Mount Nansen Snow Survey Program 2012-2013

Prepared for:

Yukon
Energy Mines and Resources
Assessment and Abandoned Mines Branch
Box 2703, K-419
Whitehorse, Yukon
Y1A 2C6

Prepared by:

EDI Environmental Dynamics Inc.
2195-2nd Avenue
Whitehorse, Yukon
Y1A 3T8

EDI Contact:

Meghan Marjanovic, B.Sc.
Meighan Kearns, B.Sc.
867-393-4882

EDI Project No:

12-Y-0129
July, 2013

2012 ENVIRONMENTAL EMPLOYER OF THE YEAR

EDI ENVIRONMENTAL DYNAMICS INC.

This page is intentionally blank.

EXECUTIVE SUMMARY

EDI Environmental Dynamics Inc. was retained in 2012 by Assessment and Abandoned Mines to implement a monthly snow survey program at the Mount Nansen site through the winter of 2012/13. This represents year 2 of the Mount Nansen Snow Survey Program and will add to the data collected by EDI during the winter of 2011/2012. The goal of the Mount Nansen Snow Survey Program was to continue to gather snow data representative of the Dome Creek drainage and waste rock pile and to investigate relationships between snow water equivalent (SWE) and elevation, aspect, and mine disturbance.

Survey methodology and study design remained the same as in 2012/13, with snow surveys conducted at snow courses within each of the six snow survey areas. The Dome Creek Valley snow survey area had ten snow courses from low to high elevation; both the south- and north-facing slope survey areas had two snow courses each, to characterize differences in aspect; the waste rock pile survey area had three snow courses to gather data for mine-disturbed areas; the meteorological station had four snow courses to aid with interpretation of the snow depth data; and the Victoria Creek airstrip survey area had one snow course to provide a comparison to the Yukon Government EMR snow survey. There were only four deviations from the 2011/12 program, as four snow course locations had to be moved due to impacts from overflow ice within the Dome Creek Valley.

Seven snow survey field visits were conducted between October 2012 and May 2013. Snow surveys were conducted with a metric Prairie Snow Sampler and spring scale to measure snow depth and SWE. All data was entered into a Microsoft Access database.

Continuous data recorded at the Mount Nansen meteorological station provided valuable information on the site conditions during the winter. Air temperature ranged from a minimum of -36.4°C in January 2013 to maximum of 18.7°C in May 2013. Snow depth ranged from 0.0 cm in October 2012 to 68.9 cm in April 2013. Average wind speeds ranged from 5.8 to 10.5 km/hour with gusting winds up to 45.7 km/hour. The predominant wind direction during the winter months was from the southwest.

Based on the survey data, monthly snow depths for the Mount Nansen site ranged from 0.0 cm in November 2012 to 61.3 cm in April 2013. Monthly SWE for the site ranged from 0.0 cm to 18.0 cm and snow density ranged from 0% to 64%. A strong relationship between SWE and elevation was difficult to define as there was variability in topography, wind and vegetation between sites along the Dome Valley transect, and the difference in elevation between sites was small. There was a difference between north- and south-facing aspects; the south-facing slopes generally had lower snow depths and snow water equivalents than the north-facing slopes. Snow data from the waste rock pile was highly variable throughout the winter and extremely wind affected. The meteorological station snow survey area was highly influenced by wind, which resulted in snow re-distribution. The resulting difference between the snow survey data and the snow sensor data was up to 48% difference for SWE.

Historical records (38 years) from the Mount Nansen airstrip (Yukon Government Water Resources and Department of Energy Mines and Resources) indicated that the winter of 2012/2013 was above average for snow depth and SWE.

ACKNOWLEDGEMENTS

EDI Environmental Dynamics Inc. (EDI) would like to thank AAM for their assistance and direction throughout the survey program, provision of the weather data, as well as their review of this report.

AUTHORSHIP

This report was prepared by EDI Environmental Dynamics Inc. The EDI staff who contributed to this project include:

Meghan Marjanovic, B.Sc., R.P.Bio ....Primary Author, Data Management

Meighan Kearns, B.Sc., R.P.Bio .... Senior Review, Data Management

Laura Grieve, B.Sc. .... GIS Mapping, Data Management

Field work was completed by the following EDI Staff: Meighan Kearns, Laura Grieve, Joel MacFabe and Danny Skookum (also of the LSCFN).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

This page is intentionally blank.

1 INTRODUCTION

In 2012, EDI Environmental Dynamics Inc. was retained by Assessment and Abandoned Mines (AAM) to implement a monthly snow survey program at the Mount Nansen site throughout the winter of 2012/13. This represents the second year of the Mount Nansen Snow Survey Program, which was initiated in the 2011/12 season.

Yukon Government (YG) Water Resources Branch (WR) and Department of Energy, Mines and Resources (EMR) have been conducting snow surveys at the Victoria Creek Airstrip (elevation: 1,021 meters above sea level [m.a.s.l.]) since 1976.

The snow surveys were designed to support the construction of a site water balance and meet water information requirements for the project proposal submission to the Yukon Environmental and Socio-Economic Assessment Board (YESAB). The goal of the 2012/13 Mount Nansen Snow Survey Program was to augment the database started in 2011, including data that better represented the Dome Creek drainage and waste rock pile area.

This report describes the study design, site descriptions, methodology, results and discussion of the 2012/13 Snow Survey Program.

1.1 STUDY DESIGN

In 2011/12 EDI worked with AAM and Lorax Environmental to design the Mount Nansen Snow Survey Program in order to better represent variation across the site. In total there were six snow survey areas selected to characterize the relationships between snow water equivalent (SWE) and elevation, aspect and disturbance (Table 1). The snow survey study area boundary was defined by the Dome Creek watershed with an additional site nearby the YG WR/EMR snow course.

Table 1. Six snow survey areas selected for the Mount Nansen Snow Survey Program.

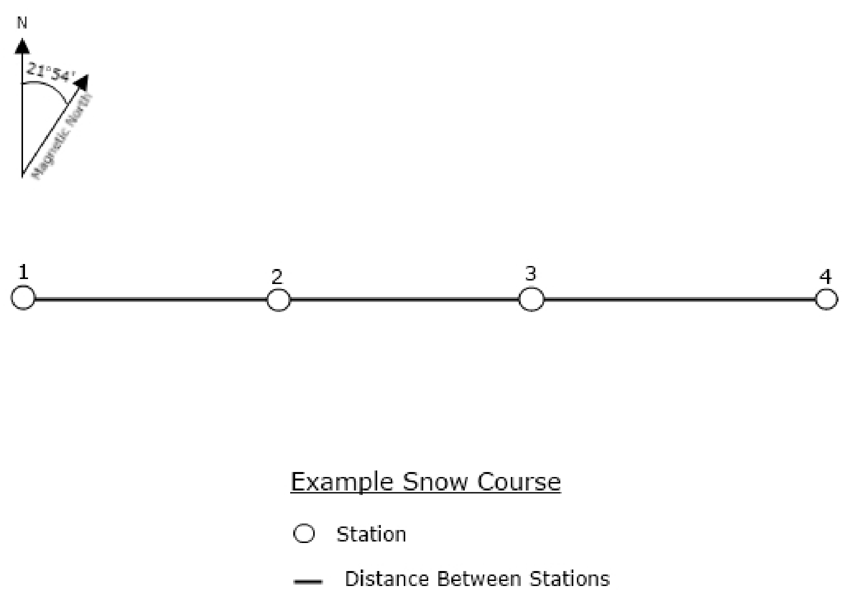
Survey Area	Rationale
Dome Creek Valley	To characterize the variability of the snowpack with respect to elevation within the Dome Creek Valley.
South-Facing Slopes	To characterize variability in snowpack associated with south-facing slope aspects in the Dome Creek Valley.
North-Facing Slopes	To characterize variability in snowpack associated with north-facing slope aspects in the Dome Creek Valley.
Waste Rock Pile	To characterize the snowpack on the waste rock pile and compare to areas undisturbed by mine activity.
Mount Nansen Meteorological Station	To validate the snow depth data collected by the sonic snow sensor at the new meteorological station.
Victoria Creek Airstrip	To estimate the difference between YG WR/EMR and EDI sampling programs, such that the Mount Nansen snowpack record may be extended using the YG WR/EMR historical dataset.

2 METHODS

Snow depth, snow density and SWE are the three most important physical properties of the snowpack. These snowpack properties vary both through time and across the landscape due to terrain, micro-climates and vegetation. Snow depth is simply the depth of the snowpack and may vary substantially through the winter season with re-distribution by wind, pack settling, melt and sublimation. Snow depth also varies from site to site depending on the presence, absence and type of vegetation. Similarly, snow density varies throughout the season, with lowest densities found in freshly fallen snow and highest densities found in settled and wind-affected snowpacks. This report describes snow density as a percentage or ratio of SWE to snow depth per unit area. SWE is related to both snow density and snow depth, and represents the equivalent depth of water of a snowpack. The Mount Nansen site is highly affected by wind and aspect, therefore SWE is an appropriate metric to characterize the snowpack as it normalizes the variability of both snow density and depth.

Numerous snow courses were established within each of the six snow survey areas (Table 1). A snow course is a transect line along which snow sampling locations are established at fixed intervals. Each snow sampling location is referred to as a station where one snow core is taken to gather snow depths and SWE on a monthly basis. A typical snow course layout has a number of stations (Figure 1).

EDI established snow courses in November and December 2011. Snow courses were situated in openings in the subalpine vegetation with limited potential for human disturbance and with some shelter from the wind, with the exception of the waste rock pile and meteorological station sites. Snow courses were marked with flagging attached to a tree, shrub or piece of rebar. Each Mount Nansen snow survey area is described in more detail in Section 2.1.



Station	Distance (m)	Bearing
1		
	2	90°
2		
	2	90°
3		
	2	90°
4		

Figure 1. Theoretical snow course diagram with four stations.

Snow surveys were conducted on a monthly basis, beginning in October 2012, and ending with a final sample collected the first week of May 2013. Note there was insufficient snow to conduct a snow survey during the October 2012 trip so snow surveys actually begun in November 2012. The airstrip snow course was only surveyed during one visit to coincide with the same time the YG EMR snow course at the Victoria Creek airstrip. General site information was recorded for each snow course station including date, time, weather conditions, snow conditions, and survey personnel.

Snow surveys were completed according to the British Columbia Ministry of Environment Snow Survey Sampling Guide (MOE 1981). At each station, snow depth, length of core[1], and SWE were recorded following MOE (1981) protocols. Cores were taken in the same general area during each survey based on spacing and orientation. Surveyors avoided taking cores from any areas where the snowpack had been disturbed, avoiding core holes from previous trips, snowshoe trails, and wildlife tracks.

SWE and snow density were calculated and averaged for each snow course. Snow cores at each snow course were generally collected along a contour line, and bearings and distances between cores were recorded. Snow survey personnel wore snowshoes to access the sites. All data was recorded on a standard form developed by EDI (based on MOE 1981) and then entered into a database (Microsoft Access) created specifically for this project. A quality assurance and quality control program was carried out on the database, which involved doing a comparison of the data entered in the database to the data recorded on the data entry form as well as reviewing all calculations.

SWE measurements were obtained using the gravimetric method (MOE 1981). The historical data from YG WR/EMR indicated that the snowpack at Mount Nansen was less than 1 m deep; therefore, EDI used a metric Prairie Snow Sampler, designed for shallower snowpacks less than 1 m (based on the ESC 30 design). A spring scale was used for the snow course surveys. YG WR/EMR uses a Standard Federal Sampler to monitor snowpack at the Mount Nansen station (09CA-SC01). The Prairie Sampler used by EDI has a wider base (30 cm^2 cutting area) which is less prone to over-measurement than the Standard Federal Sampler, which over-measures SWE by 10% (Goodison *et al.* 1987). Goodison et al. (1987) provide a correction factor (CF = 0.91) for the Standard Federal sampler, which was used to compare the YG WR/ EMR measurements to the EDI measurements.

2.1 SITE DESCRIPTIONS

A description of each snow survey area and snow courses is provided in the following sections. Table 3 provides a summary of snow courses and stations by survey area. Detailed location information is included in Appendix A.

Table 2. Summary of snow course details including number of stations and cores taken per station.

[1] **Snow depth** is measured while the coring tube is vertical in the snowpack whereas the **length of core** is measured after the coring tube is removed from the pack. The **length of core** measurement ensures the full core is removed from the snowpack for gravimetric measurement; however, the length of core is typically less than the snow depth as it can be compressed by the coring process, particularly in low density snowpacks.

Snow Survey Area	No. of Snow Courses	Snow Course Names	No. of Stations per Course	Total No. of Cores
Dome Valley Transect	10	SC-DC-1b to 10	4	40
North Facing	2	SC-NF-1 to 2	5	10
South Facing	2	SC-SF-1 to 2	5	10
Waste Rock	3	SC-WR-1 to 3	3	9
Meteorological Station	4	SC-MET-1 to 4	3	12
Airstrip Replicate	1	SC-AIR	5	5

2.1.1 Dome Creek Valley

The Dome Creek Valley snow survey area included ten snow courses along Dome Creek ranging in elevation from 1,022 m.a.s.l. (SC-DC-1) to 1,225 m.a.s.l. (SC-DC-10; Figure 2). Snow courses in this transect were spaced approximately 350 m apart, with four stations per course (i.e., one snow core per station; Table 2). The snow courses were located in relatively undisturbed and sheltered locations along the valley bottom.

