

**DRAFT ENVIRONMENTAL BASELINE STUDIES**

**2004 PROGRESS REPORTS**

**CHAPTER 2. METEOROLOGY**

**JUNE 2005**

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# ACRONYMS

ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADOT/PF	Alaska Department of Transportation and Public Facilities
agl	above ground level
AHRS	Alaska Heritage Resource Survey
ANCSA	Alaska Native Claims Settlement Act
APE	area of potential effect
ASTt	Arctic Small Tool tradition
BBNA	Bristol Bay Native Association
BLM	Bureau of Land Management
BP	before present
<sup>14</sup> C	Carbon 14
CRM	cultural resources management
DEM	digital elevation model
EIS	environmental impact statement
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FR	Federal Register
GIS	geographic information system
GMU	Game Management Unit
GPS	global positioning system
GLM	general linear model
LIDAR	light detection and ranging
M.A.	Master of Arts
MCHTWG	Mulchatna Caribou Herd Technical Working Group
mi <sup>2</sup>	square mile(s)
MMS	Minerals Management Service
MODIS	moderate resolution imaging spectroradiometer
mph	miles per hour
NASA	National Aeronautics and Space Administration
NDM	Northern Dynasty Mines Inc.
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRCS	Natural Resource Conservation Service

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NRHP	National Register of Historic Places
NWR	National Wildlife Refuge
PSD	Prevention of Significant Deterioration
QA	quality assurance
QAPP	quality assurance project plan
SHPO	State Historic Preservation Officer
SRB&A	Stephen R. Braund & Associates
SWE	snow water equivalent
USC	United States Code
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VHF	very high frequency

## 2. METEOROLOGY

This report presents the findings of the 2004 meteorological baseline study for the Pebble Project. Baseline meteorological monitoring at the Pebble Project area was initiated at two locations during 2004. This report describes the monitoring program and outlines the limited meteorological data that were collected during 2004.

### 2.1 Study Objectives

The objective of the meteorology baseline study is to collect data needed for engineering design and environmental purposes, including water-balance studies, and for the preparation of the air-quality construction-permit applications for the mine and road/port sites. The meteorological data are being collected in accordance with Prevention of Significant Deterioration (PSD) permit requirements and guidance. Although the mine, road, and port facilities may not require a PSD permit, PSD-quality meteorological data are being collected to support the required computer-based dispersion modeling.

In addition, negotiations with affected government agencies (U.S. Environmental Protection Agency [EPA], Alaska Department of Environmental Conservation [ADEC], National Park Service [NPS], and U.S. Fish and Wildlife Service [USFWS]) may result in a requirement to collect background pollutant data. However, an initial year of meteorological data is needed to determine the location of monitoring equipment for collecting ambient air background data, if such collection is necessary.

### 2.2 Study Area

Two meteorological monitoring stations were installed in the Pebble Project area in October 2004, and are currently operating. These stations are located in the general vicinity of the mill site/ore body (Met Station No. 1) and in the vicinity of a major tailings storage site (Met Station No. 2). The location of these two stations is given in Figure 2-1. These two stations are presently collecting data for site characterization and water-management studies. The use of two stations in the mine area will provide information regarding variations within the watershed, which is important from a water-balance perspective.

These two meteorological monitoring stations are generally designed and operated consistent with PSD guidance except that the wind instrumentation at these stations is located at the 3-meter level (PSD guidance requires 10-meter wind measurements). Therefore, the wind data collected at these stations will not be used to support air permit applications.

The operation of these two stations is scheduled to continue at least through 2005. However, Northern Dynasty Mines (NDM) may elect to discontinue operation of the mill site/ore body station (Met Station No. 1) once the future PSD-quality 10-meter-tower meteorological station in the mine site area comes on line.

## 2.3 Scope of Work

Two meteorological monitoring stations were installed at the Pebble Project area during 2004. The first station (Met Station No. 1) was installed by CH2M Hill from October 6 through 10, 2004. A second met station (Met Station No. 2) was installed by Hoefler Consulting Group and Knight Piesold from October 21 through 26, 2004.

