Activity-Based Sampling at The Swift Creek Asbestos Site

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INTRODUCTION

On August 21-25, 2006, the EPA Region 10 Office of Environmental Assessment conducted activity-based sampling at Swift Creek in Whatcom County, Washington. The objective was to provide data to evaluate the potential risk to human health associated with activities involving disturbance of dredged material from Swift Creek. The tasks required to achieve this objective were to:

- Collect personal air monitoring samples during simulated activities including loading and unloading of dredged materials, raking or spreading the dredged material, and walking or mountain bike riding on the dredged materials and creek bed.
- Collect stationary air monitoring samples around the perimeter and upwind and downwind of each activity location.
- Screen filters by phase contrast microscopy (PCM) and analyze filters by transmission electron microscopy (TEM).
- Collect soil moisture and meteorological data during activities.

BACKGROUND

An earth flow type of landslide on the west side of the Sumas Mountain initiated around 1940 resulted in a significant deposition of sediments into Swift Creek during periods of rain and snow melt. Sampling and analysis conducted by EPA in April–May 2006, confirmed that sediment from the channel and the dredged material stored on the banks of the creek are contaminated with chrysotile asbestos and a very small amount of amphibole asbestos. The EPA Integrated Risk Information System (IRIS) classifies asbestos as a Group A human carcinogen based on epidemiologic studies showing increased incidence of deaths due to primarily lung cancer and mesothelioma associated with the inhalation route of exposure.[1]

It has been demonstrated that disturbance of a matrix, such as soil, contaminated with relatively low concentrations of asbestos (<1% by weight) can potentially result in significant airborne concentrations. Recent studies indicate that analysis of air monitoring filters collected during stationary air sampling, conducted downwind from soil disturbance, will typically yield less particulate than filters from personal air monitoring samples. The turbulence and wake effects that occur as air moves around a persons body as well as the fact that people move around during activity-based sampling experiments results in data that are more representative of actual exposures than stationary monitoring data.[2]

METHODS AND MATERIALS

I. Experimental Design

This project consists of site specific activity-based sampling along the banks and in the channel of Swift Creek between Oat Coles Road and Goodwin Road. The intent was to provide a realistic measure of potential asbestos fiber release resulting from activities likely to occur at this site. Data on the weather conditions and moisture content of the dredged material was collected to document conditions at the site during the activity-based sampling. The study locations are indicated on the aerial photograph in Figure 1. They were determined to be representative based on data from analysis of bulk samples collected at this site in May 2006, which confirmed the presence of asbestos in the dredge pile material throughout this site at an average concentration of

1.7% based on polarized light microscopy (PLM) point counting analysis.[3] A site specific sampling and analysis plan[4] (SAP) and quality assurance project plan[5] (QAPP) were developed by OEA and implemented for this project. The QAPP received approval by the EPA Region 10 Quality Assurance Manager on August 2, 2006. Variation of sampling and schedules did occur for this project due to equipment malfunctions and unanticipated delays in setting up study areas.

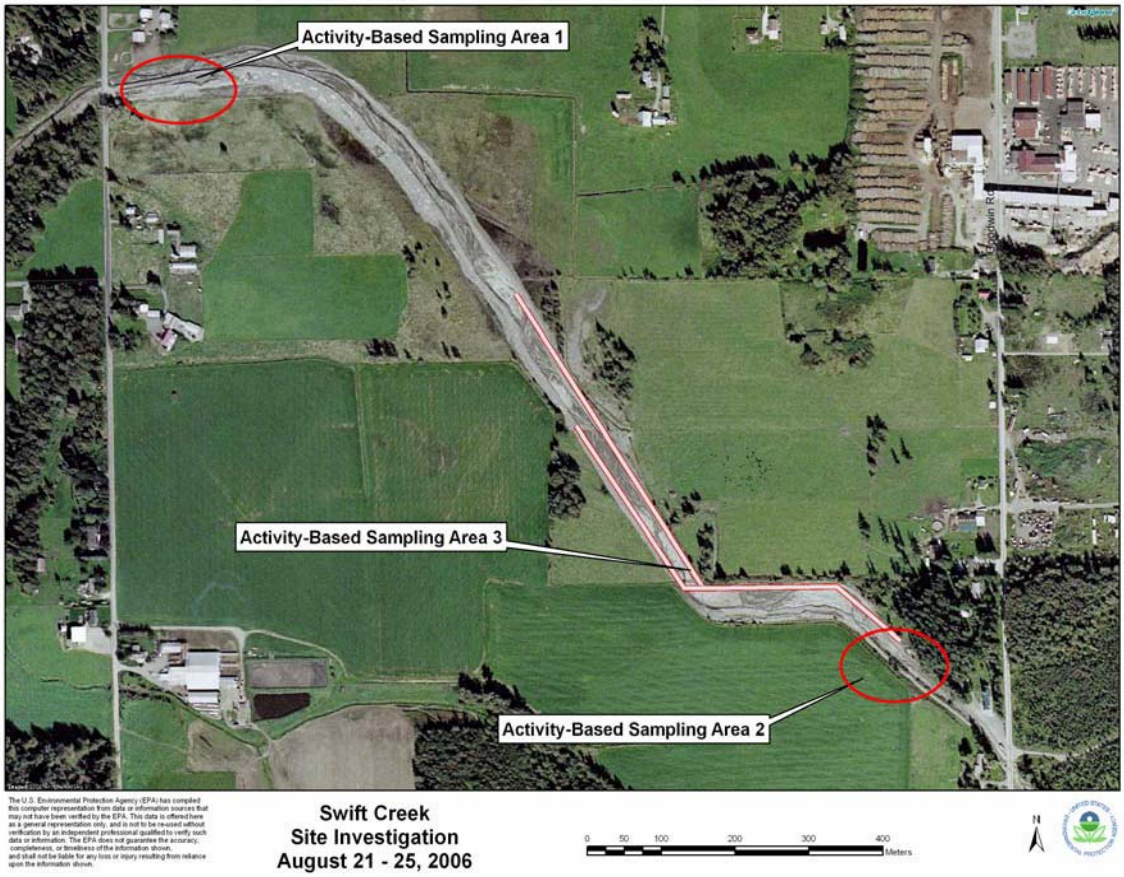


Figure 1 – Aerial view of the Swift Creek site showing activity-based sampling locations.

II. Field Team

The sampling team and individuals performing activities were from the EPA Region 10 Office of Environmental Assessment and Office of Environmental Cleanup. In addition, a representative of the Washington State Department of Health participated in two of the activities.

III. Measurements, Sampling, and Activity Scenarios

Digital photographs were taken throughout the course of this project. Several of the photographs showing examples of the activities or sampling events are included in Appendix 1. In addition, global positioning system (GPS) readings were taken at the locations where the weather station and stationary air monitors were deployed for each of the activities. A set of three maps displaying the GPS data for each day the activity-based samples were collected are included in Appendix 2. Each map relates to the three locations depicted in Figure 1.

1. Meteorological Measurements

The meteorological data for this project was collected with a Coastal Environmental Systems WeatherPak® 2000 weather station. The weather station tower was erected in close proximity to each of the ABS study areas. The station was equipped with a Gill ultrasonic sensor for measuring wind direction and velocity. The resolution for measuring wind direction was 1° and the accuracy was +/- 3°. The resolution for measuring wind velocity was 0.01 meters per second (m/s) and the accuracy was +/- 2%. The temperature sensor was accurate to +/- 0.6^o centigrade (C) and the relative humidity sensor was accurate to +/- 3% at 20° C. The readings from the weather station were periodically checked with hand-held instruments including a compass and VWR digital thermometer/hygrometer. A digital image showing the weather station tower deployed on the west side of ABS 1 is displayed in photograph 1.

2. Moisture Content Samples

The moisture content of the dredged material was determined by collecting grab samples from piles of the material that were placed in the three study areas during the ABS 2 activity. The samples were collected with stainless steel spoons and placed into new clean 250 milliliter (ml) QC class glass jars with Teflon® lined lids. A digital image showing the collection of a sample of dredge material during ABS 2 is displayed in photograph 9. An image showing the six containers of dredge material submitted for analysis of moisture content are displayed in photograph 12.

3. Field Sample Data Recording

The field sample data collected during the air monitoring associated with the activities was recorded in a log book and transferred to field asbestos data entry sheets (FADES). Copies of the field sample data sheets for this sampling event are included in Appendix 3. This software was being evaluated during this project. Overall, it was found to be very useful for keeping field records and calculating sample duration and flow information.