There were some deviations in snow course locations from the 2011/12 program in the Dome Creek Valley; three snow courses were moved to areas out of the influence of aufeis accumulation in 2012/13. Aufeis development in the Dome Creek valley had caused some issues in data quality during the 2011/12 program and minor adjustments in sampling protocol (*i.e.* shifting the core location short distances within the snow course) were made. As aufeis formation started at the beginning of October in 2012/13, EDI recommended that the affected snow courses should be relocated to more suitable locations to enhance overall data quality for the year. The new locations were not expected to have any measurable effects on the final results. These snow courses were renamed with a 'b' at the end. Table 3 provides a description of each snow course, including the courses that were moved in 2012/13.

Table 3. Snow course description for the Dome Creek Valley snow survey area.

Snow Course	Description
SC-DC-1b	This snow course was moved to higher ground for the 2012/13 Snow Survey Program, outside of the influence of the aufeis within the Dome Creek Valley. The snow course was moved 95 m northwest of the previous location. It is the lowest elevation snow course within the watershed, located downstream of the Mount Nansen Road in an open forest.
SC-DC-2b	This snow course was moved to higher ground for the 2012/13 program, outside of the influence of the ice within the Dome Creek Valley. The snow course was moved 50 m south of the previous location. Located just downstream of the Mount Nansen Road in an open area vegetated with shrubs and poplar.
SC-DC-3	Located just upstream from the Mount Nansen Road.
SC-DC-4	Located approximately mid-way between the Mount Nansen Road and the seepage pond area. Area is mostly open sub-alpine vegetation with scattered spruce trees.
SC-DC-5	Located downstream of the seepage pond area, above the creek on the right downstream bank. Area is mostly open sub-alpine vegetation with scattered spruce trees.
SC-DC-6	Located east of the seepage pond in an open, grassed area (previously disturbed area).
SC-DC-7	Located west of the tailings pond in an open, grassed area (previously disturbed area).
SC-DC-8b	This snow course was moved to higher ground for the 2012/13 program, outside of the influence of the ice within the Dome Creek Valley. It is located upstream (west) of the tailings pond in sparsely vegetated, sub-alpine forest.
SC-DC-9	Located downstream (east) of the mill along the edge of the transmission line. Shrub cover and grass for vegetation (previously disturbed area).
SC-DC-10	Located upslope from the mill.

2.1.2 North- and South- Facing Slopes

The north- and south-facing snow courses were each established at a mid-valley location around the tailings pond (SC-SF-1 elevation 1,134 m.a.s.l. and SC-NF-1 elevation 1,117 m.a.s.l.) and an upper-valley location near the mill (SC-SF-2 elevation 1,186 m.a.s.l. and SC-NF-2 elevation 1,232 m.a.s.l.; Figure 2). Each snow course had five stations where cores were taken, which followed along the topographic contour (Table 2). The south-facing slopes were more sheltered with larger trees, while the north-facing slopes had smaller, stunted vegetation and more exposure to the wind and thus experience more wind re-distribution and wind loading. Table 4 provides a description of each snow course.

Table 4. Snow course description for the north- and south-facing snow survey area.

Snow Course	Description
SC-SF-1	This snow course is located on a gentle slope, up above the northeast end of the tailings pond, in a sheltered open mature spruce forest.
SC-SF-2	This snow course is located higher in the watershed, northeast of the mill area, in an open sub-alpine spruce forest.
SC-NF-1	This snow course is located south of the tailings pond on a gentle slope, in open sub-alpine shrubland with sparse, stunted spruce trees.
SC-NF-2	This snow course is located south of the mill area on a moderate slope, in open sub-alpine shrubland with sparse, stunted spruce trees.

2.1.3 Waste Rock Pile

Three snow courses were established on the waste rock pile near the open pit on the lower, middle and top benches (SC-WR-1 elevation 1,191 m.a.s.l., SC-WR-2 elevation 1,212 m.a.s.l., and SC-WR-3 elevation 1,214 m.a.s.l.; Figure 2). Each snow course had three stations (Table 2). All three snow courses were located in exposed locations subject to wind related snow transport processes: ablation, re-distribution and scouring. Table 5 provides a description of each snow course.

Table 5. Snow course description for the waste rock snow survey area.

Snow Course	Description
SC-WR-1	This snow course is located on a lower bench of the waste rock pile. The ground surface is mostly sand and gravel, and the site faces south west.
SC-WR-2	This snow course is located on the middle bench of the waste rock pile. The ground surface is made up of large cobble and boulders, and the site faces southwest.
SC-WR-1	This snow course is located on the top of the waste rock pile, above the pit lake. The ground surface is made up of sand and gravel with the occasional large cobble or boulder.

2.1.4 Meteorological Station

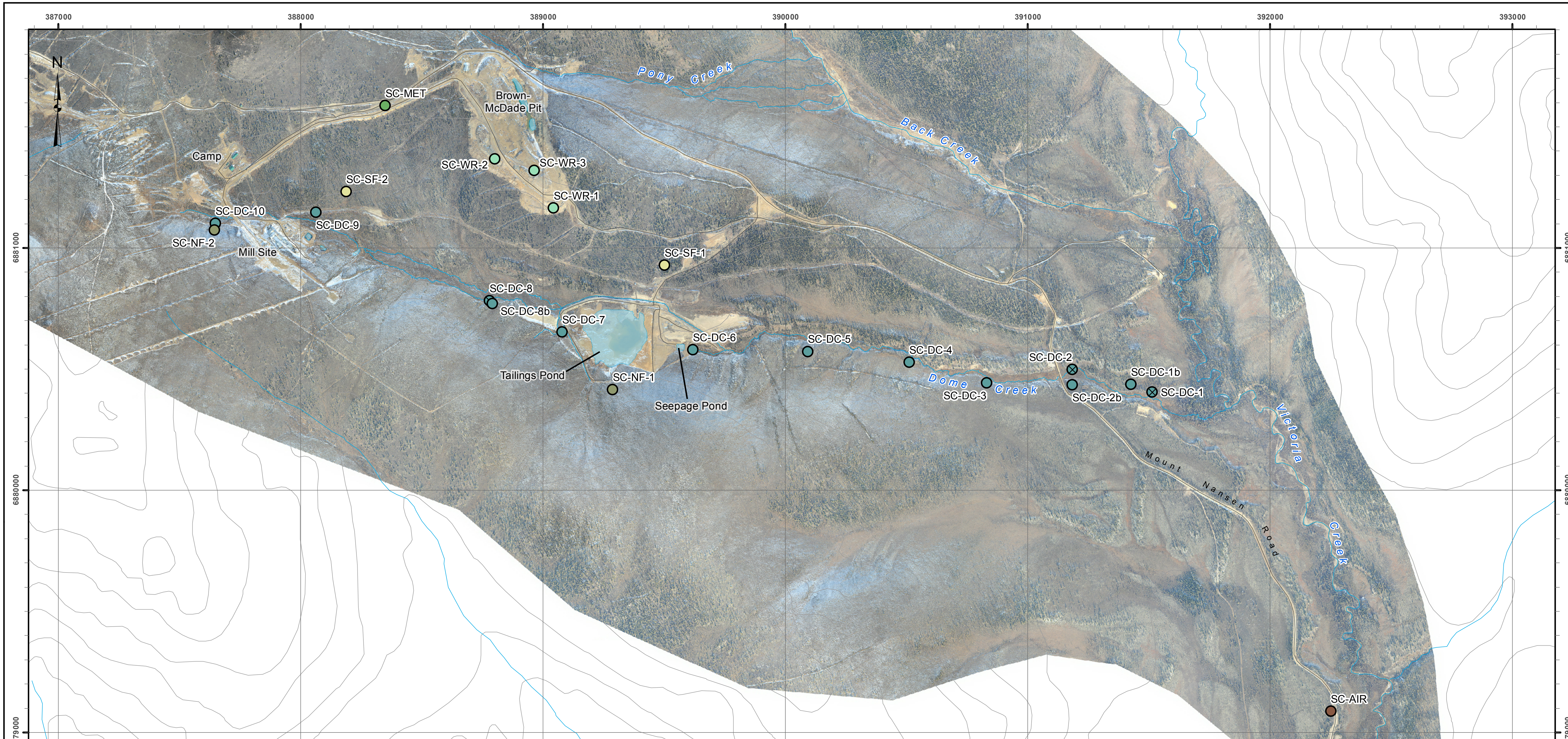
Four snow courses were established at the meteorological station (SC-MET-1 to 4; Figure 2). Snow courses extended in a line off the southwest side of the meteorological station. Each snow course was made up of three core stations in a cluster.

Each snow course had three stations where cores were taken (Table 2). These sites had some shelter provided by low vegetation, but were still exposed to wind. The Mount Nansen access road bordered the north edge of the snow courses.

The Mount Nansen site meteorological station is located in a clearing at 1,248 m.a.s.l on the north side of the Dome Creek watershed immediately downslope of the Mount Nansen Road. The station includes a snow cover depth sensor which was installed on October 17, 2011. The snowcover depth sensor is a sonar based system (SR50A Sonic Ranging Sensor, Campbell Scientific), where ultra-sonic pulses are emitted downward from a fixed mast elevation 1.975 m above the ground surface. The wind speed and wind direction sensors are located 9.5 m above the ground surface. The sensor uses air temperature to calculate the speed of sound in air which is used to calculate the distance to the top of the snowpack (spatially averaged over target area). The limitations of the sensor include anomalous measurements during falling or blowing snow, and the sensor cannot distinguish between newly fallen and low density snow. Under ideal conditions, the snow cover depth measurement has a measurement accuracy of +/-1 cm or 0.4% of the distance to the target, whichever is greater.

2.1.5 Airstrip

The Victoria Creek airstrip snow course (SC-AIR, elevation 989 m.a.s.l.) replicate site was established near the same terrace as the Mount Nansen snow course monitored by YG WR (09CA-SC1, elevation 1,021 m.a.s.l.). The replicate snow course had five stations where cores were taken during one survey visit during the April 2013 visit, at the height of the snowpack (Table 2).



Overview of Snow Course Locations at the Mount Nansen Site

Legend

- Airstrip
- Meteorological Station
- North Facing
- South Facing
- Valley Transect
- Waste Rock Pile
- × Discontinued Sampling Station
- Unpaved Road/Access
- Contours
- Watercourse
- Waterbody (pit pond and tailings)

1:250,000 topographic spatial data: Canvec and National Topographic Database (NTDB); courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Digital Elevation Model provided by Geomatics - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

Project data displayed is site specific. Data collected by EDI Environmental Dynamics Inc. (2012) was obtained using Garmin GPS technology.

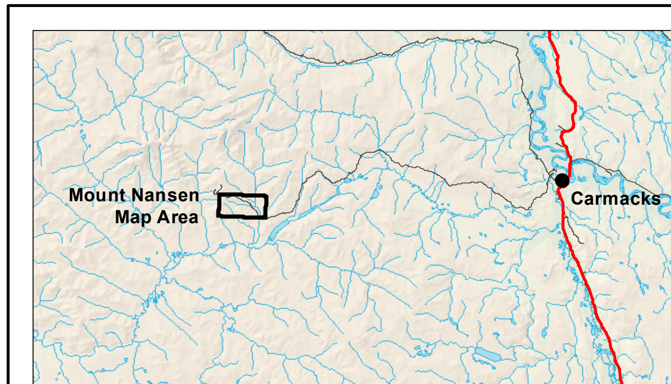
This document is not an official land survey and the spatial data presented is subject to change.

0 200 400 600 800 1,000

metres

Map Scale = 1:16,000 (printed on 11 x 17)
Map Projection: North American Datum 1983 UTM Zone 8N

Drawn:	Checked:	FIGURE 2	Date: 22/07/2013
LG	LD/MM		



Path: J:\Yukon\Projects\2012\12_Y_0129_AAM_Nansen_WQ_Hydro_Snow\Mapping\Fig2_SnowSurveySites_10June2013.mxd

3 RESULTS

3.1 WINTER METEOROLOGICAL SUMMARY

The data downloaded from the Mount Nansen meteorological station provided a continuous record of snow depth, air temperature, and wind speed and direction over the winter season. The data was recorded on hourly intervals and is summarized below.

Air temperature at the station ranged from a minimum of -36.4°C in January 2013 to a maximum of 18.7°C in May 2013 (Table 6). On average, December 2012 was the coldest month during the sampling period and May 2013 the warmest. Snow depth at the meteorological station ranged from a minimum of 0.0 cm in October to a maximum of 68.9 cm in April (Table 6). The highest monthly average snow depth was for April 2013 at 64.0 cm. Average monthly wind speeds at the station ranged from 5.8 km/hour to 10.5 km/hour, with gusting winds up to a maximum of 45.7 km/hour (recorded on April 9, 2013 at 18:00). The prominent wind direction over the 2012/13 winter season was from the southwest (Figure 3). Appendix B provides detailed figures of hourly and monthly meteorological data.

Table 6. Average monthly air temperature, snow depth and wind speed at the Mount Nansen meteorological station from October 2012 to May 2013.