On October 15, 2004, Hoefler Consulting Group was contracted to operate and maintain both met stations. Key personnel for Hoefler Consulting Group on this study included Brian Hoefler, P.E. (senior consultant), Al Trbovich (project manager), Steve Mackey (monitoring task manager), and Eric Brudie (lead engineer/auditor). Mr. Mackey and Mr. Brudie conducted and/or supervised all station installations and field work during 2004 (with the exception of the Met Station No. 1 installation by CH2M Hill).

This meteorological baseline study was conducted according to the approach described in the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (Northern Dynasty Mines Inc., 2004). The two meteorological stations have each been equipped with identical instrumentation. The stations each monitor the following parameters:

- Wind speed.
- Wind direction.
- Standard deviation of wind direction.
- Air temperature.
- Precipitation.
- Evaporation (summer only).

In addition to operating the meteorological instrumentation, Hoefler Consulting Group also performed repairs, equipment upgrades, calibrations, audits, and maintenance for the two meteorological stations during 2004. Data review and validation were also performed on the limited data collected in 2004. These limited data will be reported in the first-quarter 2005 meteorological data report.

## 2.4 Methods

Approved procedures for collecting meteorological data, as well as background pollutant data for permitting purposes, are well documented in ADEC and EPA guidance documents. These monitoring procedures were also outlined in the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (Northern Dynasty Mines Inc., 2004).

A quality assurance project plan (QAPP) is being developed for this monitoring program. The QAPP includes the elements suggested in the ADEC quality assurance (QA) plan for meteorological monitoring and in the following ADEC guidance documents:

- *Elements for Ambient Air Monitoring Quality Assurance Project Plan (QAPP)* (September 2004).
- *Ambient Air and/or Meteorological Monitoring QAPP Checklist* (September 2004).

- *PSD Quality – Ambient Air Quality and Meteorological Monitoring Data Report Format* (Revised January 2005).

The QAPP will also be consistent with the following EPA guidance documents:

- *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* (EPA-450/4-87-07).
- *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV- Meteorological Measurements* (EPA/600/R-94/038d, April 1994).
- *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA 454/R-99-005, February 2000).

Meteorological instrumentation manufactured by Met One Instruments and Campbell Scientific was used for this study. All instrumentation meets or exceeds EPA PSD specifications for meteorological data collection, except that a wind measurement height of 3-meters is being used presently at these two met stations. The following meteorological parameters are being measured at the two stations:

- Wind speed (meters per second).
- Wind direction (degrees).
- Standard deviation of wind direction fluctuations (degrees).
- Air temperature at 2 meters (degrees Celsius).
- Total precipitation (millimeters of liquid water).
- Evaporation, summer only (millimeters of liquid water).

Evaporation measurements will start in early May because the evaporation sensors will not work in below-freezing temperatures. To allow winter precipitation measurements, the precipitation gauges are equipped with a snowfall adapter device that contains antifreeze for operation at below-freezing temperatures.

## 2.5 Results and Discussion

The two Pebble Project meteorological (met) stations were installed in October 2004. Monitoring equipment problems limited data collection during the remainder of 2004. High winds, snow and ice, and repeated freeze/thaw cycles at these sites contributed to some monitoring equipment failures. Problems and/or concerns with station dataloggers, power supplies, and data communications equipment were also identified and addressed during 2004. However, new and upgraded monitoring equipment was installed during November and December, and the stations were reliably collecting data at the end of the year.

Table 2-1 summarizes major activity during 2004 in establishing and operating these two new meteorological stations.