4. Activity-based Sampling

Three activities involving different levels of disturbance of the dredged material were simulated for this study:

- Loading and unloading of dredged material with heavy equipment– (ABS 1)
- Shoveling and raking dredged material over a surface - (ABS 2)
- Recreational activity (mountain biking, jogging, and walking)– (ABS 3)

Each of the activity-based sampling scenarios involved two individuals performing the above simulated activities. Due to the duration of the activities, the daytime temperatures, and the personal protective equipment required for this project, the individuals would alternate tasks with each other and additional workers would rotate in every hour to provide rest breaks. When one individual rotated into an activity to replace another, the air monitoring equipment was transferred from one worker to the next. This process took approximately 60 seconds. Evaluating individual tasks within the activity scenarios, raking versus shoveling for example, was beyond the intended scope of this project.

A summary of the sampling information is included in Table 1. Each of the three activity scenarios was repeated three times with at least two personal air monitoring samples being

collected for TEM analysis and one personal air monitoring sample collected for screening by phase contrast microscopy (PCM) or designated as a field duplicate for TEM analysis. The personal monitoring pumps were fastened to a belt that was attached to a shoulder harness worn by the participants. The filter cassettes were fastened with a clip to the shoulder harness and were situated within the individuals breathing zone oriented in the downward position. During the ABS 1 and ABS 2 events, both stationary (perimeter) samples and personal air monitoring samples were collected. Stationary monitors were also placed up-wind and downwind during ABS 1. The generator used to power the pump used to collect the up-wind sample failed. After that up-wind and downwind samples were not collected for the remainder of ABS 1 and for ABS 2 due to the generator problems. During ABS 3, only personal air monitoring samples were collected due to the shape and size of the study area.

Table 1 – Summary of Samples Collected for this Project

Sample Number	Date	Activity	Repetition	Sample Type	Analysis Type	Duration	Ave Flow	Air Volume
6346000	8/22/2006	ABS 1		Stationary	TEM	483	5.9	2830
6346001	8/22/2006	ABS 1		Stationary	TEM	484	5.8	2785
6346002	8/22/2006	ABS 1		Stationary	TEM	509	5.6	2833
6346003	8/22/2006	ABS 1		Stationary	TEM	473	5.7	2701
6346004	8/22/2006	ABS 1		Stationary	TEM	0	generator	failed
6346005	8/22/2006	ABS 1		Stationary	TEM	474	10.1	4783
6346006	8/22/2006	ABS 1	1	Personal	TEM	195	3.1	602
6346007	8/22/2006	ABS 1	1	Personal	TEM	180	3	547
6344008	8/22/2006	ABS 1	1	Personal	PCM	180	3	542
6346009	8/22/2006	ABS 1	2	Personal	TEM	183	3	555
6346010	8/22/2006	ABS 1	2	Personal	TEM	183	3	544
6344011	8/22/2006	ABS 1	2	Personal	PCM	183	3	549
6346012	8/23/2006	ABS 1	3	Personal	TEM	170	3.6	604
6346013	8/23/2006	ABS 1	3	Personal	TEM	170	3.4	579
6346014	8/23/2006	ABS 1	3	Personal	TEM	0-fault	0	0
6346015	8/23/2006	ABS 2		Stationary	TEM	297	5.7	1693
6346016	8/23/2006	ABS 2		Stationary	TEM	301	5.5	1659
6346017	8/23/2006	ABS 2		Stationary	TEM	299	5.6	1665
6346018	8/23/2006	ABS 2		Stationary	TEM	300	6	1797
6346019	8/23/2006	ABS 2	1	Personal	TEM	177	3.1	550
6346020	8/23/2006	ABS 2	1	Personal	TEM	179	3.1	550
6346021	8/23/2006	ABS 2	1-QA	Personal	TEM	179	3.1	561
6346022	8/23/2006	ABS 2	2	Personal	TEM	181	3.5	638
6346023	8/23/2006	ABS 2	2	Personal	TEM	181	3.4	614
6344024	8/23/2006	ABS 2	2	Personal	PCM	181	2.1	386
6346025	8/23/2006	ABS 2		Stationary	TEM	202	5.5	1106
6346026	8/23/2006	ABS 2		Stationary	TEM	203	5.4	1100
06344027-4030	8/23/2006	ABS 2		Grab	Moisture	N/A	N/A	N/A
6346031	8/24/2006	ABS 2	H&S	Personal	TEM	100	2	201
6346032	8/24/2006	ABS 3	1	Personal	TEM	188	3	569
6346033	8/24/2006	ABS 3	1	Personal	TEM	188	3.1	575
6344034	8/24/2006	ABS 3	1	Personal	PCM	188	3.1	577
6346035	8/24/2006	ABS 2		Stationary	TEM	236	5.6	1311
6346036	8/24/2006	ABS 2		Stationary	TEM	235	5.3	1254
6346037	8/24/2006	ABS 2		Stationary	TEM	236	5.3	1259
6346038	8/24/2006	ABS 2		Stationary	TEM	294	5.7	1680
6346039	8/24/2006	ABS 2	3	Personal	TEM	185	3.6	659
6346040	8/24/2006	ABS 2	3	Personal	TEM	185	3.6	659
6344041	8/24/2006	ABS 2	3	Personal	PCM	185	3	555
06344042-4043	8/24/2006	ABS 2		Grab	Moisture	N/A	N/A	N/A
6346044	8/24/2006	ABS 3	2	Personal	TEM	181	3	549
6346045	8/24/2006	ABS 3	2	Personal	TEM	181	3	551
6344046	8/24/2006	ABS 3	2	Personal	PCM	181	3.1	553
6346047	8/24/2006	ABS 3	3	Personal	TEM	176	3.6	625
6346048	8/24/2006	ABS 3	3	Personal	TEM	176	3.4	592
6344049	8/24/2006	ABS 3	3	Personal	PCM	176	3	522
6346050-6051	8/24/2006	N/A		QC	TEM	N/A	N/A	N/A
6344052	8/24/2006	N/A		QC	PCM	N/A	N/A	N/A

Meteorological data including wind velocity and direction, temperature, and relative humidity were collected during all activities. Environmental samples of dredged material used for ABS 2 were collected and analyzed for moisture content.

A. Health and Safety

The individuals participating in the activities wore level C personal protective equipment (PPE) consisting of a Tyvek® suit, latex gloves, leather safety boots, and full face air purifying respirator with P-100 HEPA cartridges. During the ABS 3 recreational activity, the leather safety boots were substituted with athletic footwear. After the participants completed their portion of the field activities, they were decontaminated with rinse water before they removed their PPE. A digital image showing an individual being decontaminated during ABS 3 is shown in Photograph 11. Used PPE was disposed of in plastic asbestos debris bags and transported to the Manchester Environmental Laboratory for disposal.

A personal air monitoring sample was collected at the conclusion of the ABS 2 activity during the process of removing plastic tarps associated with that part of the project. This was designated as a health and safety (H&S) sample and was not representative of the samples collected during the activity-based sampling. Removal of the plastic tarps did appear to generate a greater amount of airborne dust than the activity scenarios. The result of analysis for this sample is included in Table 2 for comparison purposes.

B. Personal Air Monitoring

The personal air monitoring samples were collected with Gilian® Hi volume personal sampling pumps attached with 6.4 millimeter (mm) inside diameter Tygon® R3603 tubing to a filter cassette. The pumps were calibrated in the field immediately before and after sampling using a Gilian® electronic soap-film meter with a personal monitoring flow cell, serial number 002598-S. The flow cell on the meter was serviced and verified accurate within 0.2% by Sensidyne, Inc. on May 1, 2006. A copy of the calibration certificate is included in Appendix 4a. The before and after flow rates were used to determine an average flow rate that was recorded on the filter cassette and in the field sample data documentation. The filter cassettes used for this project were Zefon® 0.8 µm mixed cellulose ester (MCE) type.

The personal air monitoring samples were collected at a flow rate between 2.0 and 3.6 liters per minute. The target analytical sensitivity for personal monitoring samples was 0.001 structures per cubic centimeter (s/cc) and the target detection limit was 0.003 s/cc based on a target air volume of 500 liters. The sampling duration was generally 180 minutes which required individuals to change out with other workers approximately every 60 minutes. One of the personal monitoring pumps failed to operate properly during repetition 3 of ABS 1.