Parameter		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
Air Temperature (°C)	**Mean**	**-6.2**	**-16.6**	**-18.4**	**-13.2**	**-8.4**	**-10.9**	**-7.7**	**4.4**
	Min	-17.8	-24.9	-32.1	-36.4	-17.3	-24.6	-18.0	-9.3
	Max	13.4	-2.9	-0.6	3.9	0.6	0.9	2.6	18.7
Snow Depth [1] (cm)	**Mean**	**3.8**	**23.2**	**41.4**	**47.5**	**56.4**	**59.4**	**64.0**	**15.2**
	Min	0.0	11.9	26.5	42.4	49.3	56.8	59.2	0.0
	Max	19.9	31.3	57.3	51.7	61.6	62.2	68.9	67.6
Wind Speed (km/hour)	**Mean**	**6.7**	**5.8**	**6.4**	**6.6**	**6.8**	**6.8**	**9.7**	**10.5**
	Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Max	26.3	20.9	29.5	37.7	41.4	29.0	45.7	34.8

[1] The snow depth data was adjusted -2.9 cm to reflect mean observed offset with barren ground at the end of winter.

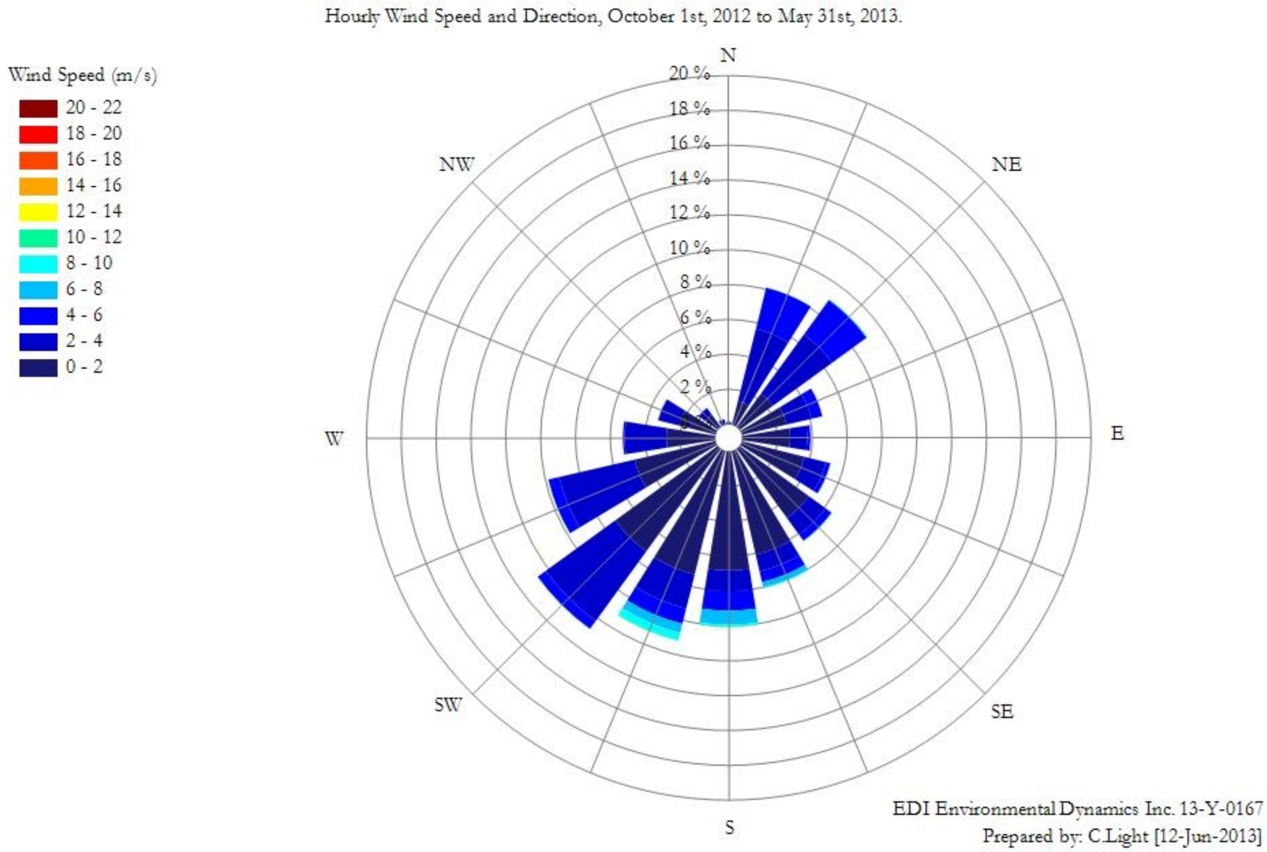


Figure 3. **Winter season wind direction, magnitude, and frequency (percent time) recorded at the Mount Nansen meteorological station (el. 1,248 m.a.s.l.) between October 1, 2012 and May 31, 2013.**

3.2 SNOW SURVEY RESULTS

EDI conducted snow surveys on a monthly basis from November 2012 to May 2013. An attempt was made to conduct the first snow survey in October 2012, but insufficient snow had accumulated and a snow survey could not be conducted. Based on all stations in the Snow Survey Program, the average snow depth for the Mount Nansen site for the 2012/13 program ranged from 0 cm in November to 61.3 cm in March (Appendix C). Snow depth peaked in March for most snow courses, with a smaller amount of snow courses peaking in April. There was no detectable trend to explain why some snow courses peaked in April versus March, as these courses were scattered around the mine site, two on the Dome Creek Valley transect, one on a north facing slope and the other on the waste rock pile.

Average SWE for the site ranged from 1.5 cm in November to 18.0 cm in April. Average snow density for the site ranged from 6% in November to 64% in May. Variability between snow courses is associated with spatial factors such as elevation, aspect, vegetation and ground surface topography. Overlapping with these factors is the interaction of the landscape surface with local meteorology. The resultant snowpack reflects both snowfall amounts and the site specific micro-climate. Results for individual snow survey areas are described in more detail below with data provided in Appendix C.

3.2.1 Dome Creek Valley

Average snow depth for the Dome Creek Valley snow courses ranged from 11.8 cm in November at SC-DC-8 to 60.3 cm in March at SC-DC-10 (Appendix C). Snow water equivalent ranged from 1.5 cm at SC-DC-8 in November to 14.0 cm at SC-DC-10 in May (Figure 4). Snow density ranged from 13% in November at SC-DC-8 to 60% at SC-DC-8b in May.

The Dome Creek Valley snow survey was designed to characterize snowpack-elevation relationships. Results indicated that influences of micro-climates, slope position and the relative openness of the tree cover were important factors.

Across the Dome Creek Valley transect there was only a 203 m difference in elevation. Some snow courses had less than a 10 m difference in elevation between them, although they were at least 350 m apart. The low magnitude of difference in elevation between snow courses, combined with the high degree of site variability in terms of topography, vegetation, and resulting wind patterns, confounds any potential relationship between elevation and SWE. Some sites were more exposed compared to others, for example SC-DC-4 was located in a relatively sheltered, undisturbed location, whereas SC-DC-7 was located in a relatively more disturbed area, open and exposed to the wind.

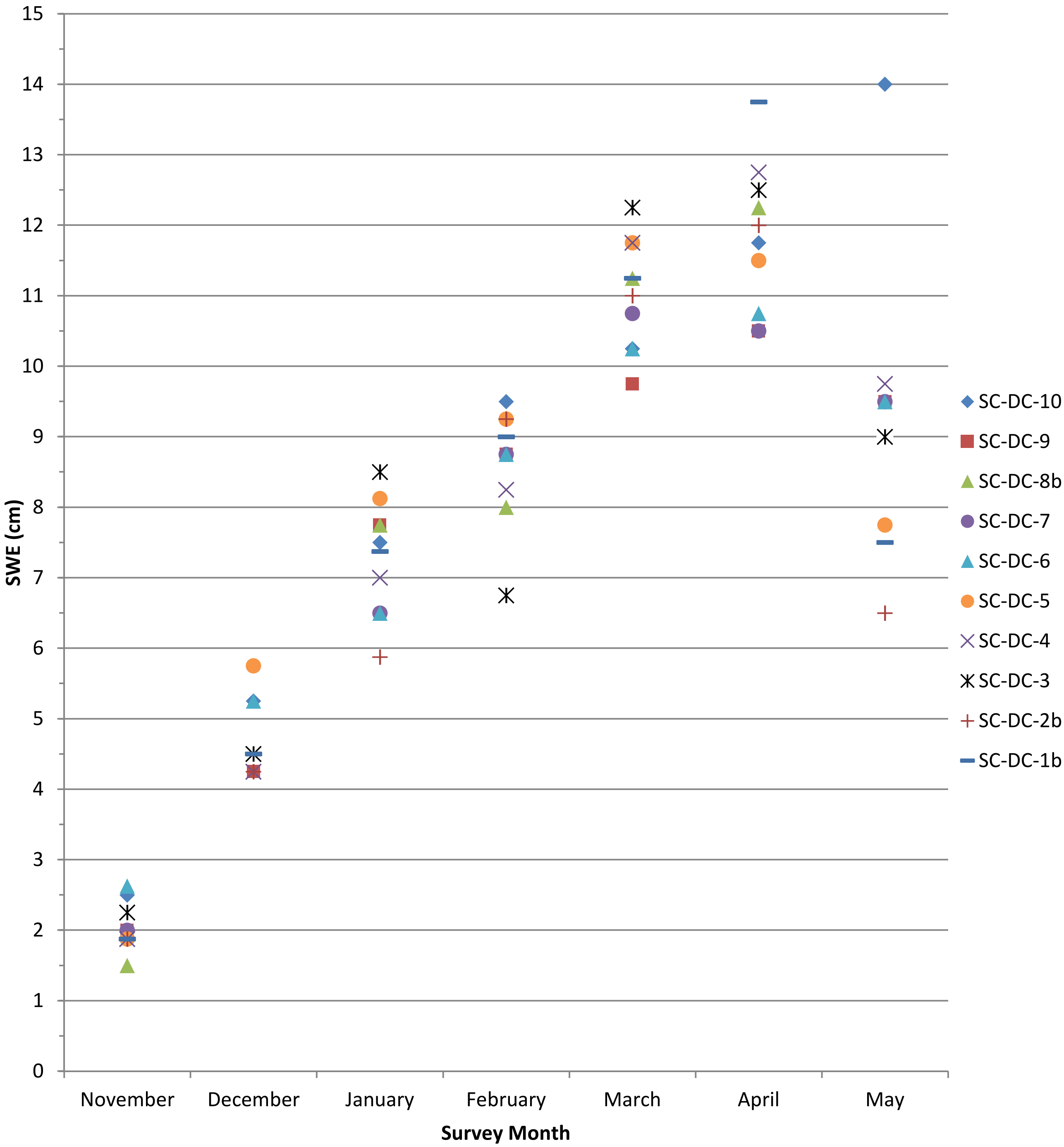


Figure 4. SWE for snow courses along the Dome Creek Valley from November 2012 to May 2013.

3.2.2 North- and South-Facing Slopes

Average snow depth for the north-facing slopes ranged from 9.8 cm in November to 59.2 cm in April (Appendix C). Average snow depths for the south-facing slopes were slightly lower, ranging from 12.6 cm in November to 55.0 cm in March (Appendix C). Snow density ranged from 20% to 56% for the north-facing slopes and 15% to 64% for the south-facing slopes throughout the winter. SWE for the north-facing slopes ranged from 2.0 cm to 18.0 cm and for the south-facing slopes from 2.0 cm to 12.2 cm (Figure 5). Snow depth and SWE decreased considerably on the south-facing slopes from April to May, whereas there was a much more gradual decline in SWE and snow depth on the north-facing slopes (Figure 5). Based on field observations and the meteorological data, the characteristics of the snowpack with respect to aspect appears to be related to both wind exposure (i.e., wind loading and re-distribution), tree cover (i.e., more trees are present on the south aspects) and direct solar radiation (i.e., melt).