TABLE 2-1  
Major Meteorological Monitoring Activity During 2004

Date(s)	Activity
October 6-10, 2004	Installation of Met Station No. 1 by CH2M Hill. A radio communications repeater and base station were also installed to support remote data communications.
October 15, 2004	Hoefler Consulting Group was given authorization from NDM to assume met station operations and installation.
October 21-26, 2004	Installation of Met Station No. 2 by Hoefler Consulting Group Knight Piesold. The communication radios were also reinstalled at the Met Station No. 1, the repeater, and the base station,
November 16-21, 2004	Repairs of both stations were conducted. A solar panel was added to Met Station No. 2. Battery discharge problems and datalogger errors at Met Station No. 1 (resulting in lost data) were found and corrected. Repairs and upgrades were also made to the system's communication repeater site and base-station site. A performance audit of Met Station No. 2 was also conducted.
December 2-7, 2004	Repairs and upgrades to both met stations were conducted. A solar panel was added to Met Station No. 1. The Met Station No. 2 batteries and wind generator system were replaced and upgraded. Datalogger errors were found at both met stations, with resulting data losses. The repeater site antenna was replaced and remounted to a higher elevation. A performance audit of Met Station No. 1 was also conducted.
December 15-17, 2004	The dataloggers at both stations were replaced to address the datalogger errors experienced with the original Met One units. Failures in the radio telemetry system were investigated and traced to a corroded repeater radio, which was removed for repairs.

During the meteorological station start-up period of October through December 2004, several monitoring-station problems and concerns were identified and addressed. The problem areas identified in 2004 included station power-supply problems, station datalogger problems, storm damage and sensor icing, and data-communications concerns. Each of these areas of concern is discussed below.

The power-supply systems at both stations needed upgrades, repairs, and improvements during 2004. Each station's power supply was originally configured with three to four batteries and a wind generator for battery charging. After Hoefler Consulting assumed responsibility for the stations, solar panels were added to each station as a backup to the wind generators. All three wind generators (at the two stations and the radio repeater) failed during 2004, emphasizing the need for solar panels. The Met Station No. 2 wind generator was replaced, but the other two locations were operating with only solar battery charging at the end of 2004. Met station No. 1 experienced repeated battery discharging during its first month of operation, due to the high power consumption of wind-sensor bearing heaters (these had to be removed from the station). Another problem with the station power supply was water and blowing snow flooding the battery containers (ice chests). These power supply problems were all successfully addressed in 2004 (with further improvements in February 2005).

The original dataloggers at both stations were wired improperly by the manufacturer (Met One Instruments) and were subject to data losses whenever low battery voltage was encountered. The wiring problem caused the dataloggers to shut down even when the batteries were only partially discharged.



This wiring problem and some battery discharge problems caused the Met One dataloggers to encounter repeated low-voltage disconnects, which the datalogger could not recover from. These datalogger problems caused considerable data losses in 2004 (see Tables 2-2 and 2-3). The Met One dataloggers were finally replaced with Campbell Scientific dataloggers in December 2004 to correct the problem. The Campbell Scientific dataloggers can properly recover from a low-battery episode without losing all data. When the dataloggers were replaced, a wiring problem with the temperature sensors was encountered. This problem was not repaired until January 2005; therefore, the temperature data from December 17, 2004, thru the end of the year were not valid).

The two stations and the repeater site experienced considerable storm damage and icing problems, which were addressed in station visits during November and December. The repeater site experienced extreme rime-ice buildup, which damaged an antenna, cables, and a wind generator. Wind and blowing snow at the two stations damaged the precipitation-gauge wind screens, tipped over the Met Station No. 1 precipitation gauge, flooded the batteries, and damaged two wind generators. Ice buildup and/or blockage on the precipitation gauge was a concern at times during 2004, but was nullified by the datalogger failures (the frozen precipitation gauges were encountered only when data had been lost due to datalogger problems anyway). The wind sensors at each station also experienced periods of rime-icing freeze-up, which corrected itself within a few days. All storm damage was repaired as it was discovered in 2004, and many equipment upgrades were implemented in 2004 to reduce potential for future problems.

A substantial amount of time and resources was spent on the met-station data-communications system in 2004. Work on the communication system during 2004 included repairing storm-damaged components, extending the repeater antenna, upgrading the communication radios to a rugged waterproof model, integrating the radios to the new dataloggers, and adding a telephone modem into the base station. Concerns regarding data communications did not result in any lost data, but limited the ability to regularly review the collected met data (to properly identify and respond to any problems). Although proper data communications were not established until February 2005, much work in 2004 was spent on establishing data communications from the two met stations to Hoefler's Anchorage office.