C. Stationary Air Monitoring

Stationary air monitoring was conducted during the ABS 1 and ABS 2 experiments and consisted mostly of perimeter samples and one downwind sample collected during ABS 1. Stationary air monitoring was not conducted during the ABS 3 experiment due to the narrow shape and length (approximately ½ mile) of the ABS 3 study area.

The stationary air monitoring pumps were calibrated in the field immediately before and after sampling using a Gilian® electronic soap-film meter with a personal monitoring flow cell,

serial number 0208000-H. The flow cell on the meter was serviced and verified accurate within 0.16% by Sensidyne, Inc. on May 1, 2006. A copy of the calibration certificate is included in Appendix 4b. As with the personal air monitoring, the before and after flow rates were used to determine an average flow rate that was recorded on the filter cassette and in the field sample data documentation. The filter cassettes used for this project were Zefon® 0.8 µm mixed cellulose ester (MCE) type. The target analytical sensitivity for stationary monitoring samples was 0.0001s/cc and the target detection limit was 0.0003 s/cc based on a target air volume of at least 2,400 liters.

- Perimeter Samples – The perimeter samples were collected with Airmetrics® stationary monitors deployed directly adjacent to the four sides of the study area for ABS 1 and ABS 2. A digital image showing one of the perimeter monitors deployed on the west side of ABS 1 is displayed in photograph 2. The Airmetrics® stationary pumps ran on 12 volt DC batteries. The perimeter samples were collected at a flow rate of approximately 5 liters per minute.

- Downwind Sample - The downwind sample was collected with an Allegro® Hi Volume pump that was deployed within approximately 100 feet of the ABS 1 activity. The Allegro® pump was connected to a gas powered generator. The downwind sample was collected at a flow rate of approximately 10 liters per minute. The calibration and sample cassette was the same as was used for the perimeter samples.

D. Activity Scenarios

- ABS 1 - Loading and unloading dredged material with heavy equipment

During ABS 1, dredged material was excavated from the piles on the south bank of the west end of the site. The study area for this activity was approximately 25 m x 25 m (80’ x 80’). The excavation work was done with a 74 horse power John Deere industrial tractor (model 310G) equipped with a 1 cubic yard front-end loader. During this activity the workers wearing air monitoring equipment would use the loader to scoop the dredged material from the storage piles on the south bank of the creek and place it into a Ford F550 dump truck with a 3 cubic yard capacity bed. The workers then dumped the load of dredged material within the ABS 1 study area or transported it to three locations along an access road on the south bank of the east side of the site where it was deposited into piles to be used for ABS 2. Digital images showing excavating and dumping of dredge material in the ABS 1 study area are displayed in photographs 3 and 4. A digital image showing dredge material being dumped at the ABS 2 location is displayed in photograph 5.

- ABS 2 - Shoveling and raking dredged material over a surface

In ABS 2, piles of dredged material were moved with a shovel and wheelbarrow and spread with a metal garden rake over three study areas measuring approximately 3 meters (10’) by 18.3 meters (60’) long. The dredged material was spread to a depth of approximately 5 centimeters (2”). The study areas were covered with 10 mil plastic sheets used to segregate the dredged material from the road and to provide a moisture barrier. Digital images showing spreading of dredge material during ABS 2 are displayed in photographs 6, 7, and 8. Each worker wore at least one or two air monitors while performing these tasks and the workers were permitted to switch between tasks during the period of time they were being monitored.

- ABS 3 - Recreational activity (mountain biking, jogging, and walking)

ABS 3 was conducted from the east end to the central portion of the site on both sides of the creek. This activity involved teams consisting of two individuals, one following the other, either riding mountain bikes, jogging, or walking along portions of the dredge piles. A digital image showing two individuals riding mountain bikes during ABS 3 is displayed in photograph 10. The individuals participating in the activities wore at least one or two air monitors and were permitted to switch between the recreational activities during the period of time they were being monitored.

IV. Analytical Methods

The personal and stationary air monitoring samples were analyzed by TEM using an analytical method by the International Organization for Standardization (ISO) titled ISO 10312 Ambient air - Determination of Asbestos Fibres – Direct-Transfer Transmission Electron Microscopy Method. A sub-set of samples was screened with a phase contrast microscope (PCM) by method NIOSH 7400 Asbestos and other Fibers by PCM. The screening analysis was intended primarily to determine the degree of filter loading during the ABS experiments. Also six grab samples of dredged material were collected and analyzed for moisture content using ASTM method D2216.

V. Quality Assurance and Quality Control

Quality assurance (QA) and quality control (QC) were defined in Section D-1 of the QAPP and based on the analytical methods used. The QA/QC samples consisted of duplicate and replicate analysis in the laboratory, analysis of field duplicates, and analysis of lot blanks.

RESULTS OF ANALYSIS

I. Meteorological Data

The weather conditions during the sampling were favorable with a relatively light breeze ranging from 0 to 3.8 m/s (0 to 8.5 miles per hour) primarily from the southwest for most of the sampling events. The temperature ranged from 14.6^{o} C to 23.7^{o} C (58.3 ^{o} to 74.7 ^{o} F) and the relative humidity ranged from 47% to 75%. There was no visible precipitation observed during this project. A summary of the weather conditions measured during each repetition of each activity is included in Appendix 5.

II. Moisture Content of Dredged Material

The average moisture content of the dredged material used for ABS 2 was 7% for samples obtained from the interior of the loads. The average moisture content of the dredged material after it was spread on the plastic sheet and allowed to dry was 3.6%. The analysis of moisture content was performed at the Manchester Environmental Laboratory. The data package for the moisture content analysis is included in Appendix 6.

III. Air Monitoring

The PCM analysis used to screen samples in the field was conducted by EPA. The samples analyzed by PCM were loaded with the appropriate amount of particulate (< 50% of the

filter surface covered with particles), and therefore required no adjustment to the sampling duration or flow rates. The data package and quality assurance narrative for the screening analysis of air samples by PCM are included in Appendix 7. The TEM analysis was conducted under a contract with the Washington State Department of Ecology by Lab/Cor, Inc., in Seattle Washington. Lab/Cor, Inc. is accredited (identification number 101920-0) through the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the Department of Commerce under the National Institute of Standards and Technology (NIST). NVLAP accreditation certifies that the laboratory has met an established level of competence. It does not guarantee the accuracy of the analytical results. The final data package and a copy of the data review, verification, and validation for the asbestos analysis by TEM are included in Appendix 8.

The analysis of air samples collected during all three of the activity scenarios revealed that asbestos became airborne when the dredged material was disturbed. The results of analysis suggest that depending on the level of disturbance, the concentration of airborne asbestos can approach or even exceed the permissible exposure limit (PEL) set by the Occupational Safety and Health Administration (OSHA) which is 0.10 fibers per cubic centimeter (f/cc) of air based on an eight-hour time weighted average. The results displayed in this report are for the asbestos classified as PCME fibers or structures using the ISO 10312 terminology, which have a width range of 0.25 µm – 3.0 µm and length greater than 5.0 µm, and a 3:1 length to width aspect ratio. ISO 10312 results are reported in structures per cubic centimeter (s/cc) of air.

Chrysotile was the predominant asbestos detected in the air monitoring samples analyzed for this project. There was also a small number of amphibole fibers (actinolite and tremolite) detected as well. The majority of the chrysotile fibers were relatively short and thin but there were still several in the PCME size range. About half (4 out of 9) of the amphibole fibers detected were in the PCME size range. The only samples free of chrysotile or amphibole fibers were the lot blanks.

1. Personal Air Monitoring Samples

The results of analysis of the personal air monitoring samples collected for this project are displayed in Table 2. The data indicate the work done with the heavy equipment (front-end loader and dump truck) resulted in relatively higher airborne concentrations of PCME fibers than the other two activity scenarios.

The concentration of PCME asbestos fibers detected in samples collected during ABS 1 ranged from 0.0324 s/cc to 0.2080 s/cc. The airborne concentration of asbestos fibers detected in the personal monitoring samples collected during ABS 1 were at least one order of magnitude greater than the concentrations detected in the stationary samples collected during repetitions 1 and 2 of this activity.

The results of analysis for ABS 2 showed airborne concentrations of PCME asbestos fibers ranged from 0.0087 to 0.0403 s/cc. As was the case in ABS 1, the airborne concentration of PCME asbestos fibers detected in the personal monitoring samples collected during ABS 2 were generally one order of magnitude greater than the concentrations detected in the stationary samples collected during the three repetitions of this activity. The concentration of PCME asbestos fibers detected in the health and safety sample collected when the dredged material was removed from the plastic tarp after ABS 2 was 0.1320 s/cc.

