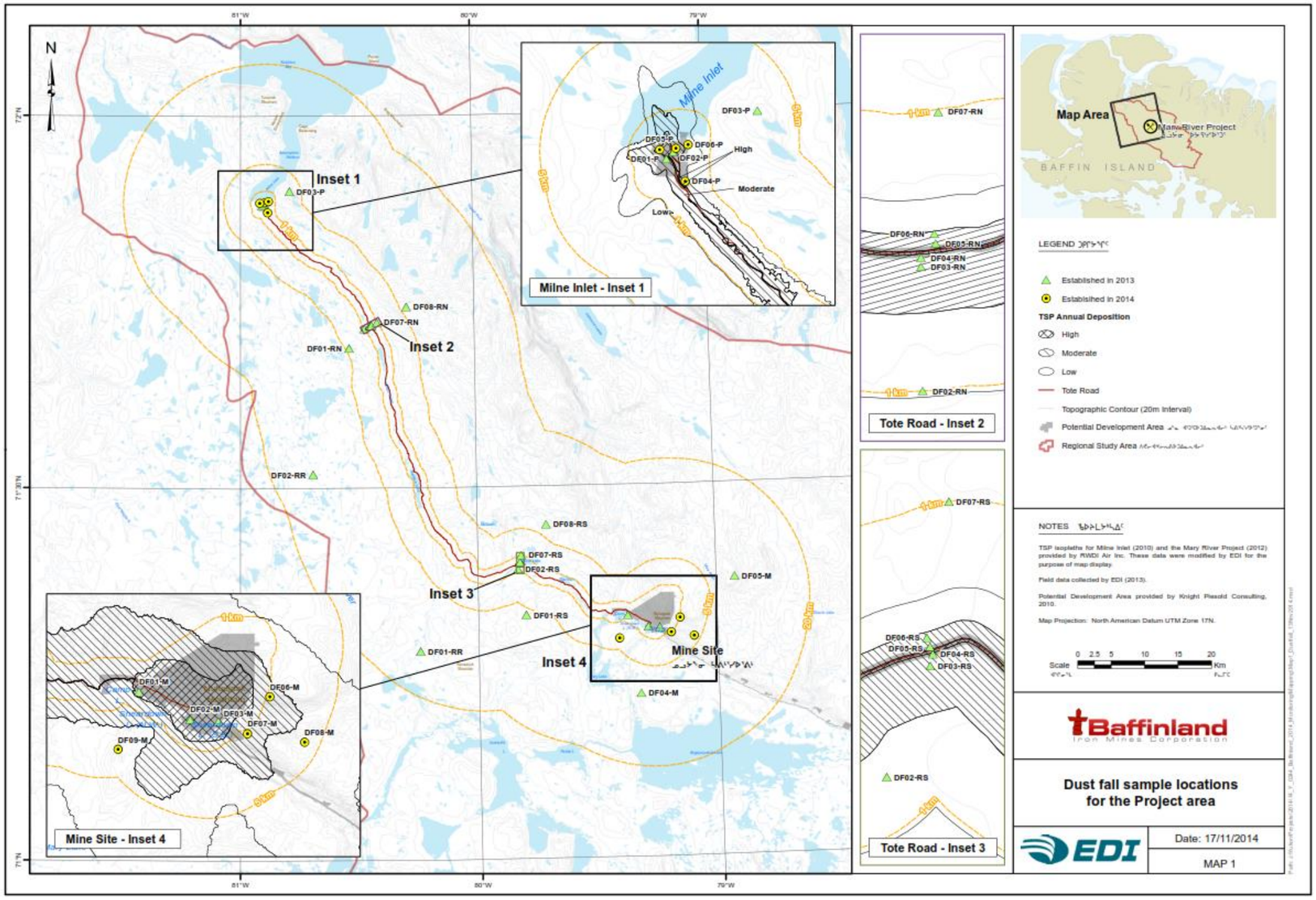

Attachment 7 - Dust Management Protocol

Baffinland Iron Mines Corporation
Mary River Project

Dust Management Protocol for the Mary River Project Roads

Revision No.:	A	**Procedure Number:**	
Revision Date:	July 31, 2013	**Date Reviewed:**	July 31, 2013
Date Revision Effective:	August 1, 2013		

1. Introduction

Under Baffinland Iron Mines Corporation (Baffinland) project approvals from the Nunavut Impact Review Board (NIRB), Baffinland has committed to "developing and implementing mitigation measures which control fugitive dust emissions" (NIRB, Final Hearing Report Terms and Conditions, Dec 28, 2012, Appendix A, #2). The objective of this Dust Management Protocol for the Mary River Project roads is to establish the operational requirements that will be implemented on the Mary River Project (the Project) to meet this commitment and the commitments established in the Mary River Project Health, Safety and Environment Policy (2013) to achieve a safe, health and environmentally responsible workplace.