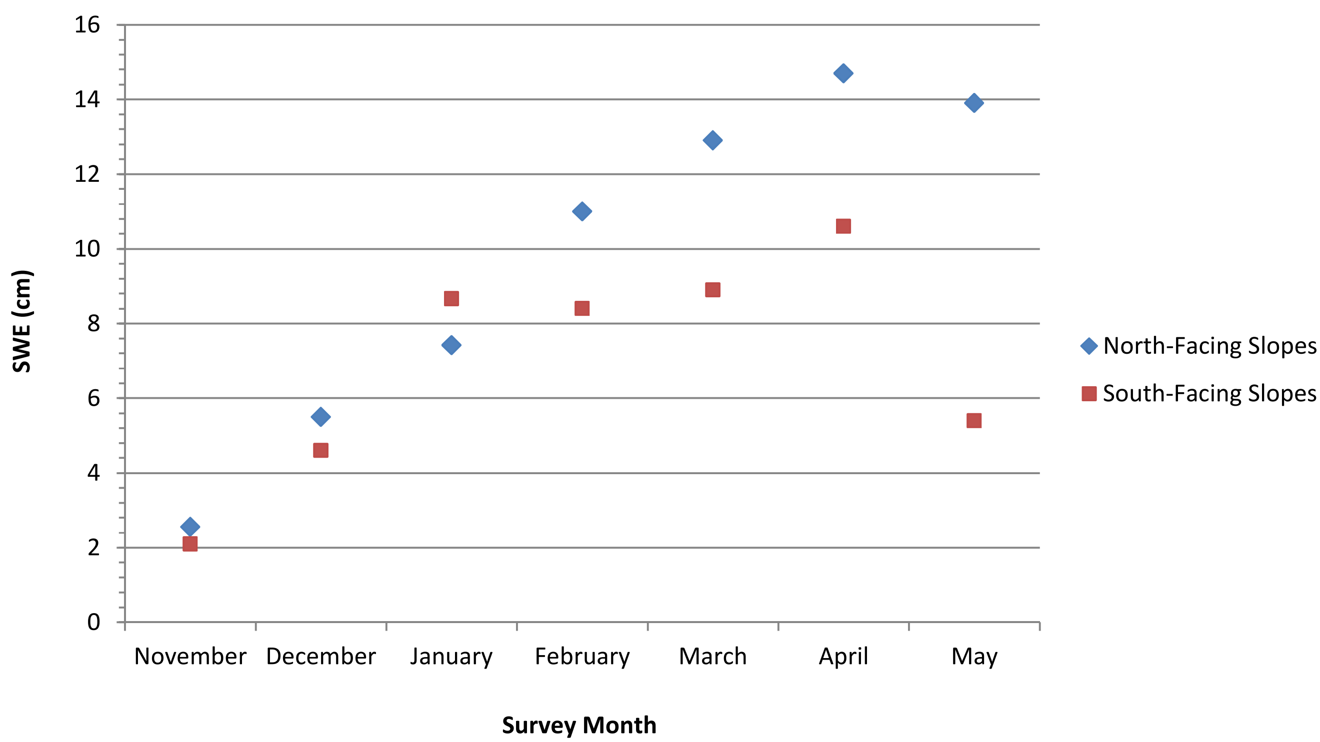


Figure 5. SWE for the north- and south-facing slope snow courses from November 2012 to May 2013.

3.2.3 Waste Rock Pile

The average snow depth for the waste rock snow courses ranged from 15.3 cm in November to 56.3 cm in March (Appendix C). Average SWE equivalent ranged from 2.2 cm to 15.7 cm (Figure 6) and snow density ranged from 11% to 48%.

There was considerable variability in snow depths, SWE, and snow densities between the three waste rock snow courses. The SC-WR-2 snow course, located on the middle elevation bench of the waste rock pile, had higher SWE and snow depths compared to the other two waste rock snow courses (Figure 6). This snow course was oriented towards the west aspect and had more uneven ground surfaces with depressions and large rocks compared to other locations on the pile (southerly aspects).

The waste rock pile snow survey area was included in this study to investigate potential differences in SWE between mine-disturbed areas and undisturbed areas. For this purpose, the waste rock data was compared to the south-facing slope data, as they were located at similar elevations and aspects. When SWE from both study areas were compared, the data showed similar trends (Figure 7); however, the waste rock snow courses showed greater variability through the winter (Figure 7). This may suggest that mine-disturbed areas are subject to much greater snowpack variability due to the effects of wind; whereas, undisturbed areas show less variability through the winter.

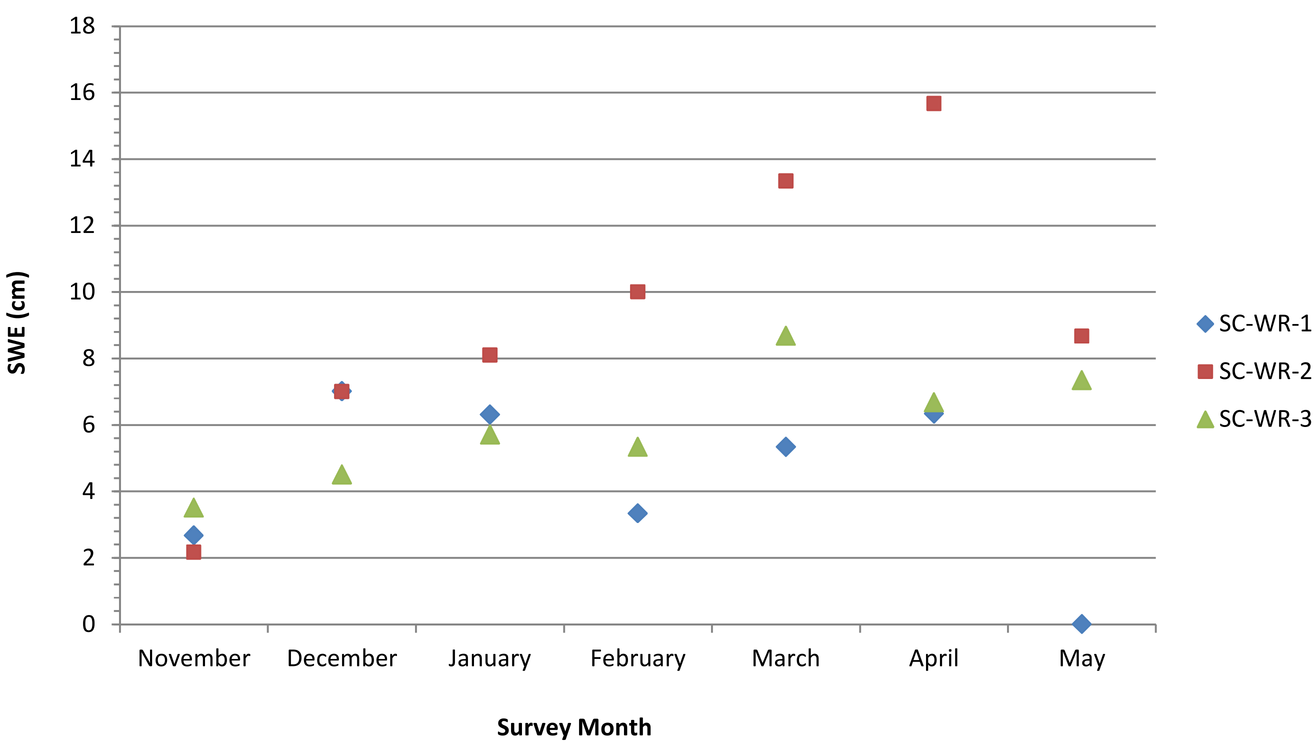


Figure 6. SWE for the three waste rock pile snow courses from November 2012 to May 2013.

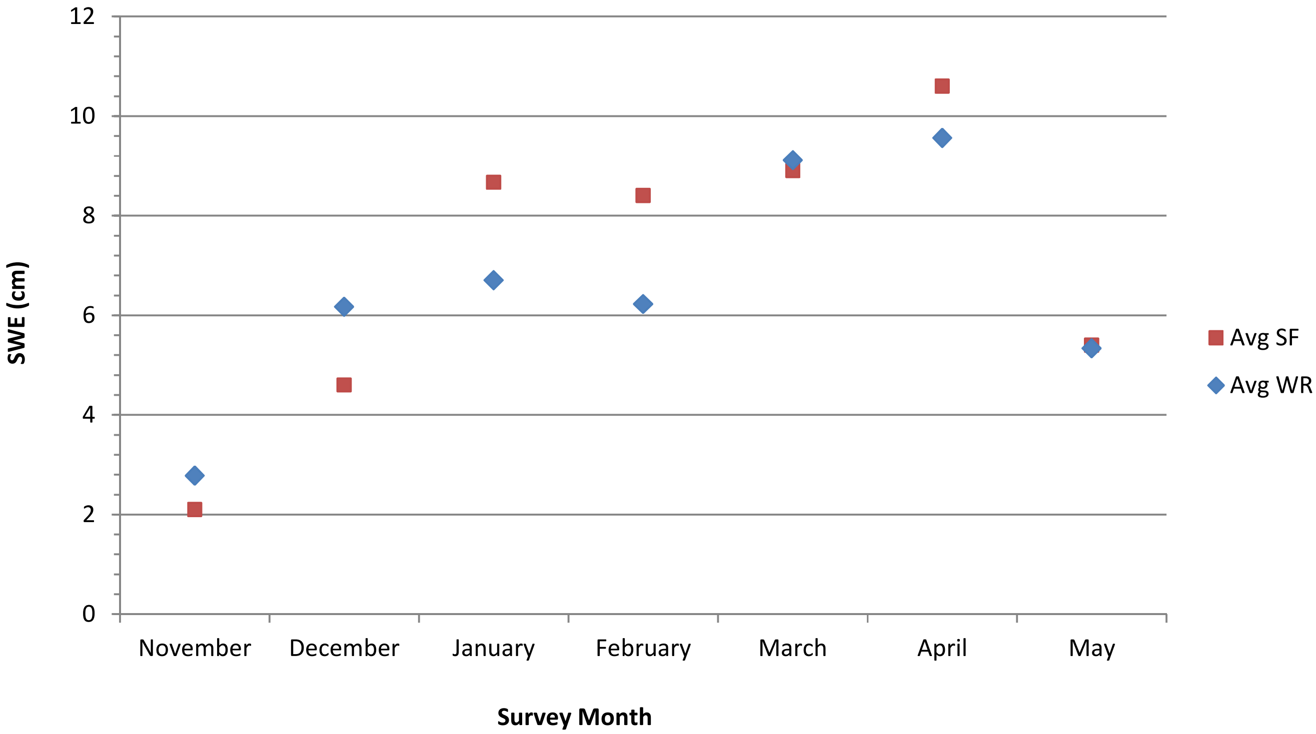


Figure 7. Average SWE for mine disturbed areas (waste rock snow courses) compared to undisturbed areas (south-facing snow courses) from November 2012 to May 2013.

3.2.4 Meteorological Station

Average snow depth at the SC-MET snow courses ranged from 10.0 cm in November to 59.8 cm in April (Appendix C). SWE ranged from 1.5 cm in November to 13.5 cm in April and snow density ranged from 8% in November to 52% in May.

Snow survey data was compared to the sensor data for the same date as the monthly surveys. The snow sensor snow depth data was converted to SWE based on the average monthly snow density for the meteorological station snow course (Table 7). This assumes that the snow density at the sensor is similar to that from the SC-MET snow course and functions to normalize the data for analysis (Figure 8).

The general equation for SWE is: *SWE = snow depth * snow density*

The SWE values for the snow sensor and SC-MET snow survey were most similar during the months of November, March and April with a 10%, 3% and 4% difference (Table 7). The differences become more pronounced through the winter with a 22% to 48% difference from December 2012 to February 2013. The estimated SWE value at the snow sensor was always higher than the average SWE from the SC-MET snow courses (Figure 8).

These differences are partly interpreted to be the result of sampling location and method, as the snow sensor collects data at a static location, while the average of the snow courses is based on the sampling of 12 different core locations across a 6 m distance. The snow course data is therefore subject to among site variability as core locations may experience different micro climates. The meteorological station is located in a relatively exposed location, on an open bench, which faces south, and is adjacent to the Mount Nansen Road. There is a windrow of shrubs and trees on the southern perimeter but the area is still subject to winds and regular re-distribution of snow. There is also measurement error with the SC-MET snow course as 12 cores are surveyed and then averaged. Also because there are a large number of core locations constrained to a small survey area, which are then sampled on a monthly basis, the area has experienced relatively high amounts of disturbance, which may affect the snowpack being sampled.

Table 7. Estimated SWE for the meteorological station based on snow depth measured by the snow sensor and the assumed snow density from the SC-MET snow course, compared to the SWE at the SC-MET station (snow sensor snow depth values are corrected with the -2.9 cm offset).

Survey Dates	Sensor Snow Depth (cm)	Assumed Snow Density at Sensor (%)	SWE		% difference in SWE
			Estimated SWE at Sensor (cm)	SWE at SC-MET (cm)	
13-Nov-12	21.9	8%	1.7	1.5	10%
10-Dec-12	36.5	19%	7.1	5.5	22%
15-Jan-13	45.3	30%	13.7	7.1	48%
12-Feb-13	56.2	30%	16.9	10.0	41%
12-Mar-13	61.5	21%	13.0	12.6	3%
16-Apr-13	62.3	23%	14.1	13.5	4%
06-May-13	34.2	52%	17.9	11.5	36%

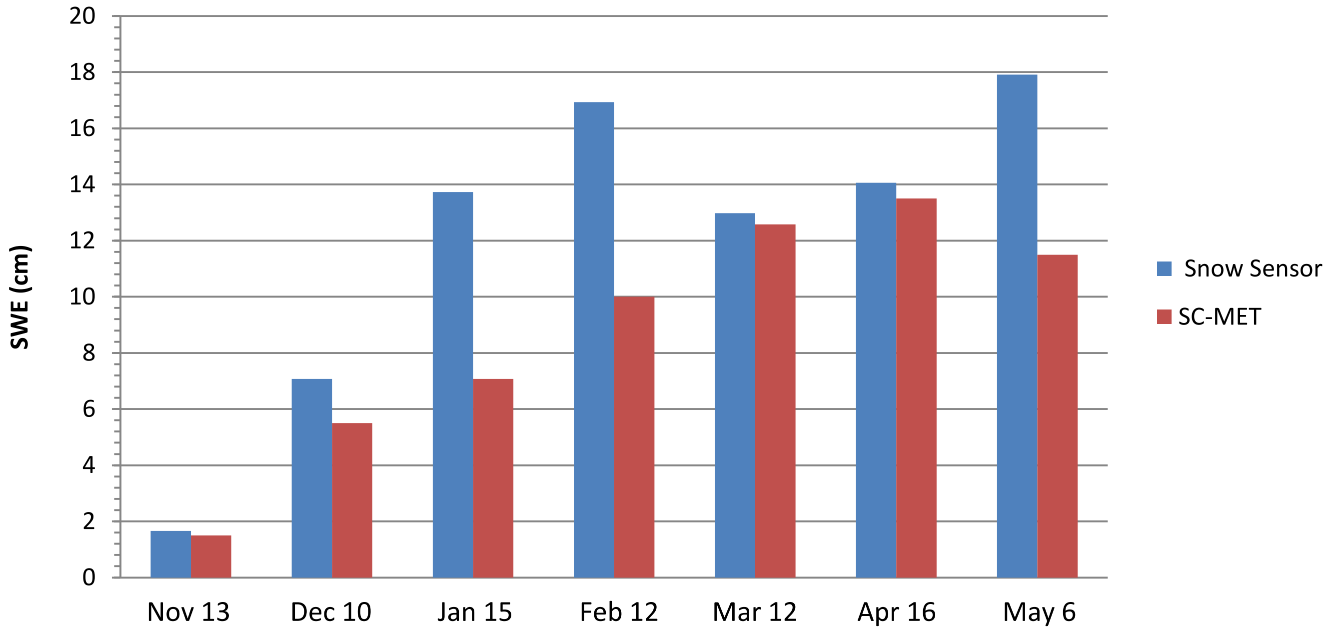


Figure 8. Comparison between estimated SWE for the meteorological station snow sensor and average SWE for the SC-MET snow course.