The results of analysis for four of the samples collected during ABS 3 showed airborne concentrations of PCME asbestos fibers ranging from 0.0090 to 0.0934 s/cc. The results of

analysis for two of the samples collected during ABS 3 were below the detection limit for the PCME asbestos fiber category; however, structures in categories other than the PCME asbestos fiber category were detected. Two individuals participated in this activity with one following the other either riding the mountain bike, jogging, or walking. Based on discussion with the participants, the higher concentration of asbestos fibers was generally detected in the filters that were worn by the individual that was in the follower position for this activity.

Table 2 – Summary of Analytical Results for Personal Air Monitoring Samples

Activity	Repetition	Sample Number	Worker	Air Volume	Analysis	PCM Screen fiber/cc	Fiber PCME structure/cc
ABS 1	1	6346006	KM	602	TEM		0.0441
	1	6346007	MT	547	TEM		0.0324
	1	6346008	MT	542	PCM	0.02	
ABS 1	2	6346009	KM	555	TEM		0.0638
	2	6346010	MT	544	TEM		0.0326
	2	6346011	MT	549	PCM	0.02	
ABS 1	3	6346012	DT	640	TEM		0.2080
	3	6346013	KM	613	TEM		0.0867
	3	6346014	DT - QA dup	0	TEM	Pump	Failed
ABS 2	1	6346019	JW	550	TEM		0.0242
	1	6346020	GP	550	TEM		0.0284
	1	6346021	GP-QA dup	561	TEM		0.0338
ABS 2	2	6346022	GS	638	TEM		0.0338
	2	6346023	RP	614	TEM		0.0087
	2	6346024	RP	386	PCM	0.02	
ABS 2	3	6346039	GS	659	TEM		0.0403
	3	6346040	DT	659	TEM		0.0269
	3	6346041	DT	555	PCM	0.01	
ABS 2	H/S	6346031	DT	201	TEM		0.1320
ABS 3	1	6346032	JW	569	TEM		0.0934
	1	6346033	GP	575	TEM		< 0.0231
	1	6346034	GP	577	PCM	0.01	
ABS 3	2	6346044	JW	549	TEM		< 0.0121
	2	6346045	GP	551	TEM		0.0161
	2	6346046	GP	553	PCM	0.02	
ABS 3	3	6346047	DT	625	TEM		0.0567
	3	6346048	GS	592	TEM		0.0090
	3	6346049	GS	522	PCM	0.02	

The initials of only the first worker involved in the collection of each sample are included in this table as an identifier.

2. Stationary Monitoring Samples

The results of analysis of the stationary air monitoring samples collected for this project are displayed in Table 3. The data show detectable levels of asbestos in all the stationary samples collected during ABS 1 and ABS 2. The concentration of PCME fibers detected during both activities ranged from 0.0003 s/cc to 0.0282 s/cc. As was the case with the personal monitoring

samples, the stationary samples collected during ABS 1 had the highest concentration of asbestos fibers. Another trend observed during ABS 1, repetitions 1 and 2, was that the north and east air monitors showed a higher concentration of airborne asbestos than did the south and west air monitors due to the prevailing wind out of the west –southwest at a velocity between 0.3 to 3.5 m/s (0.67 to 7.83 miles per hour). This trend was observed to a lesser degree during ABS 2 repetitions 1 and 2. The concentration of asbestos detected in the filters from ABS 2, repetition 3 did not differ significantly probably due to lower wind velocities that did not exceed 2 m/s (4.47 miles per hour).

Table 3 – Summary of Analytical Results for Stationary Air Monitoring Samples

Activity	Repetition	Date	Sample No.	Pump No.	Location	Air Volume	Fiber PCME
ABS 1	1 and 2	8/22/2006	6346000	3173	North Perimeter	2830	0.0282
	1 and 2	8/22/2006	6346001	3180	South Perimeter	2785	0.0005
	1 and 2	8/22/2006	6346002	3192	West Perimeter	2833	0.0008
	1 and 2	8/22/2006	6346003	3182	East perimeter	2701	0.0023
	1 and 2	8/22/2006	6346004	67999	up wind	Generator	Failed
	1 and 2	8/22/2006	6346005	68006	down wind	4783	0.0009
ABS 2	1	8/23/2006	6346015	3173	East Perimeter	1704	0.0003
	1	8/23/2006	6346016	3180	North Perimeter	1659	0.0018
	1	8/23/2006	6346017	3192	West perimeter	1665	0.0005
	1	8/23/2006	6346018	3182	South Perimeter	1797	0.0004
	2	8/23/2006	6346025	3186	South Perimeter	1106	0.0005
	2	8/23/2006	6346026	3194	East Perimeter	1100	0.0035
	3	8/24/2006	6346035	3192	North Perimeter	1311	0.0012
	3	8/24/2006	6346036	3194	South Perimeter	1254	0.0011
	3	8/24/2006	6346037	3186	East Perimeter	1259	0.0012
	3	8/24/2006	6346038	3173	West perimeter	1680	0.0019

CONCLUSIONS

Chrysotile fibers were detected in all the samples collected for this project with the exception of the QC lot blanks. A small number of amphibole (actinolite or tremolite) fibers were also detected in a small number of samples. The majority of the chrysotile fibers were relatively short and thin but there were still several in the PCME size range.

The personal air monitoring samples had the greater concentration of airborne asbestos fibers than the stationary samples. Generally the concentrations of asbestos detected in the stationary samples were at least one order of magnitude lower than the personal air monitoring samples. This finding is in agreement with other EPA field studies which have demonstrated similar results.

The weather during the sampling was favorable with relatively light winds out of the south west. The perimeter samples collected downwind from the activity generally had the higher concentration of asbestos fibers detected than the perimeter samples that were stationed upwind.

REFERENCES

[1] ATSDR, Toxicological Profile for Asbestos (updated), September 2001.

[2] Hildemann, Lynn; Major Sources of Personal Exposure to Airborne Particulate Matter, Seminar at EPA Region 9, March 15, 2005.

[3] Ecology and Environment, Inc., Swift Creek Asbestos Integrated Assessment Draft Report, Everson, Washington, TDD Number: 06-03-0020, September 2006.

[4] U.S. EPA Region 10, Quality Assurance Project Plan (QAPP) for Activity Based Sampling and Analysis, Swift Creek, Whatcom County, Washington, Revision 1.2., August 2006.

[5] U.S. EPA Region 10, Activity Based Sampling and Analysis Plan, Swift Creek, Whatcom County, Washington, Revision 1, August 2006.

Photo 1 – This image shows the ABS 1 site including the up wind air monitor, weather station tower, and Honda generator for providing AC power.

Photo 2 – This image shows the ABS 1 site west perimeter delineated with yellow caution tape and an Airmetrics stationary air monitor.

Photo 3 – This image shows ABS 1 where the dredged material was loading into a dump truck.

Photo 4- This image shows ABS 1 where the dredged material was dumped inside the study area.

Photo 5- This image shows dumping of dredged material from ABS 1 onto a plastic sheet for use during ABS 2.

Photo 6 – This image shows ABS 2 where the dredged material is moved with a shovel and wheel barrow and raked over the plastic sheet.

Photo 7- This image shows how the plastic sheet was covered during ABS 2.