Dust is an inevitable problem on all project roads and the control of dust must be a fundamental part of any environmental management plan. Dust on project roads is formed when fine particles become entrained in the atmosphere by the turbulent action of wind or by the mechanical disturbance of fine materials. Dust is a concern from safety, health, environment and operational standpoint. It can lead to:

- decreased visibility along project roads leading to increased risks of vehicle accidents.
- potentially adverse health effects for people who inhale airborne particles (especially a concern for people with prior respiratory issues).
- potentially adverse environmental effects including limiting photosynthesis levels on plants due to dust deposition and introducing contaminates to water ways.
- premature wear on engines and motor vehicles from increased inhalation of fine particles into engines on roadways.

To help mitigate the concerns, the Mary River Project will employ the following protocol to manage dust on project roads.

2. Dust Suppression Protocol

2.1 Determining When Dust Suppression is Required

Dust suppression methods may only be used on Mary River Project Site Roads when 'significant' dust generation is occurring. The determination if dust generation is significant is at the professional opinion and discretion of the Senior Construction Representative on-site with consultation with the Baffinland Environmental Department Representative on-site.

As a guideline, dust that is visibly being carried as a cloud off the roadway should be considered significant.

2.2 Primary Dust Suppression – Water

The wetting of road surfaces with water will be the primary method to mitigate dust concerns on the Mary River Project roads. If *significant* dust generation is occurring the following conditions shall be adhered to for the wetting of road surfaces with water:

- Water shall be collected only from approved sources as directed by the on-site Baffinland Environmental representative to ensure that the quality of water being used for dust suppression meets all water quality requirements for discharge under the Projects water use licenses and land use permits.
- Contaminated water shall not to be used for dust suppression.
- Water shall be applied to roads using on-site water trucks using a spray bar arrangement.
- The rate of water application should be enough to suppress dust but not sufficient to allow water to puddle or pool on the road surface.
- The frequency or rate of water application will vary depending upon the prevailing site conditions and shall be determined by the Senior Construction representative on-site with consultation with the Baffinland Environmental Department representative on-site.
- Only trained operators assigned and trained on the water truck operation shall be used to apply water on Mary River Project site roads to suppress dust on a as required basis.
- On a daily basis water volume and source used for dust suppression shall be tracked by and reported to the Baffinland Environmental Department representative on-site.

2.3 Secondary Dust Suppression – Calcium Chloride ($CaCl_2$)

The Government of the Nunavut, Environmental Protection Service, Department of Sustainable Development has a guideline, Environmental Guideline for Dust Suppression (as shown in Attachment A), that sets out requirements to be followed when using chemical dust suppressants in Nunavut. Currently there are three (3) approved dust suppressants in Nunavut: calcium chloride, Bunker C and DL10. The Mary River Project has restricted the list of approved chemical dust suppressants on project roads to calcium chloride ($CaCl_2$) only. 'Calcium Chloride' by Sel Warwick Inc. of Victoriaville, Québec is offered as an example of a commercially manufactured $CaCl_2$ that can be used on Mary River Project Roads (see Attachment B for MSDS Sheet).

Calcium Chloride may be applied as a dust suppressant on Mary River Project roads if measures are needed to mitigate the safety, health, environmental and/or operational

concerns arising from dust generation on Project roads *and* if primary dust suppressant is deemed to be ineffective due to operational restrictions (e.g. equipment/operator availability), weather conditions or safety reasons.

It is at the discretion of the Senior Construction representative on-site with consultation with the Baffinland Environmental Department representative on-site if the use of $CaCl_2$ as a dust suppressant is necessary.

If 'significant' dust generation is occurring and secondary dust suppression is deemed required, the following conditions shall be adhered to for the application of $CaCl_2$ on Mary River Project roads. $CaCl_2$ shall be applied to in a granular or brine solution.

2.3.1 Application Timing

- If possible, work should be applied to a lightly wetted road or scheduled after a light rainfall, when unpaved road surfaces and accumulated aggregate are damp and better able to absorb control measures.
- While damp surfaces are desirable, working in rain or on overly wet/saturated roadbeds shall be avoided as $CaCl_2$ is more easily transported in runoff to roadside soils and nearby watercourses.

2.3.2 Granular Application

- As a guideline, 0.5 kg of $CaCl_2$ shall be applied for every square meter of road area (or 1 lbs/yd)
- If possible, granular $CaCl_2$ shall be applied using a spinning disk vehicle mounted system. If a vehicle mounted system is not available, $CaCl_2$ shall be applied in accordance with all other requirements evenly across project roads manually.
- Granular $CaCl_2$ shall be applied to a pre-wetted surface (or after a light rainfall) however, avoid applying $CaCl_2$ to overly wet or saturated roadbeds where there is a high potential for chemical transportation.
- Ensure the application of granular $CaCl_2$ is limited to the travelled road surface.
- Be cautious applying granular $CaCl_2$ to road surfaces near watercourses or over watercourse crossings.
- Only a trained personnel shall be used to apply granular $CaCl_2$ on Mary River Project Site Roads to suppress dust on a as required basis.
- Have a spill response plan in place and a functional spill kit on each applicator and/or in application area.
- On a daily basis volume of granular $CaCl_2$ shall be tracked and reported to the Baffinland Environmental Department representative on-site.
- Ensure all equipment used on site is well maintained and free of fluid leaks.