3.2.5 Mount Nansen Airstrip

EDI conducted one snow survey of the SC-AIR snow course on April 16, 2013. YG WR/EMR conducted their Mount Nansen snow survey at the Victoria Creek airstrip (09CA-SC1) on February 25, March 26 and April 29, 2012. The April 29/April 16 pairing are considered sufficiently close to be compared. The sampling locations and snow core sampler used by EDI were not the same as YG; however assumptions and corrections are described below:

- The YG snow course is located near the airstrip and was approximately 450 m southeast of the SC-AIR snow course established by EDI closer to the Mount Nansen Road. Both snow courses are at similar elevations in relatively open forest with relatively flat topography, therefore aspect and wind exposure are similar at both sites.
- YG uses a Standard Federal Sampler for their snow surveys, which required that a correction factor of 0.91 (Goodison *et al.* 1987) be applied to all SWE data collected by YG in order to compare it to data collected by EDI with a Metric Prairie Sampler.
- The YG snow course includes ten snow cores taken at 15 m intervals, while the EDI SC-AIR snow course included five cores taken at 2 m intervals.

Measurements collected by YG (09CA-SC1) and EDI (SC-AIR) were summarized and compared (Table 8). The April 29, 2013 measurement (YG, SWE = 9.5 cm) and the April 16, 2013 measurement (EDI, SWE = 9.4 cm) are reasonably similar considering the variability among sites observed elsewhere in the Mount Nansen Snow Survey Program. The average snow depth measurements are quite different

Table 8. Comparison of snow data between YG and EDI data collected in 2012/13 (correction factor was applied to YG SWE data).

Snow Survey Station	Date	Average SWE (cm)	Average Snow Depth (cm)
YG – 09CA-SC1	25-Feb-13	9.1	61.0
	26-Mar-13	9.6	58.7
	29-Apr-13	9.5	61.0
EDI – SC-AIR	16-Apr-13	9.4	49.2

3.2.5.1 Historical Comparison

For comparison to historical data collected by YG WR/EMR since 1976, the 2012/13 season was above average for snow depth and SWE (Table 9; Figure 9); however, slightly below the values for the last five years (2008-2012). The SWE for the SC-AIR snow course in 2013 was also above average (Table 9).

Table 9. SWE and snow depth for the YG (09CA-SCI) Victoria Creek Airstrip snow course, comparing the 2013 surveys with the 38-year average for the snow course (correction factor has been applied to all SWE data).

YG Survey	2013 Survey		38-Year Average	
	SWE	Snow Depth	SWE	Snow Depth
25-Feb-13	9.1	61.0	6.2	43.1
26-Mar-13	9.6	58.7	7.4	45.8
29-Apr-13	9.5	61.0	1.9	9.6

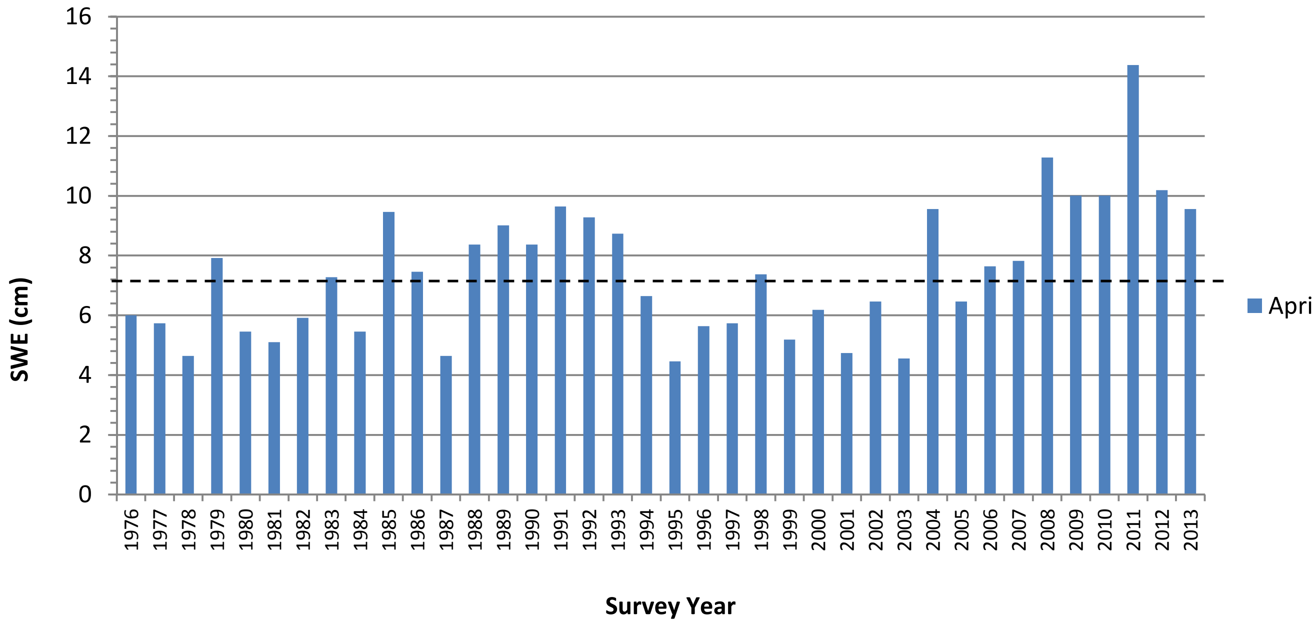


Figure 9. **Historical SWE for the YG (09CA-SC1) Victoria Creek Airstrip snow course from 1976 to 2013 for the April surveys (correction factor applied). The dashed line is the 38-year average SWE for the snow course.**

4 CONCLUSIONS

The 2012/13 Mount Nansen Snow Survey Program has provided an additional year of site specific and detailed data for snow depth, SWE and snow density across the Mount Nansen site. During the winter of 2012/13 there was a high degree of variability at the site. All snow survey parameters are highly influenced by wind and sun angle effects, which are in turn related to aspect, topography, and vegetative cover.

Similar results were seen in the 2012/13 program compared to the 2011/12 program. No strong relationship between elevation and SWE was identified. As noted previously, this may be related to the relatively small difference in elevation among stations along the Dome Creek Valley as well as the variability in topography, vegetation, and site disturbance along the transect.

When comparing north- and south-facing slopes, snow depth and SWE were lower at the south-facing stations, likely due to wind exposure, tree cover and direct solar radiation.

A comparison of mine-disturbed and undisturbed areas suggest the mine-disturbed areas were subject to much greater variability in snow depth, SWE and snow density throughout the winter due to higher wind exposure.

The meteorological station snow course was also subject to a high degree of variability due to wind exposure. This led to differences of up to 48% between the snow survey data and the snow sensor data throughout the winter. Differences between the snow survey and snow sensor data were attributed to sampling location, the number of cores, and the fact that the snow survey was constrained within a small area. This caused the snow survey area to become cumulatively disturbed with each subsequent monthly survey. In hindsight this snow course likely had an overabundance of core locations, and if surveying were to continue at this location a re-design of the snow course is advised with less cores taken.

The SWE value measured at the SC-AIR snow course was similar to those collected by YG in 2012/13, which was found to be above average compared to the 38-year average for the YG snow course. The snow depth data was also above average in 2012/13 for the area.

5 REFERENCES

5.1 LITERATURE CITED

Ministry of Environment [MOE]. 1981. Snow Survey Sampling Guide. Surface Water Section, Water Management Branch, Ministry of Environment, Province of British Columbia. Parliament Buildings, Victoria, BC. V8V 1X5. SS13-81. 27 pp.

Goodison, B.E., J.E. Glynn, K.D. Harvey, and J.E. Slater. 1987. Snow surveying in Canada: a perspective. Canadian Water Resources Journal, Vol. 12(2): 27-42.

5.2 SPATIAL DATA

1:50,000 CanVec topographic data from Government of Canada, Natural Resources Canada, Earth Sciences Sector, Centre for Topographic Information. Geogratis website (http://geogratis.cgdi.gc.ca).

1:20,000 TRIM positional files from the Land and Resource Data Warehouse (http://lrdw.ca). Copyright belongs to Her Majesty the Queen in Right of the Province of British Columbia.

Disclaimer:
Maps presented in this document are a geographical representation of known features. Although the data collected and presented herein has been obtained with the utmost attention to quality, this document is not an official land survey and should not be considered for spatial calculation. EDI Environmental Dynamics Inc. does not accept any liability for errors, omissions or inaccuracies in spatial data sourced from the above cited spatial data.

This page is intentionally blank.

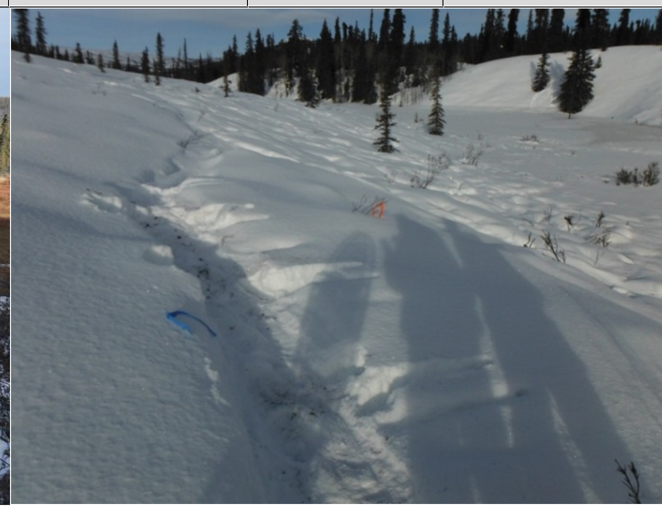
APPENDIX A SNOW COURSE DESCRIPTIONS

This page is intentionally blank.

SC-DC-1b	DOME CREEK VALLEY TRANSECT			8V 391426, 6880436	
Description	Lowest elevation snow course on Dome Creek Valley Transect, closest to confluence with Victoria Creek. This site was moved to higher ground during the 2012/13 program to avoid impacts from ice formation across the Dome Creek Valley. The site was moved 95 m northwest of the original location. Access is from the Dome Creek road crossing walking downstream about 350 m. Site is on a bench up from the left downstream bank of the creek in an open, mature spruce forest with willow understory.				
Number of Stations	4	Distance	1.5 m	Bearing	58 degrees


SC-DC-2b	DOME CREEK VALLEY TRANSECT			8V 391184, 6880434	
Description	This site was moved to higher ground during the 2012/13 program to avoid impacts from ice formation across the Dome Creek Valley. The site was moved 50 m south of the original location. Located on downstream side of Dome Creek road crossing (approximately 40 m from road) on right downstream bank. Small spruce trees and willows surrounding area.				
Number of Stations	4	Distance	1 m	Bearing	60 degrees

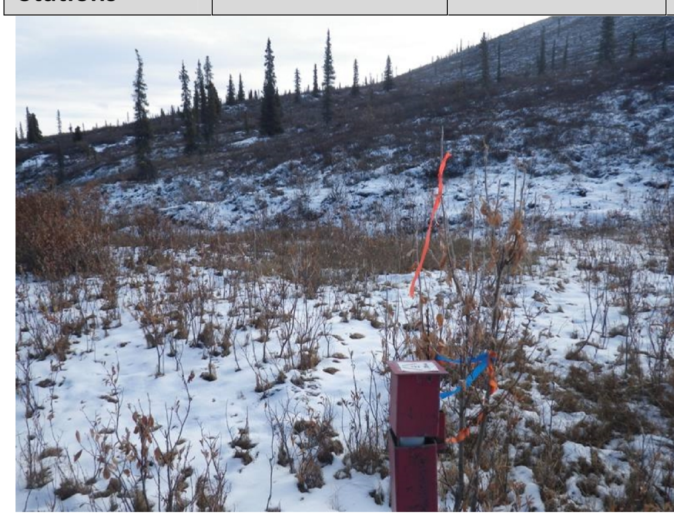

SC-DC-3	DOME CREEK VALLEY TRANSECT			8V 390849, 6880483	
Description	Upstream of the Dome Creek road crossing above right downstream bank, out of the influence of overflow ice. Vegetation is mostly willow, grass and other shrubs.				
Number of Stations	4	Distance	1.5 m	Bearing	284 degrees