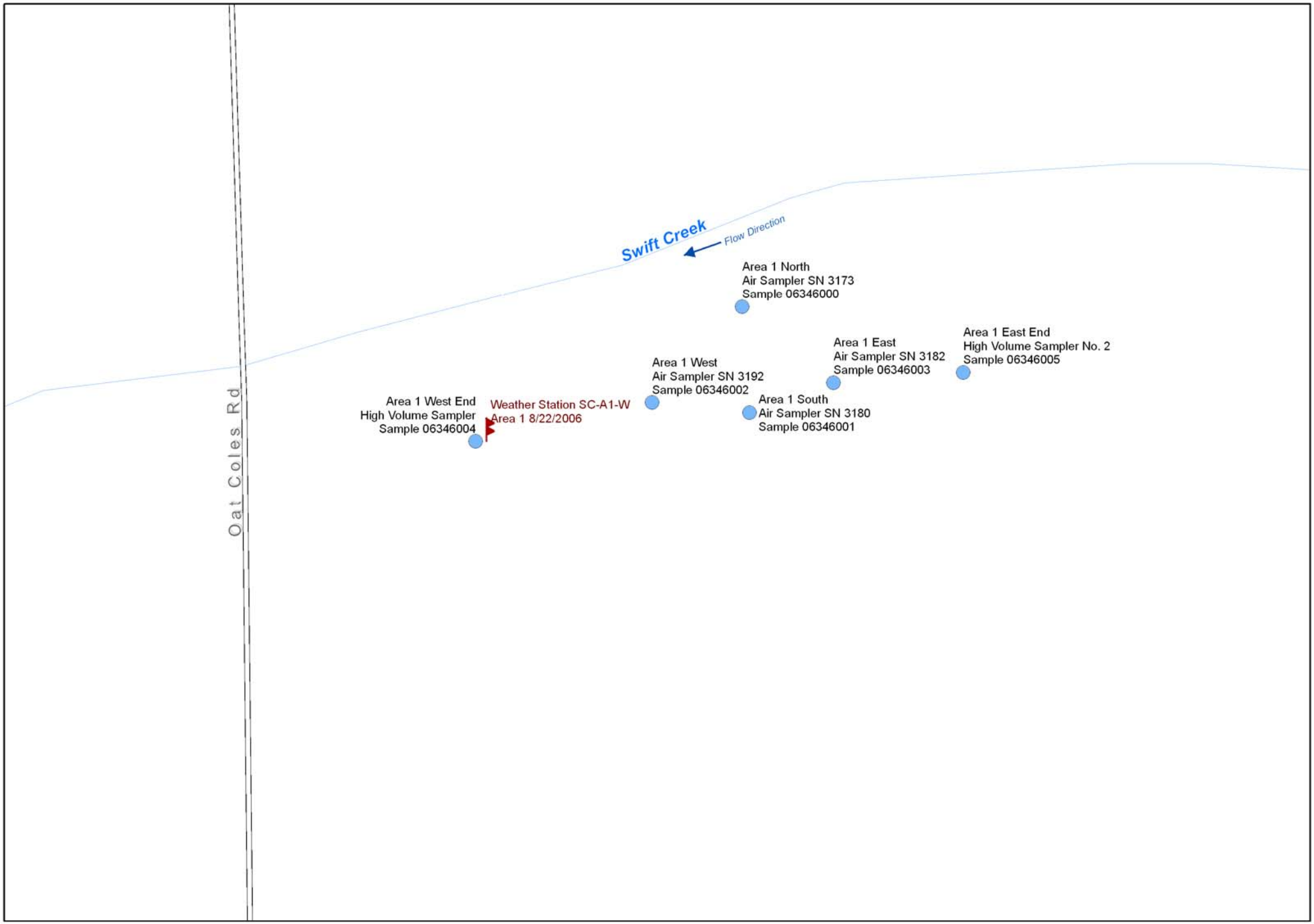
Photo 8 – This image shows four stationary monitors used during ABS 2 and a worker recording GPS location data for the stationary monitors.

Photo 9-This image shows a grab sample of dredged material being collected from one of the piles from ABS 2. The sample was analyzed for moisture content.

Photo 10 - This image shows two individuals riding mountain bikes during ABS 3. They were riding in a westerly direction on the north bank of Swift Creek.

Photo 11 – This image shows one individual spraying another down with clean rinse water during decontamination.

Photo 12 – This image shows samples of dredged material that was collected during ABS 2 for analysis of moisture content.

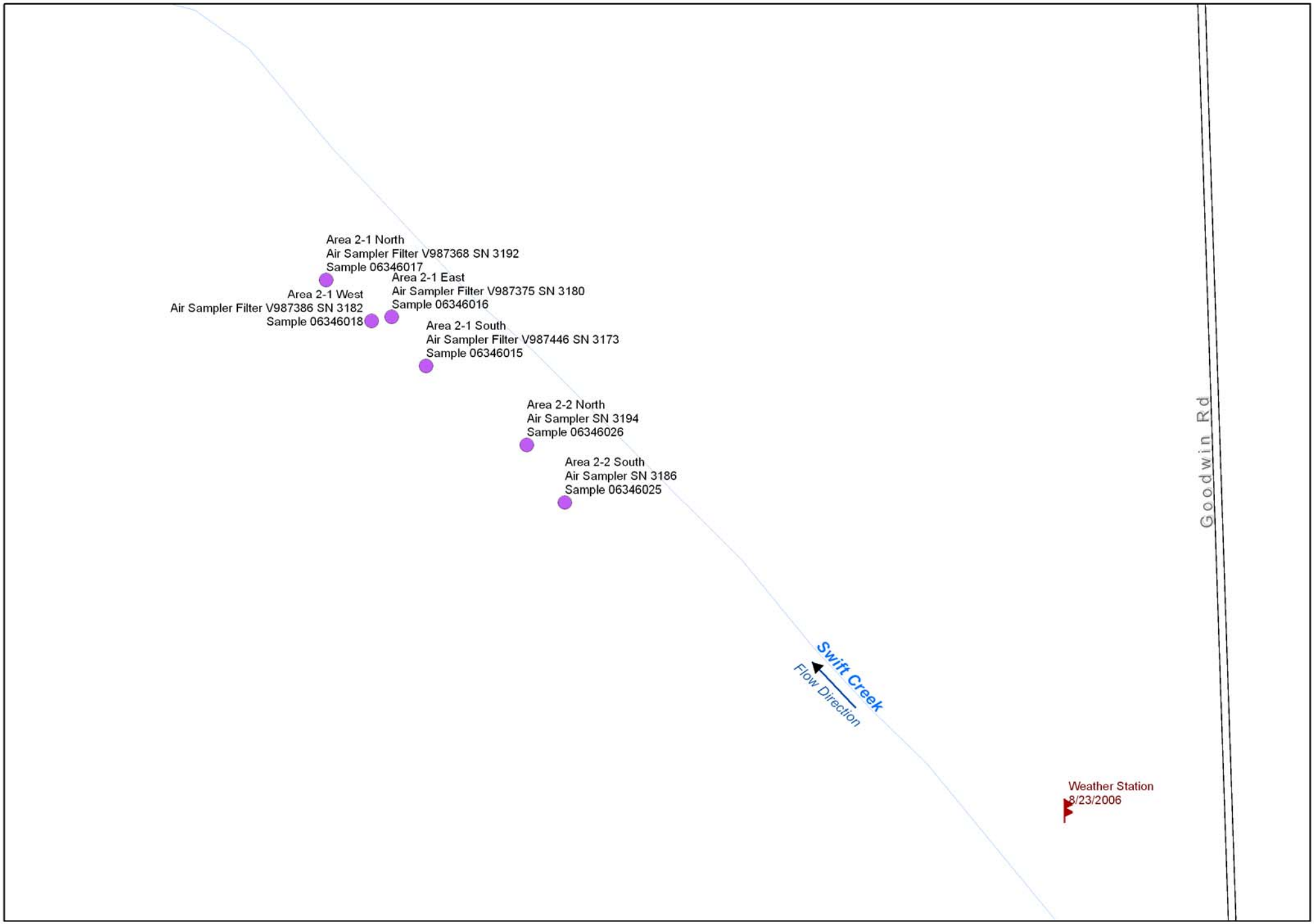


The U.S. Environmental Protection Agency (EPA) has compiled this computer representation from data or information sources that may not have been verified by the EPA. This data is offered here as a general representation only, and is not to be re-used without verification by an independent professional qualified to verify such data or information. The EPA does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any loss or injury resulting from reliance upon the information shown.