2.3.3 Brine Production

- Water for brine solution shall be collected only from approved sources as directed by the on-site Baffinland Environmental representative to ensure that the quality of water being

used for dust suppression meets all water quality requirements for discharge under the mine's water use licenses and land use permits.

- Contaminated water shall not to be used for $CaCl_2$ brine solution production.
- On a daily basis water volume and source used for brine production shall be tracked by and reported to the Baffinland Environmental Department representative on-site.

2.3.4 Brine Application

- $CaCl_2$ brine solution shall be applied to roads using on-site water truck using spray bar arrangement.
- The rate of $CaCl_2$ brine application should be enough to suppress dust but not sufficient to allow water to puddle or pool on the road surface.
- Ensure the application of $CaCl_2$ brine is limited to the travelled road surface.
- Be cautious applying $CaCl_2$ brine to road surfaces near watercourses or over watercourse crossings.
- The frequency or rate of $CaCl_2$ brine application will vary depending upon the prevailing site conditions and shall be determined by the Senior Construction representative on-site with consultation with the Baffinland Environmental Department representative on-site
- Only a trained operator(s) assigned and trained on the water truck operation shall be used to apply water on Mary River Project Site Roads to suppress dust on a as required basis.
- Have a spill response plan in place and a functional spill kit on each applicator and/or in application area.
- On a daily basis brine volume used for dust suppression shall be tracked by and reported to the Baffinland Environmental Department representative on-site.
- Ensure all equipment used on site is well maintained and free of fluid leaks.

2.3.5 Storage

- $CaCl_2$ shall be stored in accordance with applicable regulations and shall be handled with care.
- Transfer and loading of $CaCl_2$ shall occur at designated sites away from watercourses.
- Care shall be taken to avoid spilling chemicals during transfer and loading.
- Equipment and tools shall be cleaned in a designated area, if possible. Any wash water generated by cleaning tools and equipment shall be managed in a manner that will prevent its direct release to watercourses.
- Ensure all equipment used on site is well maintained and free of fluid leaks.

3. References

The Government of the Nunavut, Environmental Protection Service, Department of Sustainable Development. Environmental Guideline for Dust Suppression. 2002

Agnico Eagle Mines Ltd. – Meadowbank Division. Dust Suppression Protocol for Roads. 2008

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City of Albuquerque, Environmental Health Department, Air Quality Division. Fugitive Dust Control Methods. 2005

Environment Australia, Department of the Environment. Best Practice Environmental Management in Mining: Dust Control. 1998

Water, Air and Climate Change Branch, Environmental Protection Division, BC Ministry of Environment. Road salt and Winter Maintenance for British Columbia Municipalities, Best Management Practices to Protect Water Quality. 1998.

Attachment(s)/Enclosure:

Attachment A - Environmental Guideline for Dust Suppression, Government of Nunavut, Environmental Protection Service, Department of Sustainable Development (January 2002).

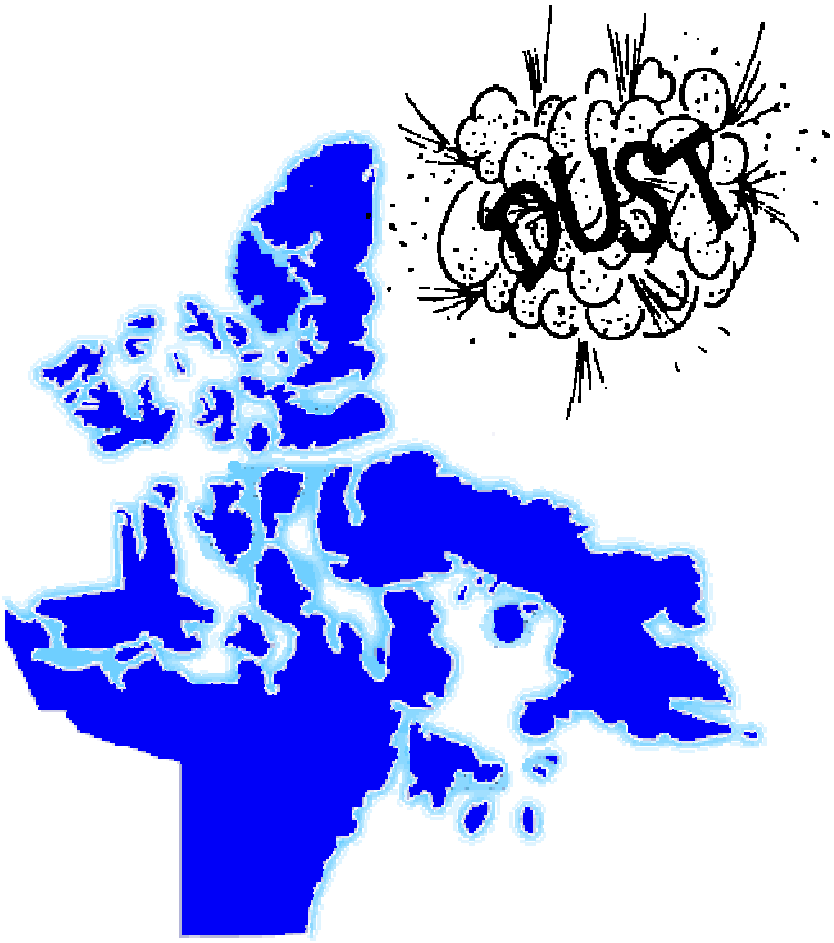
Attachment B – MSDS Sheet ‘Calcium Chloride’ by Sel Warwick Inc. of Victoriaville, Québec