SC-DC-4	DOME CREEK VALLEY TRANSECT			8V 390501, 6880533	
Description	Located on an upper bench, up from right downstream bank of Dome Creek. Scattered old spruce trees and shrubs. Terrain quite hummocky.				
Number of Stations	4	Distance	1.5 m	Bearing	144 degrees


SC-DC-5	DOME CREEK VALLEY TRANSECT			8V 390038, 6880617	
Description	Accessed down from Seepage Pond, follow creek downstream or snowmobile trail. Site is between two larger spruce trees. Relatively open area up above right downstream bank of creek.				
Number of Stations	4	**Distance**	2 m	**Bearing**	275 degrees


SC-DC-6	DOME CREEK VALLEY TRANSECT			8V 389619, 6880578	
Description	Located below the Seepage Pond. Start at a red, metal groundwater monitoring well and move in a downstream direction, there is also a willow marked with flagging tape. Site is nestled within valley bottom, but is open as vegetation is mostly willow and grass.				
Number of Stations	4	**Distance**	1m	**Bearing**	114 degrees

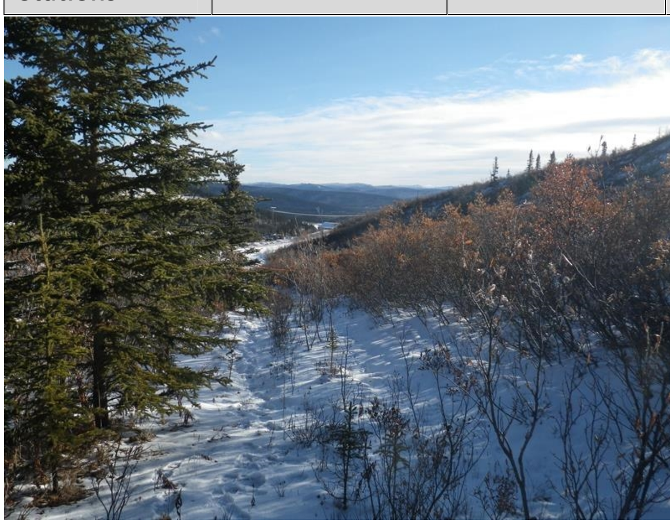



SC-DC-7	DOME CREEK VALLEY TRANSECT			8V 389080, 6880653	
Description	Site is located in a flat open area, upstream of Tailings Pond area, south of Upper Dome Creek. Drive to end of road around Tailings Pond and access on foot from there. A willow is flagged marking the location.				
Number of Stations	4	Distance	1.5 m	Bearing	254 degrees


SC-DC-8b	DOME CREEK VALLEY TRANSECT			8V 388792, 6880769	
Description	This site was moved to higher ground during the February 2013 program, 15 m south and 2 m up from the previous SC-DC-8 snow course. It is accessible by walking along top the right-downstream bank of Dome Creek from SC-DC-7. The snow course is approximately 350 m northwest from SC-DC-7. Sparse vegetation, some willow and scattered spruce. Photos below show SC-DC-8 (left) and new SC-DC-8b (right).				
Number of Stations	4	Distance	2.5	Bearing	168 degrees

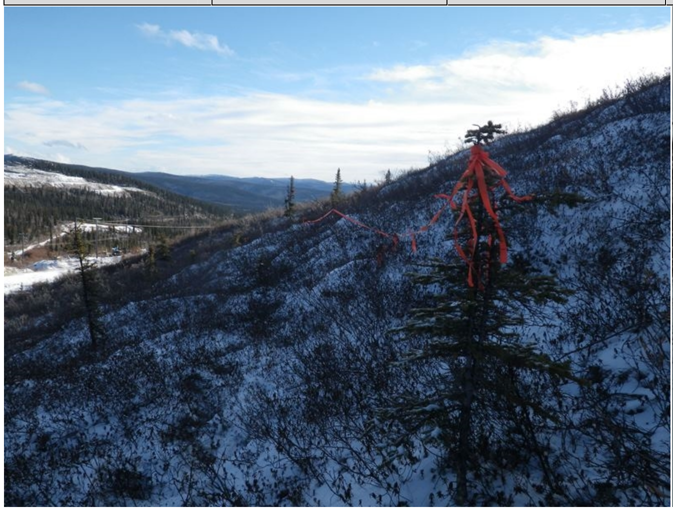

SC-DC-9	DOME CREEK VALLEY TRANSECT			8V 388063, 6881155	
Description	Site is accessible by parking near the mill, and following the road/transmission line down. Snow course takes place near a power pole. Site boundary is flagged.				
Number of Stations	4	Distance	2 m	Bearing	100 degrees


SC-DC-10	DOME CREEK VALLEY TRANSECT			8V 387649, 6881101	
Description	Accessed from a trail leading up above the mill, near the DX water quality sampling location. This station is the highest elevation site along the Dome Valley Transect. Site is somewhat north facing on a bit of a slope (10 degrees). There are willow shrubs and spruce trees. Site is flagged with orange flagging.				
Number of Stations	4	Distance	2 m	Bearing	273 degrees




SC-NF-1	NORTH FACING SLOPE			8V 389288, 6880414	
Description	Above Tailings Pond area. Very sparse trees, flagged a tree with a sparse leader. Access easiest from SC-DC-7 (at north end of Tailings Pond).				
Number of Stations	5	Distance	2 m	Bearing	90 degrees

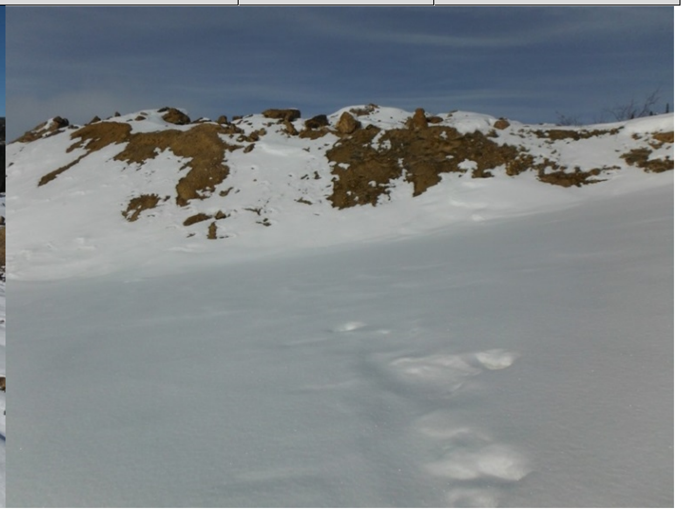

SC-NF-2	NORTH FACING SLOPE			8V 387645, 6881073	
Description	Easiest access from SC-DC-10 (about 50 m away) using trail above Mill Site. Site is open stunted spruce forest with shrub understory.				
Number of Stations	5	Distance	2 m	Bearing	81 degrees



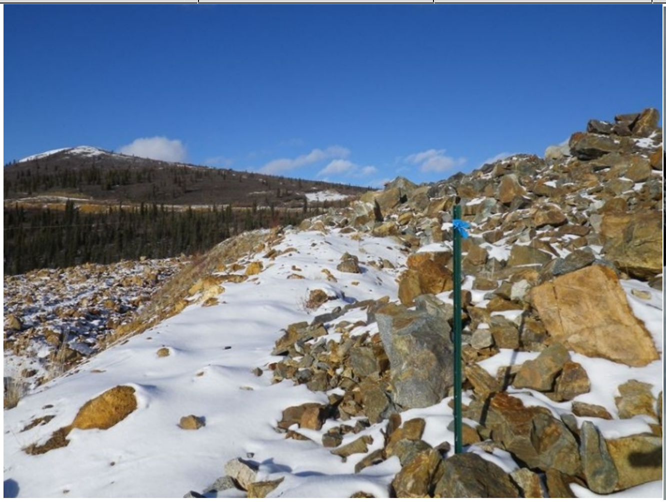

SC-SF-1	SOUTH FACING SLOPE			8V 387645, 6881073	
Description	Access from tailings/seepage access road before crossing bridge. There is a slight pull off after downhill before bridge. Access directly up hill to flagged spruce tree. Site is in an open mature spruce forest.				
Number of Stations	5	Distance	2 m	Bearing	99 degrees


SC-SF-2	SOUTH FACING SLOPE			8V 388125, 6881209	
Description	Up on south facing slope, above SC-DC-9. Accessible from road/transmission line that leads downstream from Mill. Site is about 60 m up slope from transmission line. Located in relatively open mature spruce forest with shrub understory.				
Number of Stations	5	Distance	2 m	Bearing	109 degrees

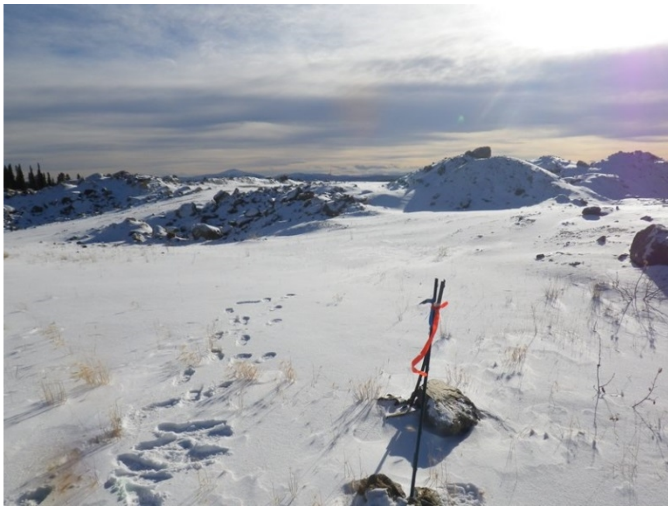

SC-WR-1	WASTE ROCK PILE			8V 389044, 6881164	
Description	Lower bench of waste rock pile. There is some flagged rebar at site and two pieces of bent rebar sticking out of ground. Snow course is located on open flat ground with a gravel, cobble and sand substrate.				
Number of Stations	3	**Distance**	2 m	**Bearing**	165 degrees

SC-WR-2	WASTE ROCK PILE			8V 388802, 6881366	
Description	Middle bench of waste rock pile. Accessible from across road from SC-WR-1. Flagged rebar delineating start of snow course. Substrate beneath is sand and gravel with large cobble and boulders.				
Number of Stations	3	**Distance**	2 m	**Bearing**	324 degrees




SC-WR-3	WASTE ROCK PILE		8V 388965, 6881319		
Description	Site is just above from Brown McDade-Pit. There is a side road that leads to the site and an open flat area with some waste rock piling on south side.				
Number of Stations	3	**Distance**	2 m	**Bearing**	340 degrees




SC-MET-1-4	METEOROLOGICAL STATION		8V 388350, 6881586		
Description	The survey area started out as four snow courses arranged with two on either side of the fencing of the meteorological station. However during the 2012/13 program, all snow courses were moved to the southwest side of the fencing for ease of access. Data from each of the four snow courses is averaged for an overall SC-MET average to compare to the snow sensor data collected at the station.				
Number of Stations	3 per snow course	**Distance**	0.5 m	**Bearing**	212 degrees


SC-AIR	AIRSTRIP REPLICATE			8V 392251, 6879088	
Description	The site is accessible off the Mount Nansen Road west of the Victoria Creek crossing. The site is in a relatively open forest on a similar bench as the YG Airstrip snow course.				
Number of Stations	5	Distance	1.5 m	Bearing	230 degrees

APPENDIX B WEATHER DATA

This page is intentionally blank.