Swift Creek Site Investigation
August 22, 2006
Activity-Based Sampling Area 1

0 10 20 40 60 Meters

N

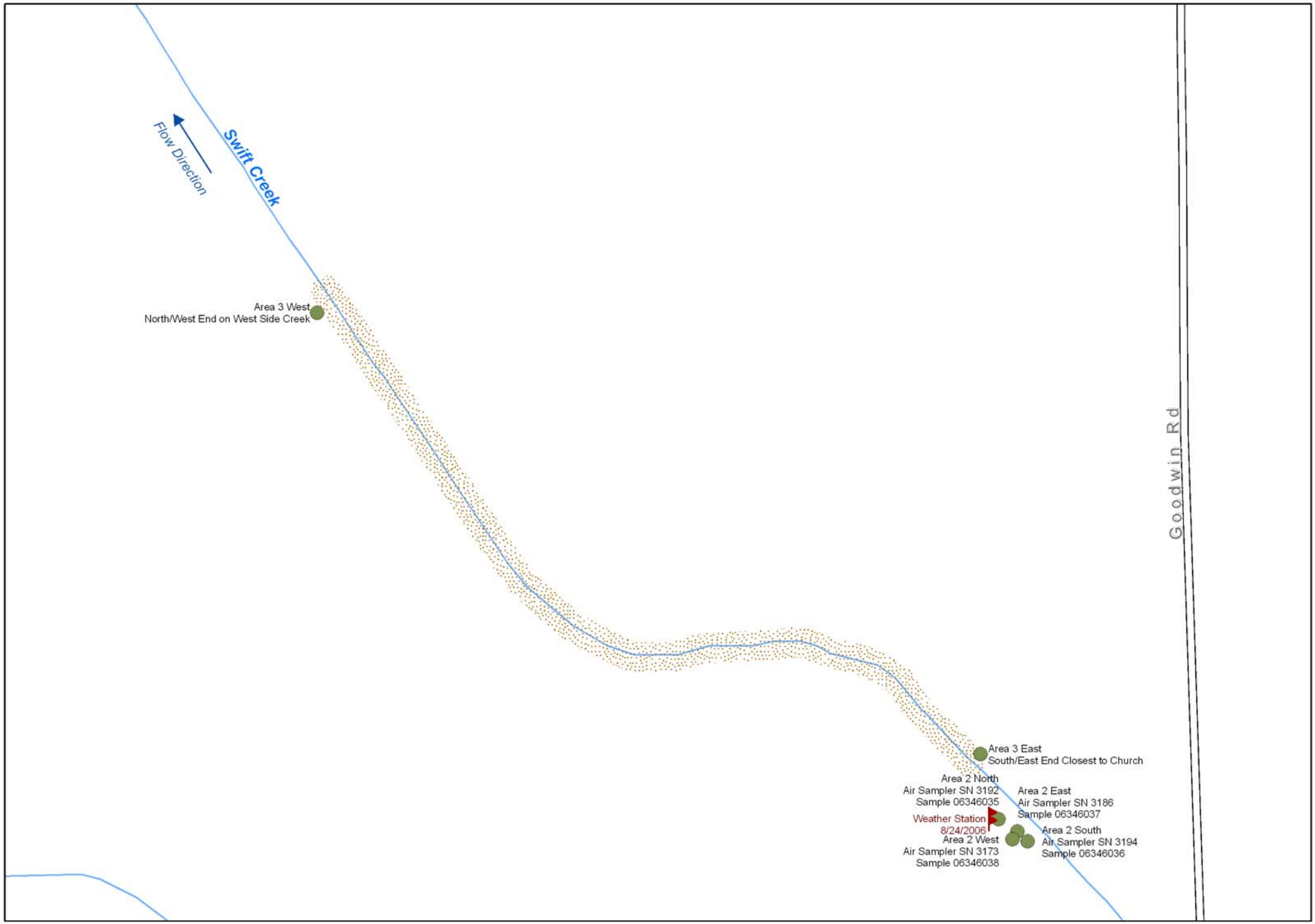


The U.S. Environmental Protection Agency (EPA) has compiled this computer representation from data or information sources that may not have been verified by the EPA. This data is offered here as a general representation only, and is not to be re-used without verification by an independent professional qualified to verify such data or information. The EPA does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any loss or injury resulting from reliance upon the information shown.

Swift Creek Site Investigation
August 23, 2006
Activity-Based Sampling Areas 2-1, 2-2

0 10 20 40 60 Meters

N



The U.S. Environmental Protection Agency (EPA) has compiled this computer representation from data or information sources that may not have been verified by the EPA. This data is offered here as a general representation only, and is not to be re-used without verification by an independent professional qualified to verify such data or information. The EPA does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any loss or injury resulting from reliance upon the information shown.

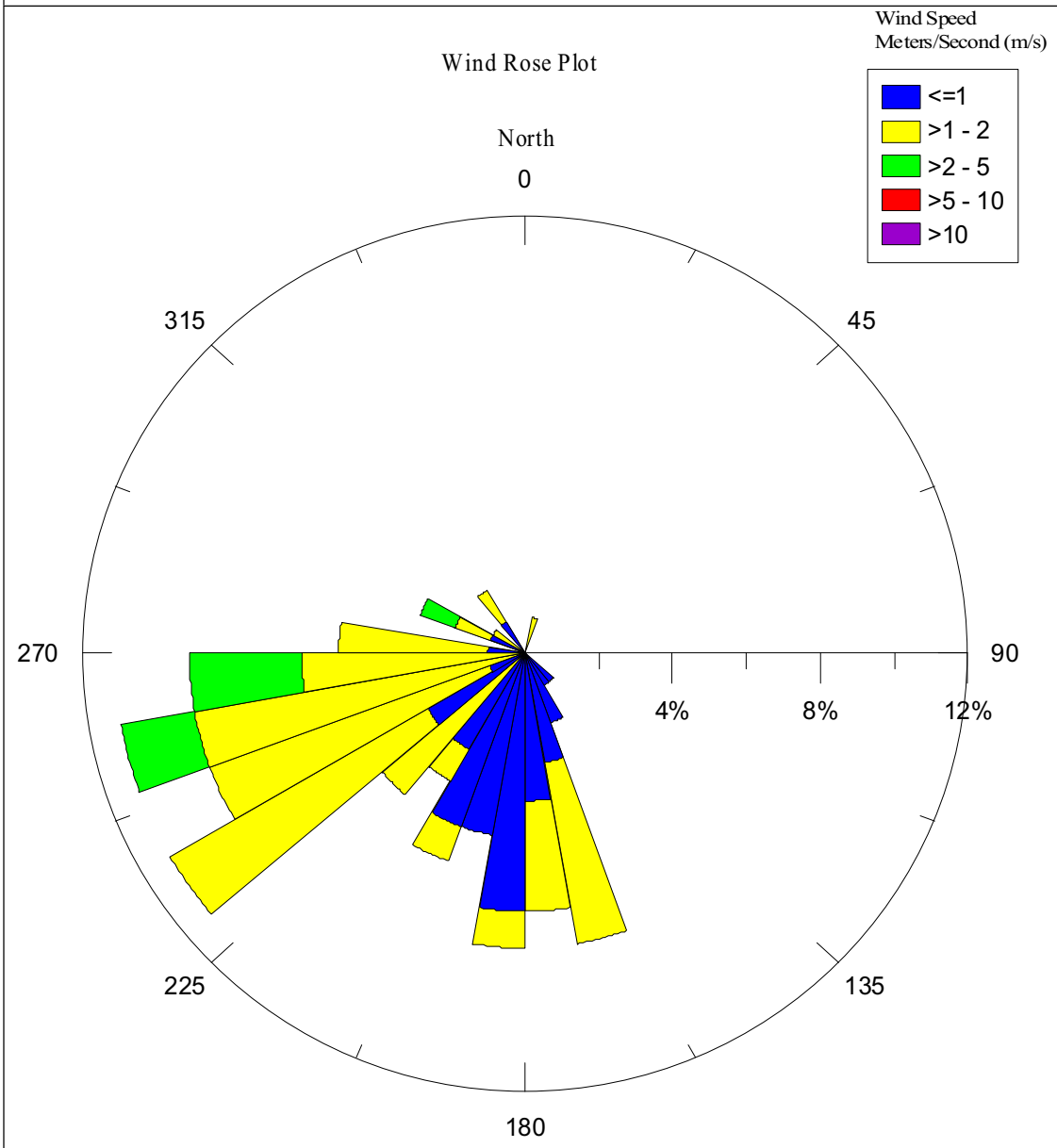
Swift Creek Site Investigation
August 24, 2006
Activity-Based Sampling Areas 2 and 3