Attachment A

Nunavut Environmental Guideline for Dust Suppression

Government of Nunavut, Environmental Protection Service, Department of Sustainable Development (January 2002).

ENVIRONMENTAL GUIDELINE FOR Dust suppression



Department of Sustainable Development
Environmental Protection Service

Nunavut

GUIDELINE: DUST SUPPRESSION

AS AMENDED BY:

USE OF GUIDELINE

A guideline is not law and is therefore not enforceable. It does however, assist an inspector to determine what action(s) may be required of him. Paragraph 2.2(c) of the Environmental Protection Act allows the Minister to develop co-ordinate and administer guidelines. The Act [subsection 5(1)] makes it an offence to discharge a contaminant into the environment, subject to some exceptions [subsection 5(3)]. When a discharge occurs and it is inconsistent with the guideline, the discharge is considered an unacceptable risk. The inspector may then consider issuing an order or laying an Information.

A guideline allows for some leniency in applying the law. A court would probably be inclined to consider the application of a guideline favorably because the public is aware of the standards they are expected to meet.

This Guideline is not law.
It is prepared by Environmental Protection Service,
Department of Sustainable Development
Government of the Nunavut

January, 2002

Guideline for Dust Suppression

January, 2002

GUIDELINE FOR DUST SUPPRESSION

1 Introduction

The purpose of this guideline is to make you aware of the procedures you must follow before applying a dust suppressant in Nunavut. The Department of Sustainable Development, Environmental Protection Service, (EPS) has currently approved three dust suppressants for use in Nunavut. The publication provides guidance for applying these products and a process for approving other dust suppression products.

Section 2.2 of the *Environmental Protection Act* gives the Minister of Sustainable Development the authority to develop, co-ordinate and administer these guidelines (see appendix A).

1.1 Definitions

Approved Product	A product approved by EPS for dust suppression.
Leachate Test	Leachate Extraction Procedure - Canadian General Standards Board (CGSB) #164-GP-1-MP (or as amended) or equivalent.
PCB	Polychlorinated biphenyl.
Roadway	The traveled surface of a road, from shoulder to shoulder; it does not include the side slopes or ditches.
Set	The point at which the product becomes stable, according to the manufacturer's specifications.
Used Oil	Any oil from an industrial or non-industrial source that has become unsuitable for its intended purpose due to the presence of impurities or the loss of original properties.

1.2 Why are dust suppressants used?

Reasons for using dust suppressants include:

Safety	Untreated roads may lead to more accidents. Accident potential is increased due to loss of visibility.
Health	Dust particles may become a health hazard when they become trapped in the lungs.
Vegetation	Large amounts of dust may induce changes in vegetation due to increased heat absorption and decreased transpiration.

Aquatic Resources	High levels of dustfall into aquatic systems may adversely affect aquatic plants and fish that are not adapted to high levels of sedimentation.
Aesthetics	Dust produces an immediate visual impact that may affect residents who live near dust prone roads.
Road Maintenance Costs	Treated roads can lower road maintenance costs by reducing general loss and blading time.

An Ambient Air Quality Guideline established under the Environmental Protection Act sets standards respecting the maximum desirable levels of dust in ambient air in the NWT/Nunavut. Measured as total suspended particulate (TSP), the standards for dust over 24 hours are 120 micrograms per cubic metre (µg/m^3) and averaged over a year are 60 µg/m3. These standards apply to the whole of the NWT/Nunavut. They define the long term goal for air quality to protect unpolluted parts of the Territories and for the continuing development of control options in polluted areas.

1.3 Roles and Responsibilities

Although the *Environmental Protection Act* does not require permits for the application of dust suppressants in Nunavut, all suppressants must first be approved by EPS. While general conditions are provided for approved dust suppressants, additional conditions may be required on a case by case basis.

The responsible party, being the landowner, road authority or municipal authority, must make provisions to notify the public and contact the Department of Sustainable Development before applying suppressants. The responsible party must also verify that the products are approved for use and properly applied by the applicator. If the product migrates from the roadway and is deemed to violate the *Environmental Protection Act*, the person(s) responsible must be prepared to take appropriate remedial measures.

Applicators are also accountable for their actions. Applicators are responsible for ensuring that the product is approved for use in Nunavut, is correctly applied to the designated area and does not migrate off the site. Applicators, manufacturers and retailers must provide information about new products to EPS for approval before their use in Nunavut (Section 3).