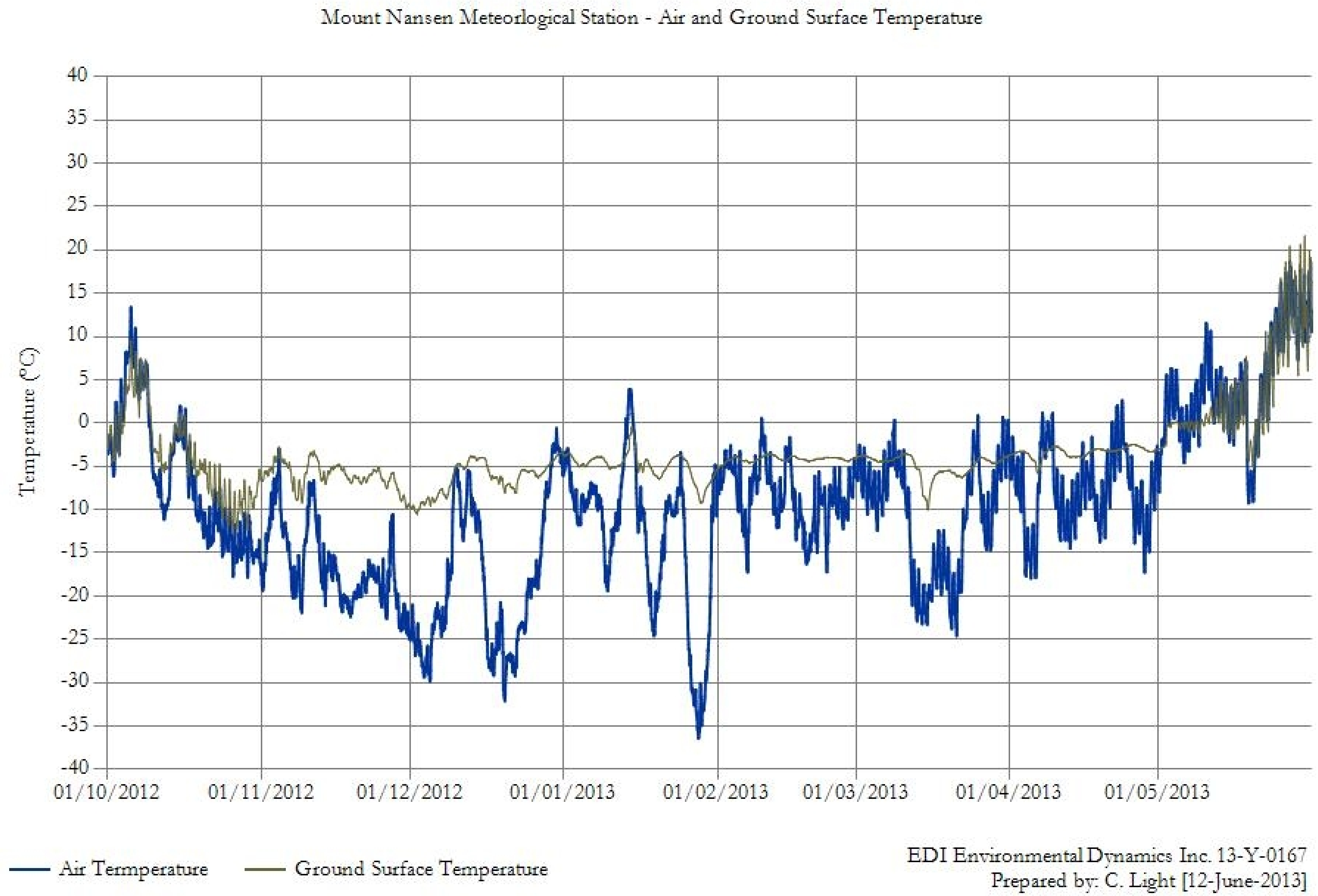


Figure B-1. Mount Nansen meteorological station data from October 1, 2012 to May 31, 2013 - average hourly air temperature and ground temperature.

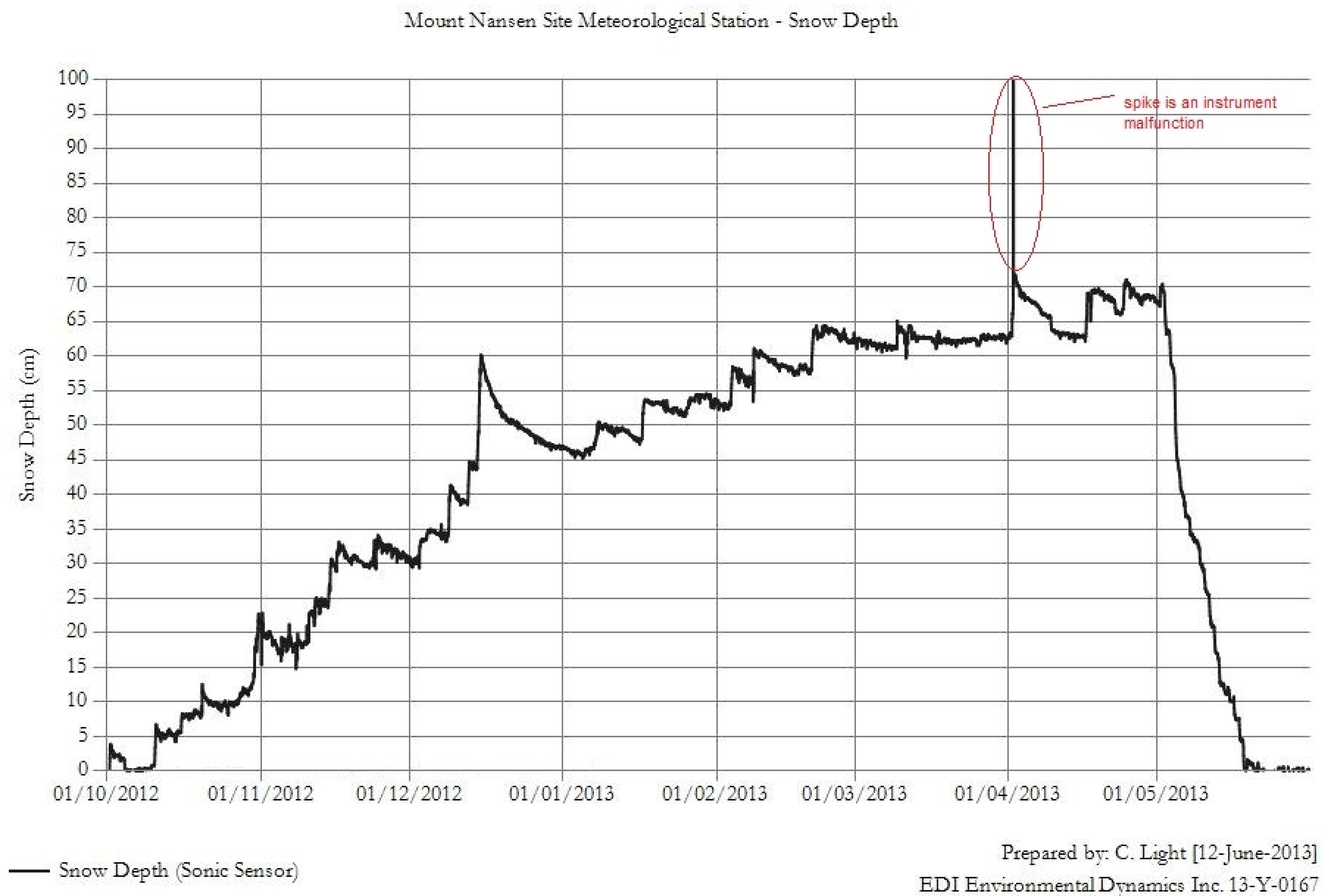


Figure B-2. Mount Nansen meteorological station data from October 1, 2012 to May 31, 2013 - snow depth.

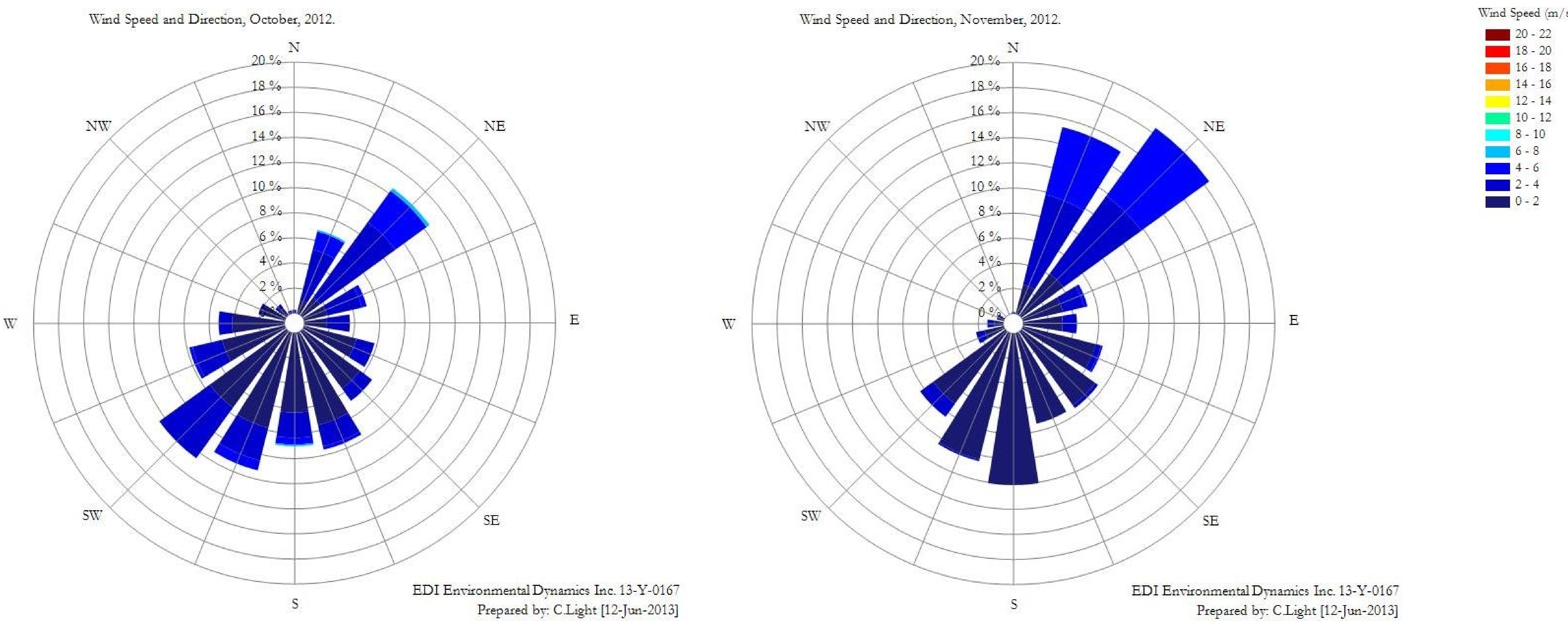


Figure B-3. Monthly wind direction, magnitude, and frequency (percent time) recorded at the Mount Nansen meteorological station (el. 1,248 m.a.s.l.) for October 2012 and November 2012.

Figure B-4. Monthly wind direction, magnitude, and frequency (percent time) recorded at the Mount Nansen meteorological station (el. 1,248 m.a.s.l.) for December 2012 and January 2013.

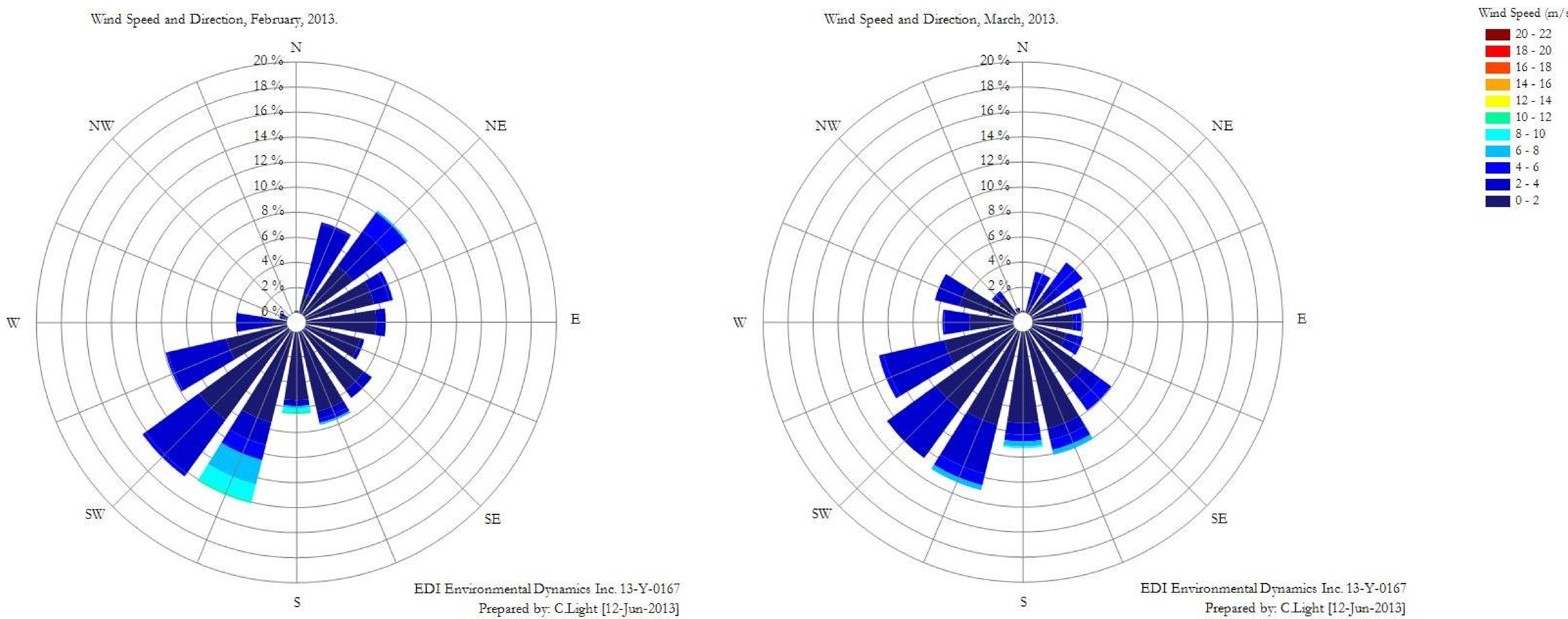
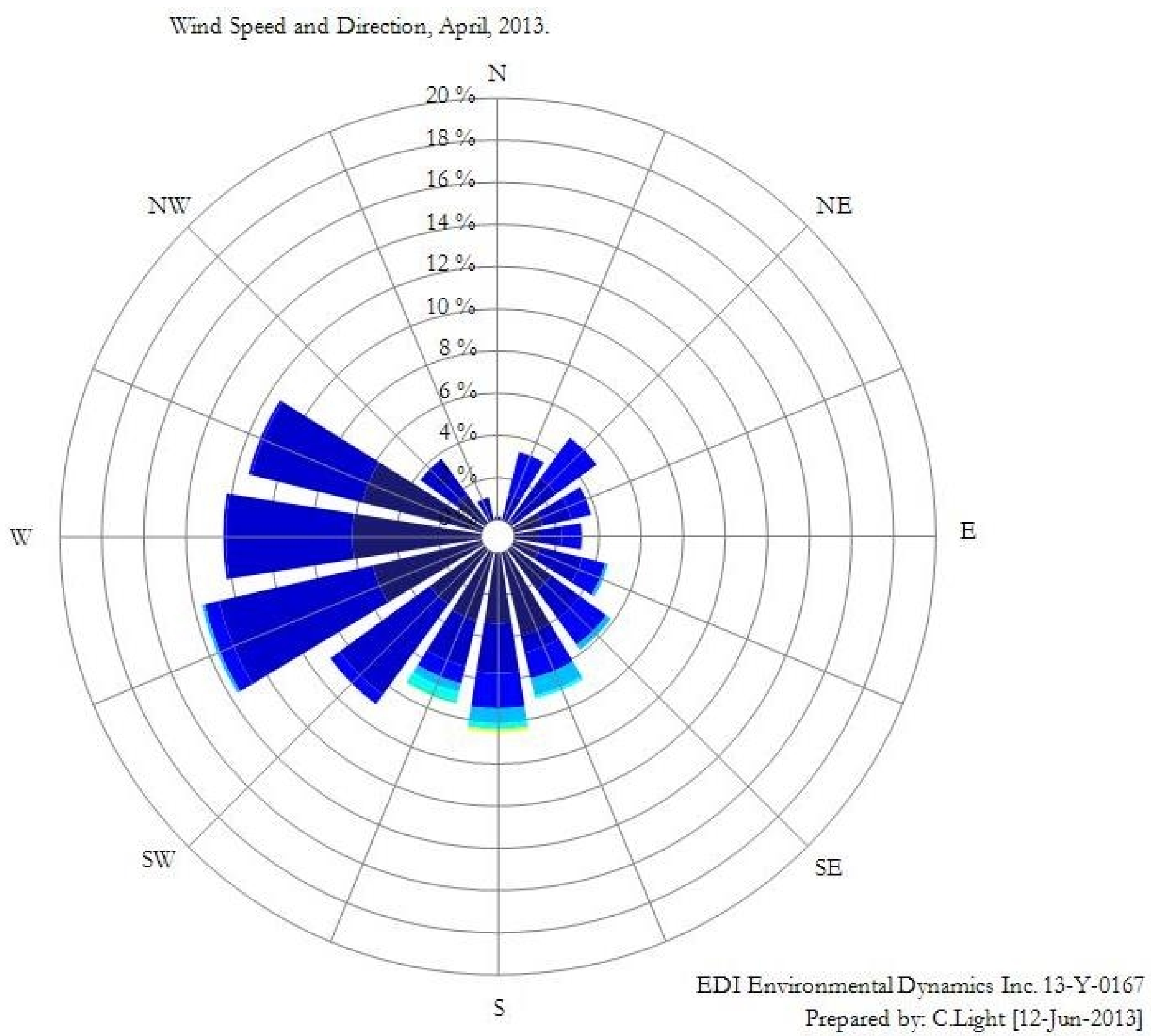