0 10 20 40 60 Meters

N

Swift Creek Asbestos Site

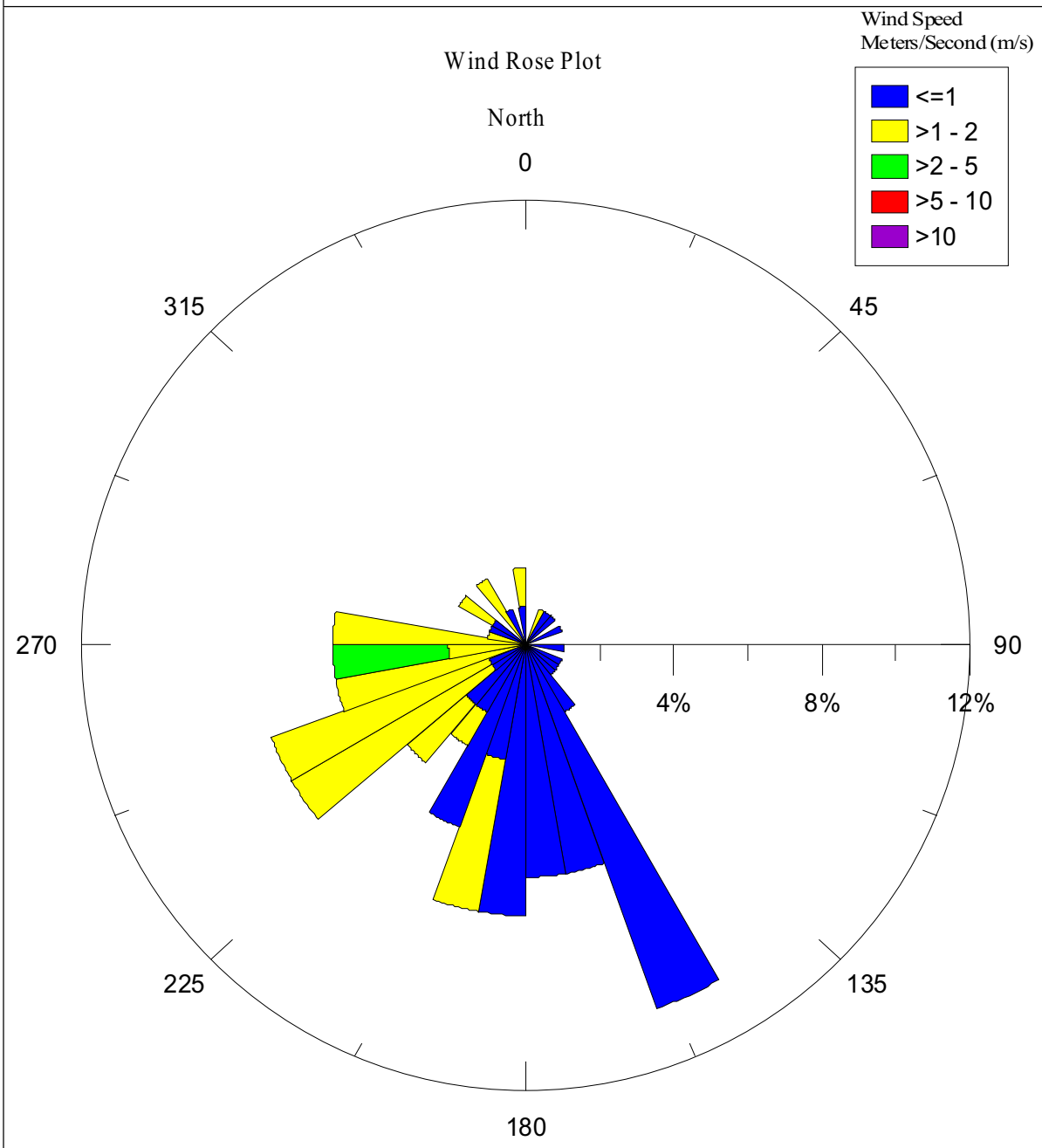
Weather Data – ABS 1 REP 1



Date: August 22, 2006	**Time:**	**Start** - 11:00 AM **Stop** – 02:16 PM	**Average wind speed**: 1.2 m/s **Range:** 0.2 m/s to 2.4 m/s
Average Air Temperature: 20.34° C **Range:** 19° C to 22.4° C	**Average Relative Humidity:** 59.24% **Range:** 52% to 65%		**Data collected by:** Jed Januch U.S. EPA Region 10 - OEA

Swift Creek Asbestos Site

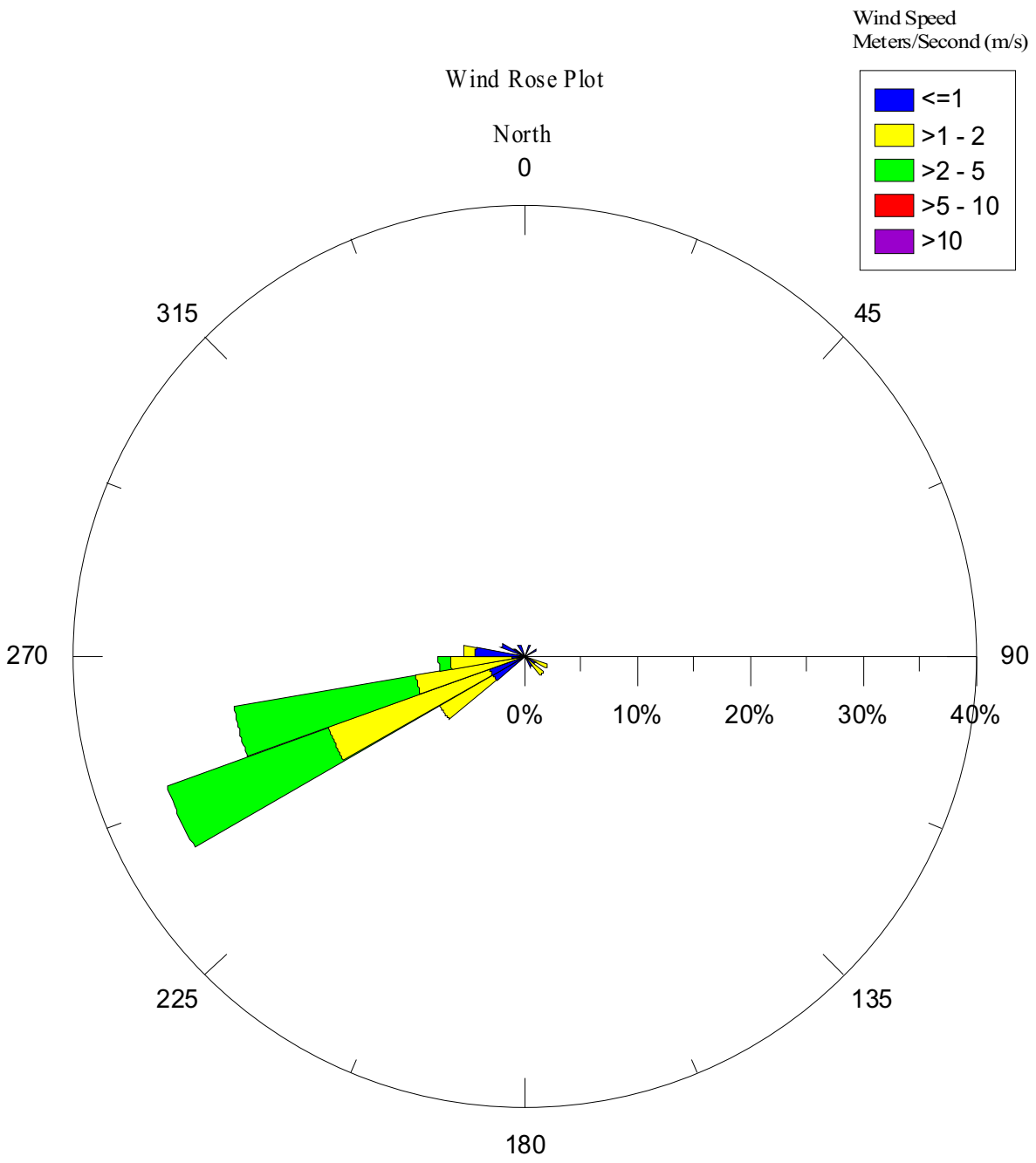
Weather Data – ABS 1 REP 2



Date: August 22, 2006	**Time:**	**Start** - 02:50 PM **Stop** – 06:00 PM	**Average wind speed**: 0.98m/s **Range:** 0 m/s to 2.5 m/s
Average Air Temperature: 22.2° C **Range:** 20.9° C to 23.7° C	**Average Relative Humidity:** 52.79% **Range:** 47% to 56%		**Data collected by:** Jed Januch U.S. EPA Region 10 - OEA