> ***It is important to remember that the responsible party (the landowner, road authority or municipal authority) is liable for any activity they authorize. Contamination of the environment and subsequent remediation of the site is ultimately their responsibility. (See Appendix A)***

2 General Dust Suppression Guidelines

There are many aspects to consider before you apply a dust suppressant in Nunavut. The following are general guidelines to be followed:

2.1 Notification for use of Approved Products

The following parties must be notified:

Property Owner	Any application of a dust suppressant should be conducted according to an agreement between the applicator and the responsible road authority or property owner. A written agreement is recommended.
Department of Sustainable Development	Before any application, provide the local Environmental Protection Officer with the following information: the location of the site, the product(s) used and a timetable for the work.
Public	Notify the affected public before any application. This can be through signs, public notices or media announcements.

2.2 Approved Products

Calcium chloride, Bunker C and DL 10 are currently the only approved dust suppressants in Nunavut. Appendix B contains a list of approved products and information regarding the application of these products.

Other products cannot be used in Nunavut until they have been approved by EPS.

> ***Used oil must not be used as a dust suppression/road stabilizing product or added to other dust suppression products.***

2.3 Application Procedures

Directions	Follow the manufacturer's specifications or other tested and approved procedures.
Roadway	The application shall be limited to the roadway, driveway or parking lot.
Rate	Carefully monitor the application rate to ensure adequate coverage without pooling or runoff of products. The amount of dust suppressant applied should not exceed the minimum amount required to effectively suppress dust.
Incorporation	Products must be bladed or incorporated into the road immediately upon application, to ensure the product does not migrate off the roadway.
Migration	The material must not migrate or run off the traveled portion of the roadway.

2.4 Environmental Concerns

2.4.1 General

Contaminants	Dust suppressants must conform with the manufacturer's specifications and must not contain concentrations of contaminants that would not normally be found in the suppressant.
PCB Concentration	Materials that contain more than 2 parts per million (ppm) of PCB are considered unacceptable and shall not be applied as a dust suppressant.

2.4.2 Water

Proximity to Water	Ensure that dust suppressants do not enter and contaminate waterbodies, including surface and groundwater. Do not allow the product to leave the roadway.
Sensitive Environments	Application rates near sensitive environments, e.g. marshes, must be closely monitored. Remember**,** environmental restoration is the responsibility of the landowner, road authority or municipal authority.
Flooding	Do not apply products to areas of roads that are subject to flooding.
Imminent Precipitation	Do not apply products if precipitation is occurring, or forecast to occur before the product sets or cures.

2.5 Spill Contingency Plan

Provide EPS with a contingency plan, if required by the *Spill Contingency Planning and Reporting Regulations*, under the *Environmental Protection Act*.

Be prepared to respond to spills, including any product that migrates off the roadway.

3 New Products

Products that have not been approved by EPS must undergo an assessment before being approved for use as a dust suppressant. The following information is required before such an assessment can be done:

Manufacturer's Information	Manufacturer's specifications and application procedures.
Laboratory Analysis	All new products must be characterized by an accredited laboratory.
Material Safety Data Sheets	Complete workplace hazardous material information system data sheets (W.H.M.I.S.).

(M.S.D.S.)	(W.H.M.I.S.).
Toxicity Tests	Toxicity tests should be provided for LC-50 and LD-50.
Leachate Tests	See section 3.1
Other requirements	Provide a proposed schedule of field tests to confirm product efficiency and appropriate application rates. Provide any other materials, tests or analysis carried out on the substance. Provide copies of approvals from other jurisdictions. Laboratory or testing costs are the responsibility of the person(s) applying for approval.

3.1 Leachate Toxicity Testing

New, non-approved dust suppressant products may be required to undergo the leachate extraction procedure to determine toxicity of the polymerized product. Testing should be carried out on a sample consisting of the polymerized material, at the standard application rate, and a representative sample of road material. Such a leachate toxicity test can be undertaken by a variety of reputable commercial laboratories. Leachate extraction procedure CGBS #164-GP-1-MP, or an acceptable equivalent, must be used. (See appendix C).

4 Conclusion

This is a brief introduction to dust suppressant application in Nunavut.

If you would like more information please contact:

Environmental Protection Service
Department of Sustainable Development
P.O. Box 1000, Station 1195
Iqaluit, Nunavut, X0A 0H0
Phone: (867) 975-5900; Fax: (867) 975-5990

Remember that this document is to inform you of the procedures you must follow before applying dust suppressants in Nunavut. If you have any questions or comments, contact the Environmental Protection Service before beginning a dust control program.

5 Bibliography

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APPENDIX A

Environmental Protection Act

The following information is a subset of the *Environmental Protection Act.* The complete Act is available for viewing at any office of the Department of Sustainable Development.