Due to the limited amount of data collected during 2004, no summaries of meteorological data parameters have been included in this progress report. The limited 2004 data will be reported in the first quarter 2005 meteorological data report, but no analysis will be conducted because of its sporadic nature. Tables 2-2 and 2-3 present summaries of the amount of data collected at each station for each parameter during each month in calendar year 2004.

## 2.6 Summary

Two new meteorological monitoring stations were installed in the Pebble Project area during 2004 and are currently operating. These two stations are located in the general vicinity of the mill site/ore body (Met Station No) and in the vicinity of a major tailings storage site (Met Station No. 2). These two stations will provide data for site characterization and water-management studies.

The two meteorological stations were installed late in the year (October 2004), and problems with monitoring equipment limited data collection during the remainder of 2004. The high winds and repeated freeze/thaw cycles at these sites have presented challenging conditions for the meteorological

monitoring equipment. However, new and upgraded monitoring equipment was installed late in the year, and the stations were reliably collecting data at the end of calendar year 2004.

TABLE 2-2  
Meteorological Data-Collection Summary for Met Station No. 1

2004 Meteorological Data Collection (valid hours per month) — Met Station No. 1						
Month <sup>a</sup>	Wind Speed	Wind Direction	Sigma Theta	Air Temperature	Precipitation	Evaporation <sup>b</sup>
Jan 2004	--	--	--	--	--	--
Feb 2004	--	--	--	--	--	--
Mar 2004	--	--	--	--	--	--
Apr 2004	--	--	--	--	--	--
May 2004	--	--	--	--	--	--
Jun 2004	--	--	--	--	--	--
Jul 2004	--	--	--	--	--	--
Aug 2004	--	--	--	--	--	--
Sep 2004	--	--	--	--	--	--
Oct 2004 <sup>c</sup>	0	0	0	0	0	n/a
Nov 2004 <sup>c</sup>	0	0	0	0	0	n/a
Dec 2004	618	618	618	245	609	n/a

Notes:

- Met Station No. 1 was installed by CH2M Hill October 6 to 10, 2004.
- Evaporation data are collected seasonally during above-freezing temperatures.
- All Met Station No. 1 data during from October and November 2004 was were lost due to power-supply failures and datalogger errors.