Figure B-5. Monthly wind direction, magnitude, and frequency (percent time) recorded at the Mount Nansen meteorological station (el. 1,248 m.a.s.l.) for February 2013 and March 2013.



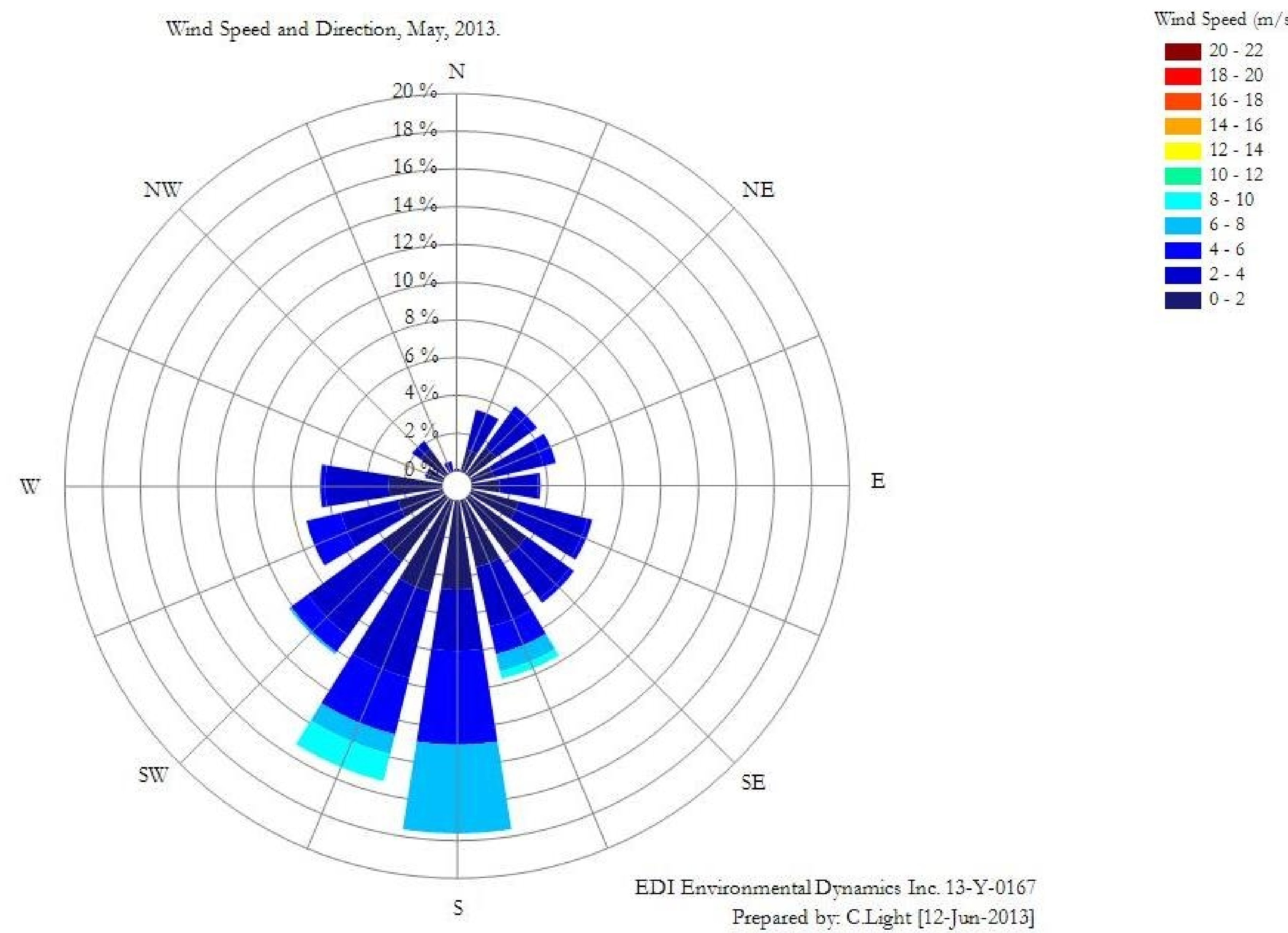


Figure B-6. Monthly wind direction, magnitude, and frequency (percent time) recorded at the Mount Nansen meteorological station (el. 1,248 m.a.s.l.) for April 2013 and May 2013.

APPENDIX C SNOW SURVEY DATA

This page is intentionally blank.

Table C-1. Average SWE, snow density and snow depth at all sites from November 2012 to May 2013.

SC ID	Elevation	Average SWE (cm)							Average Snow Density (proportion)							Average Snow Depth (cm)						
		Nov	Dec	Jan	Feb	Mar	Apr	May	Nov	Dec	Jan	Feb	Mar	Apr	May	Nov	Dec	Jan	Feb	Mar	Apr	May
SC-DC-1b	1,022	1.88	4.50	7.38	9.00	11.25	13.75	7.50	0.15	0.25	0.31	0.28	0.21	0.29	0.49	12.3	18.3	23.8	32.0	55.0	47.3	15.5
SC-DC-2b	1,029	1.88	4.25	5.88	9.25	11.00	12.00	6.50	0.13	0.18	0.23	0.23	0.20	0.24	0.56	14.8	23.5	25.8	40.3	56.0	50.0	12.3
SC-DC-3	1,034	2.25	4.50	8.50	6.75	12.25	12.50	9.00	0.17	0.22	0.27	0.26	0.22	0.24	0.46	13.5	20.3	31.5	26.3	56.0	52.5	19.5
SC-DC-4	1,044	1.88	4.25	7.00	8.25	11.75	12.75	9.75	0.17	0.24	0.35	0.24	0.23	0.27	0.48	12.0	18.0	20.5	34.0	50.3	45.5	21.3
SC-DC-5	1,068	1.88	5.75	8.13	9.25	11.75	11.50	7.75	0.16	0.23	0.28	0.25	0.21	0.23	0.39	12.0	26.0	29.3	37.0	56.0	50.3	20.0
SC-DC-6	1,074	2.63	5.25	6.50	8.75	10.25	10.75	9.50	0.21	0.20	0.20	0.27	0.19	0.21	0.45	13.3	26.8	31.8	33.0	54.3	51.5	21.0
SC-DC-7	1,104	2.00	4.50	6.50	8.75	10.75	10.50	9.50	0.16	0.16	0.24	0.21	0.20	0.20	0.53	13.0	28.0	27.3	41.5	53.5	51.5	17.8
SC-DC-8	1,118	1.50	4.50	7.75	-	-	-	-	0.13	0.19	0.26	-	-	-	-	11.8	26.3	29.0	-	-	-	-
SC-DC-8b	1,127	-	-	-	8.00	11.25	12.25	9.00	-	-	-	0.22	0.21	0.24	0.60	-	-	-	36.5	53.0	50.5	15.0
SC-DC-9	1,181	2.00	4.25	7.75	8.75	9.75	10.50	9.50	0.16	0.21	0.29	0.21	0.17	0.20	0.45	12.5	20.3	26.6	41.0	57.0	53.3	21.3
SC-DC-10	1,225	2.50	5.25	7.50	9.50	10.25	11.75	14.00	0.15	0.21	0.24	0.29	0.17	0.21	0.41	16.3	24.8	30.9	33.0	60.3	56.8	34.8
Average SC-DC	-	2.04	4.70	7.29	8.63	11.03	11.83	9.20	0.16	0.21	0.27	0.25	0.20	0.23	0.48	13.1	23.2	27.6	35.5	55.1	50.9	19.8
SC-NF-1	1,117	2.00	5.40	6.33	9.40	12.00	11.40	10.80	0.20	0.21	0.23	0.29	0.20	0.22	0.56	9.8	26.2	27.7	32.8	57.8	51.0	19.4
SC-NF-2	1,232	3.10	5.60	8.50	12.60	13.80	18.00	17.00	0.25	0.31	0.26	0.33	0.26	0.30	0.34	12.7	19.6	33.0	39.0	53.8	59.2	49.8
Average SC-NF	-	2.55	5.50	7.42	11.00	12.90	14.70	13.90	0.22	0.26	0.24	0.31	0.23	0.26	0.45	11.3	22.9	30.3	35.9	55.8	55.1	34.6
SC-SF-1	1,134	2.00	4.20	8.67	8.00	8.80	9.00	0.00	0.15	0.17	0.27	0.23	0.20	0.22	0.00	14.5	25.6	32.7	34.8	44.4	40.2	0.0
SC-SF-2	1,186	2.20	5.00	8.67	8.80	9.00	12.20	10.80	0.20	0.24	0.26	0.29	0.16	0.22	0.64	12.6	21.2	33.7	31.6	55.0	54.8	17.0
Average SC-SF	-	2.10	4.60	8.67	8.40	8.90	10.60	5.40	0.17	0.20	0.26	0.26	0.18	0.22	0.32	13.6	23.4	33.2	33.2	49.7	47.5	8.5
SC-WR-1	1,191	2.67	7.00	6.30	3.33	5.33	6.33	0.00	0.18	0.26	0.29	0.20	0.15	0.22	0.00	15.3	28.0	21.8	17.0	35.0	29.0	0.0
SC-WR-2	1,212	2.17	7.00	8.10	10.00	13.33	15.67	8.67	0.13	0.19	0.27	0.30	0.24	0.29	0.48	17.5	23.7	31.0	33.3	56.3	52.7	17.0
SC-WR-3	1,214	3.50	4.50	5.70	5.33	8.67	6.67	7.33	0.19	0.17	0.22	0.33	0.18	0.11	0.45	18.7	27.2	25.8	16.3	48.3	43.6	16.3
Average SC-WR	-	2.78	6.17	6.70	6.22	9.11	9.56	5.33	0.16	0.21	0.26	0.28	0.19	0.21	0.31	17.2	26.3	26.2	22.2	46.6	41.8	11.1
Average SC-MET	1,248	1.50	5.50	7.08	10.00	12.58	13.50	11.50	0.08	0.19	0.30	0.30	0.21	0.23	0.52	10.00	28.32	23.41	33.67	59.58	59.75	22.42
SC-AIR	989	-	-	-	-	-	9.40	-	-	-	-	-	-	0.19	-	-	-	-	-	-	49.2	-