1. In this Act;

"Contaminant" means any noise, heat, vibration or substance and includes such other substances as the Minister may prescribe that, where discharged into the environment,

(a) endangers the health, safety or welfare of persons;
(b) interferes or is likely to interfere with normal enjoyment of life or property
(c) endangers the health of animal life, or
(d) causes or is likely to cause damage to plant life or to property;

"Discharge" includes, but not so as to limit the meaning, any pumping, pouring, throwing, dumping, emitting, burning, spraying, spreading, leaking, spilling or escaping;

"Environment" means the components of the Earth and includes:

(a) air, land and water;
(b) all layers of the atmosphere;
(c) all organic and inorganic matter and living organisms, and
(d) the interacting natural systems that include components referred to in paragraph (a) to (c).

2.2 The Minister may

(a) establish, operate and maintain stations to monitor the quality of the environment in the Territories;
(b) conduct research studies, conferences and training programs relating to contaminants and to the preservation, protection or enhancement of the environment;
(c) develop, co-ordinate and administer policies, standards, guidelines and codes of practice relating to the preservation, protection or enhancement of the environment;

5. **(1)** Subject to subsection (3), no person shall discharge or permit the discharge of a contaminant into the environment.

(2) REPEALED, R.S.N.W.T. 1988, c. 117 (Supp.), s. 8.

(3) Subsection (1) does not apply where the person who discharged the contaminant or permitted the discharge of the contaminant establishes that

(a) the discharge is authorized by this Act or the regulations or by an order issued under this Act or the regulations;
(b) the contaminant has been used solely for domestic purposes and was discharged from within a dwelling-house;

(c) the contaminant was discharged from the exhaust system of a vehicle;
(d) the discharge of the contaminant resulted from the burning of leaves, foliage wood, crops or stubble for domestic or agricultural purposes;
(e) the discharge of the contaminant resulted from burning for land clearing or land grading;
(f) the discharge of the contaminant resulted from a fire set by a public official for habitat management of silviculture purposes;
(g) the contaminant was discharged for the purposes of combating a forest fire;
(h) the contaminant is a soil particle or grit discharged in the course of agriculture or horticulture; or
(i) the contaminant is a pesticide classified and labeled as Adomestic≅ under the *Pest Control Products Regulations* (Canada)

(4) The exceptions set out in subsection (3) do not apply where a person discharges a contaminant that the inspector has reasonable grounds to believe is not usually associated with a discharge from the excepted activity. R.S.N.W.T. 1988, c. 75 (Supp.), s. 5; c. 117 (Supp.), s. 8.

5.1 Where a discharge of a contaminant into the environment in contravention of this Act or the regulations or the provisions of a permit or license issued under the Act or the regulations occurs or a reasonable likelihood of such a discharge exists, every person causing or contributing to the discharge or increasing the likelihood of such a discharge, and the owner or the person charge, management or control of the contaminant before its discharge or likely discharge, shall immediately:

(a) subject to any regulations, report the discharge or likely discharge to the person or office designated by the regulations;
(b) take all reasonable measures consistent with public safety to stop the discharge, repair any damage caused by the discharge and prevent or eliminate any danger to life, health, property or the environment that results or may be reasonably expected to result from the discharge or likely discharge; and
(c) make a reasonable effort to notify every member of the public who may be adversely affected by the discharge or likely discharge. R.S.N.W.T. 1988, c. 75 (Supp.), s. 5: c. 117 (Supp.), s. 9.

6. (1) Where an inspector believes on reasonable grounds that a discharge of a contaminant in contravention of this Act or the regulations or a provision of a permit or license issued under this Act or the regulations has occurred or is occurring, the inspector may issue an order requiring any person causing or contributing to the discharge or the owner or person in charge, management or control of the contaminant to stop the discharge by the date named in the order.

7. (1) Notwithstanding section 6, where a person discharges or permits the discharge of a contaminant into the environment, an inspector may order that person to repair or remedy any injury or damage to the environment that results from the discharge.

APPENDIX B

Approved Dust Suppression Products and Application Information

Application of Bunker C

Bunker C is the heaviest viscosity oil that refineries produce, with an asphalt content varying between 7 and 25%.

Purity	Bunker C must not contain contaminants not normally found within the virgin products, i.e. tank bottom sludge, other fuels or oils, used oil, PCBs or solvents.
Blading	It must be bladed or otherwise incorporated into the road immediately upon application.
Containment	Bunker C must not be applied to sections of the road that are subject to flooding. Do not allow the product to enter waterbodies. The product contains hydrocarbons that are potentially toxic.
General Guidelines	Follow all other general guidelines listed in section 2.

Application of Calcium Chloride

This is a commonly used product in the NWT/Nunavut. It is available in granular and liquid form. Because it is hygroscopic and deliquescent, it draws moisture from the air and will control dust if applied frequently enough.

Road surface conditions and traffic volume dictate the amount, timing and frequency of calcium chloride application. With normal application procedures and concentrations, it is generally non-toxic with rapid dissolution in the environment. However, calcium chloride can wash away in heavy rain. For more information read: *Calcium Chloride as a Dust Suppressant,* (see section 5).

Toxicity to plants	Calcium chloride is toxic to some plants. Keep the product on the roadway.
Application Rate	Apply minimum amounts as it can cause roads to become slippery.
Applicator Competence	Ensure application personnel are informed of corrosive nature of the product (can be harmful to eyes and skin with direct contact).
General Guidelines	Follow all other general dust suppressant guidelines listed in section 2.