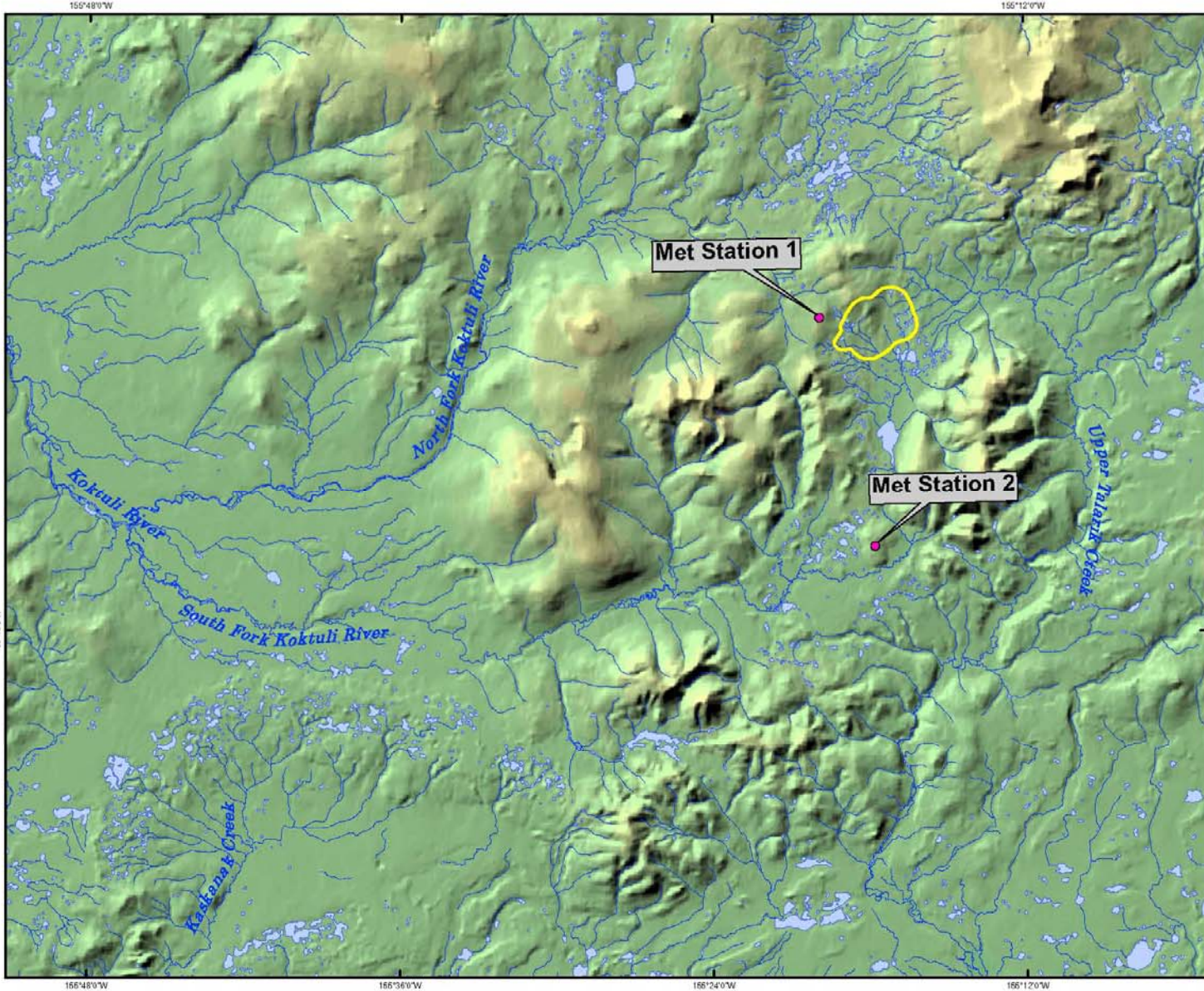
TABLE 2-3  
Meteorological Data-Collection Summary for Met Station No. 2


2004 Meteorological Data Collection (valid hours per month) - Met Station No. 2						
Month <sup>a</sup>	Wind Speed	Wind Direction	Sigma Theta	Air Temperature	Precipitation	Evaporation <sup>b</sup>
Jan 2004	--	--	--	--	--	--
Feb 2004	--	--	--	--	--	--
Mar 2004	--	--	--	--	--	--
Apr 2004	--	--	--	--	--	--
May 2004	--	--	--	--	--	--
Jun 2004	--	--	--	--	--	--
Jul 2004	--	--	--	--	--	--
Aug 2004	--	--	--	--	--	--
Sep 2004	--	--	--	--	--	--
Oct 2004	151	151	151	151	151	n/a
Nov 2004 <sup>c</sup>	397	397	397	397	397	n/a
Dec 2004 <sup>c</sup>	653	653	653	285	643	n/a

Notes:

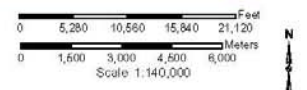
- a) Met Station No. 2 was installed by Hoefler Consulting and Knight Piesold October 21 to 26, 2004.
- b) Evaporation data is collected seasonally during above freezing temperatures.
- c) Met Station No. 2 data from 11/17/2004 to 12/4/2004 were lost due to datalogger errors.

# FIGURES



Northern Dynasty Mines Inc.  
  
**Pebble Gold-Copper Project**  
 Meteorological Station Locations  
 Figure 2-1

- Legend**
-  Orebody
  -  Meteorological Stations



Alaska State Plane Zone 5 (units feet)  
 1983 North American Datum

File: RDI_Headier_met_stations_min_11X17_top_01.mxd	Date: February 15, 2005
Version: 1	Author: RDI-DWR