APPENDIX B (cont'd)

Application of DL 10

DL 10 is an asphalt product that is mixed with water and a soap solution. DL 10 should be applied to one side of the road at a time, and then allowed to set for approximately three hours. Braking may be difficult on freshly treated road, so a pilot car may be necessary to direct traffic during the application. Vehicles should travel no faster than 20 km/hr through areas where the application has not set.

Fresh DL 10 can be washed off using soap and water. If it is allowed to dry, a solvent may be required.

General Guidelines	Follow all general dust suppressant guidelines listed in Section 2.

APPENDIX C

Leachate Extraction Procedure Test and Equivalents:

(See reference section for complete documentation).

The Environmental Protection Service may require new products to undergo the following test:

- CGSB #164-GP-1-MP *Leachate Extraction Procedure* Canadian General Standards Board (or as amended).

Or one of these equivalent tests:

- Schedules III and IV - *Environmental Quality Act - Hazardous Waste Regulation* - Gazette officielle du Quebec.
- Schedule 4 - *British Columbia Waste Management Act - Special Waste Regulation,* Government of British Columbia.
- Schedule 4 - *Regulation 347* (formerly Regulation 309), Government of Ontario.

If you would like to be placed on a mailing list to receive guideline amendments or for public consultation on Environmental Protection Service legislation please fill this out and mail or fax to:

Environmental Protection Service
Department of Sustainable Development
P.O. Box 1000, Station 1195
Iqaluit, Nunavut, X0A 0H0
Fax: (867) 979-5990

Users of this guide are encouraged to report any errors, misspellings, etc. contained within, to EPS at the above address.

Mailing List for Environmental Protection Service Information

Name: _____

Title: _____

Address : _____

_____

Phone / Fax Number: _____

Attachment B
MSDS Sheet ‘Calcium Chloride’

Sel Warwick Inc. of Victoriaville, Québec

5, Boutet Street
Victoriaville, Qc
G6P 8T6

This product is distributed by
Canada Colors and Chemicals Limited
General Inquiry: (905) 459-1232
24 Hour Emergency: (416) 444-2112
CCC: Product Code: 279213
CCC: Product Name: CALCIUM CHLORIDE FLAKE 77% -SW ML

FLAKE CALCIUM CHLORIDE

Material Safety Data Sheet

A. PRODUCT INFORMATION

TRADE NAME (PRODUCT IDENTIFIER): Flake Calcium Chloride Powdered Calcium Chloride	**CLASSIFICATION & SYMBOL** :  Class D2B	
CHEMICAL NAME AND/OR SYNONYM: Calcium Chloride Dihydrate	**FORMULA :** $CaCl_2$ 2 H_2O	**CAS NO**: 10043-52-4

BNQ Standard 2410-300 / 2009 Certificat # 1156

Canadian Standard CAN-CGSB-15.1-92

PRODUCT USE :
De-icer, Dust control, mud drilling lubricant, Freeze-proofing of ores and aggregates, thawing agent, concrete conditioner. Food Grade Calcium category is used as additive, refrigerants and heat exchange agent.

MANUFACTURER/IMPORTER: Sel Warwick Inc. 5, Boutet Street Victoriaville, Qc, G6P 8T6	**SUPPLIER/DISTRIBUTOR**: **TETRA Technologies Inc** **369, Feed Mill Road** **Eldorado, AZ 71730** **USA**
EMERGENCY TELEPHONE NO: 819-758-5229	

B. PREPARATION INFORMATION

PREPARED BY : Sel Warwick Inc. 5, Boutet Street, Victoriaville Telephone : 819-758-5229	**PREVIOUS ISSUE DATE** : December 2010
	CURRENT ISSUE DATE: June 2012

C. TOXICOLOGICAL PROPERTIES

INHALATION:
Dust or mist inhalation may irritate nose, throat and lungs

INGESTION :
Low in toxicity. May irritate gastrointestinal tract and cause nausea and vomiting

SKIN :
May cause skin irritation. Prolonged contact when moisture is present may result in superficial burns. Contact with abraded skin or cuts can cause severe necrosis

EYES:
May irritate or burn eyes

ACUTE TOXICITY: Moderate toxic LD_{50} (oral-rat) 1000 mg/kg LD_{50} (oral-mouse) 1940 mg/kg	**EXPOSURE LIMITS**: Ontario Ministry of Labour Time-Weighted Average Exposure Value (TWAEV) for Nuisance Particulate 10 mg/m^3
CHRONIC TOXICITY : Not applicable	
OTHER :	**BIOLOGICAL EXPOSURE INDICES (BEI)** : Not applicable

D. PHYSICAL DATA

MATERIAL IS AT NORMAL CONDITIONS: **Liquid** ☐ **Solid** ☒ **Gas** ☐	**APPEARANCE AND COLOR :** Small White Flakes Very hygroscopic	**ODOR THRESHOLD** : Odorless
BOILING POINT : Not available **FREEZING POINT** : ^{0}C **(MELTING POINT)** : 176^{0}C	**SPECIFIC GRAVITY :** g/cc **(H_2O =1)** Not available	**VAPOR DENSITY:** **(AIR=1)** Not applicable
SOLUBILITY IN WATER : 97.7 g/100 ml @ 0^{o}C 326 g / 100 ml @ 60^{o}C	**PH** Neutral to slightly Alkaline	**VAPOR PRESSURE:** **(mm Hg @ 20^{o}C)** Not applicable **(PSIG)**
EVAPORATION RATE : **(Ether = 1.0)** Not applicable **Slow <0.3 Fast > 3.0** **Medium 0.3 – 3.0**	**% VOLATILES BY VOLUME:** (At 20^{o}C) Not applicable	**MOLECULAR WEIGHT:** 147.02 **COEFFICIENT OF WATER/OIL DISTRIBUTION:** Not available

E. REACTIVITY DATA

STABILITY: Stable	**CONDITIONS TO AVOID :** Not applicable
INCOMPATIBILITY (MATERIALS TO AVOID): Reacts violently with bromine trifluoride (BrF_3), or a mixture of boron trioxide and calcium oxide (B_2O_3 + CaO). Sulfuric acid : yields hydrogen chloride gas, which is corrosive, irritating and reactive. Water-reactive materials, such as sodium : causes an exothermic reaction. Methyl vinyl ether : starts runaway polymerization reaction. Zinc as in galvanized iron : yields hydrogen gas with solutions, which may explode under these conditions.	
HAZARDOUS DECOMPOSITION PRODUCTS: Fumes of Chlorides (Cl) are given off at temperature above 1600 ^{o}C	
HAZARDOUS POLYMERIZATION : Will not occur ☐	**OTHER PRECAUTIONS:** Will undergo violent polymerization with methyl vinyl ether. The anhydrous, monohydrate, dihydrate and tetrahydrate forms of calcium chloride, when dissolved in water, produce considerable amounts of heat.

F. FIRE OR EXPLOSION HAZARD

CONDITIONS OF FLAMMABILITY : Not applicable	**FLASH POINT:** Not applicable **METHOD**
HAZARDOUS COMBUSTION PRODUCTS: None	
% BY VOL. IN AIR **UPPER FLAMMABLE LIMIT** : N/A **LOWER FLAMMABLE LIMIT:** N/A **AUTOIGNITION TEMPERATURE** : ^{o}C	**EXPLOSION HAZARDS** : See Section E incompatibility
SENSITIVITY TO MECHANICAL IMPACT : Not applicable	
SENSITIVITY TO STATIC DISCHARGE: Not applicable	
FIRE EXTINGUISHING PROCEDURES: Use extinguisher media appropriate for surrounding fire. For fire fighting wear NIOSH-approved self- contained breathing apparatus.	

G. HAZARDOUS INGREDIENTS (MIXTURES ONLY)

MATERIAL OR COMPONENTS/C.A.S. #	CONCENTRATION	HAZARD DATA
Not applicable		

H. PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT：

RESPIRATORY PROTECTION：
For dusty or misty conditions, wear NIOSH approved dust or mist respirator

EYES AND FACE:
For dusty or misty conditions, or when handling solutions where there is reasonable probability of eye contact, wear chemical safety goggles and hard hat. Under these conditions, do not wear contact lenses.

HANDS, ARMS AND BODY：
As a minimum, wear long-sleeve shirt, trousers, rubber boots and gloves for routine product use. Cotton gloves permitted for dry product, impervious gloves when using solutions.

STORAGE：
Cool, dry area. Prolonged storage may cause product to cake and become wet from atmospheric moisture.

NORMAL HANDLING:
Avoid contact with eyes, skin or clothing. Avoid breathing dust. Use good personal hygiene and housekeeping

ENGINEERING CONTROLS:

Ventilation:Provide general and/or local exhaust ventilation to maintain dust or fume levels below exposure limits.

Eye wash facility should be provided in storage and general work area.

ENVIRONMENTAL:

DEGRADABILITY: Not applicable	**AQUATIC TOXICITY:** Harmful to aquatic life at concentrations greater than 500 ppm. $CaCl_2$ does not bioaccumulate $TL_m96 > 1000$ mg/1

SPILL OR LEAK (Always wear personal protective equipment):
Shovel up dry chemical and place in metal drum with cover. Cautiously spray residue with plenty of water. Keep contaminated water from entering sewers and water courses.

WASTE DISPOSAL:
Consistent with the requirements of local waste disposal authorities.

I. FIRST AID MEASURES

INHALATION:
Promptly remove to fresh air. Get medical attention.

INGESTION:
If conscious, immediately give 2 to 4 glasses of water, and induce vomiting under medical supervision.

SKIN:
Remove contaminated clothing. Wash with plenty of soap and running water. Get medical attention if irritation persists.

EYES:
Flush eyes promptly with plenty of running water, continuing for at least 15 minutes. Get medical attention.