Swift Creek Asbestos Site

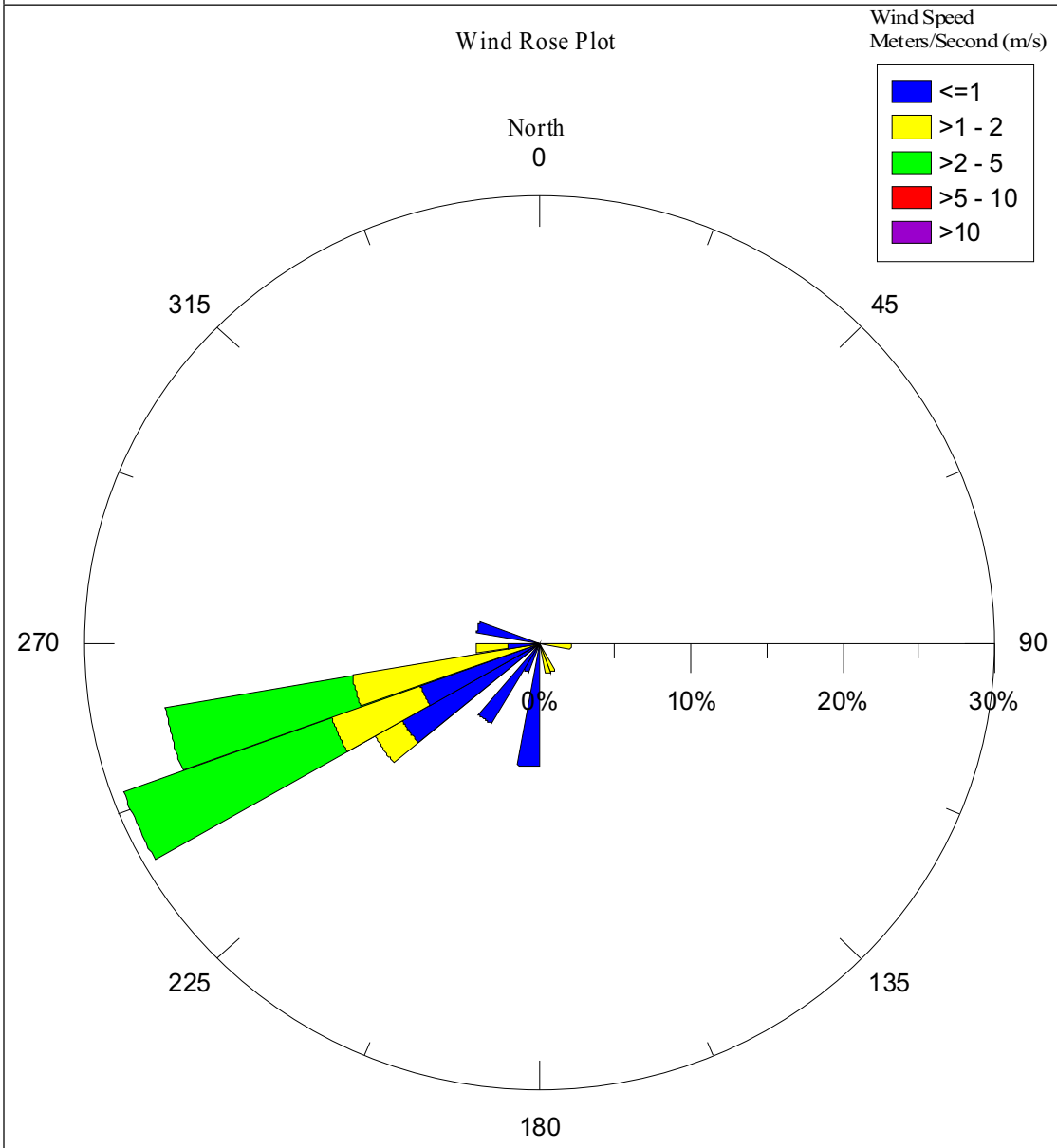
Weather Data – ABS 1 REP 3



Date: August 23, 2006	**Time:**	**Start** - 09:54 AM **Stop** – 12:56 PM	**Average wind speed**: 1.68 m/s **Range:** 0.2 m/s to 3.8 m/s
Average Air Temperature: 17.99° C **Range:** 16.2° C to 20.1° C	**Average Relative Humidity:** 69.03% **Range:** 60% to 75%		**Data collected by:** Jed Januch U.S. EPA Region 10 - OEA

Swift Creek Asbestos Site

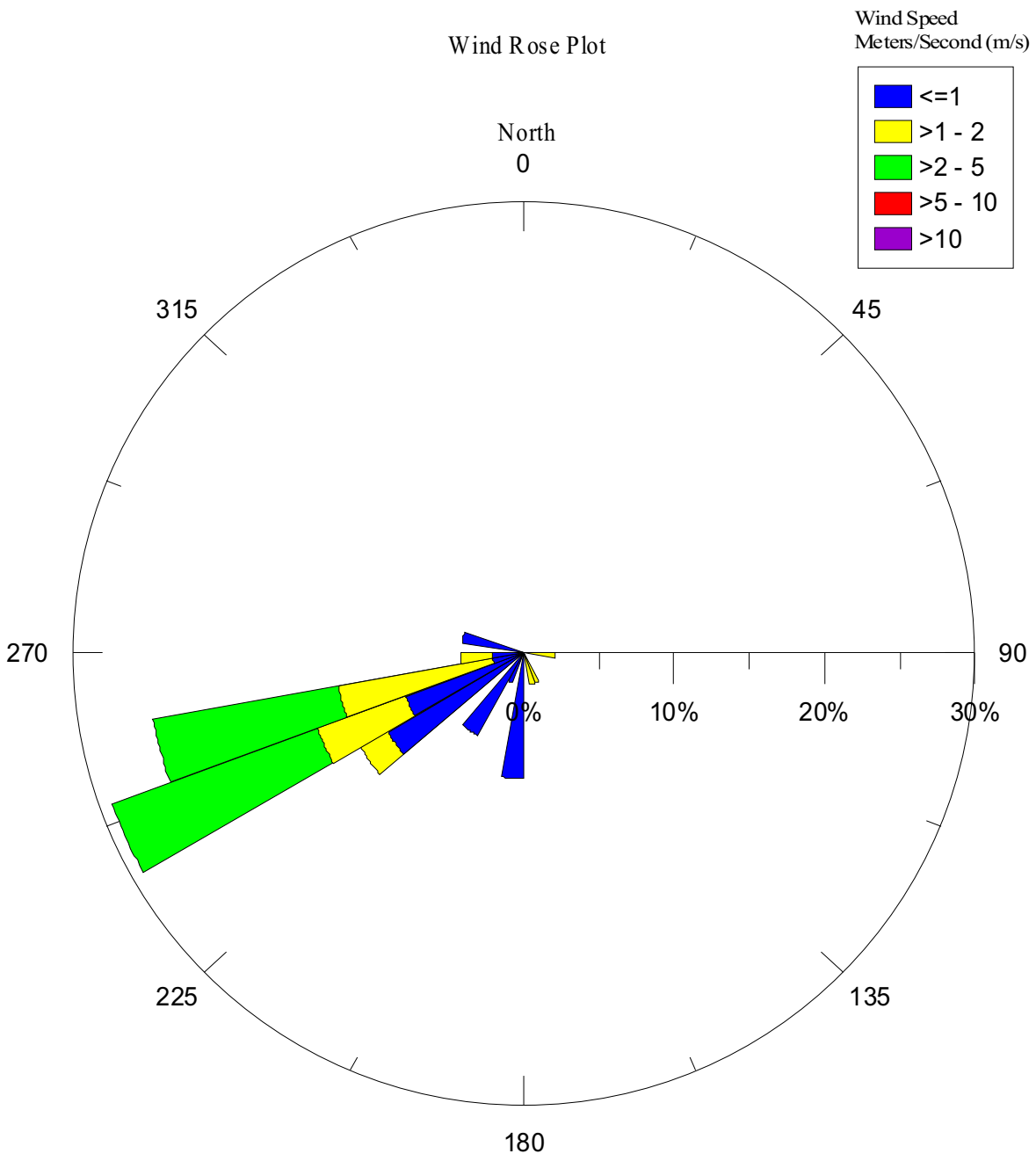
Weather Data – ABS 2 REP 1



Date: August 23, 2006	**Time:**	**Start** - 01:19 PM **Stop** – 04:19 PM	**Average wind speed**: 1.7 m/s **Range:** 0.3 m/s to 3.6 m/s
Average Air Temperature: 20.21° C **Range:** 21.2° C to 19.4° C	**Average Relative Humidity:** 60.79% **Range:** 58% to 64%		**Data collected by:** Jed Januch U.S. EPA Region 10 - OEA

Swift Creek Asbestos Site

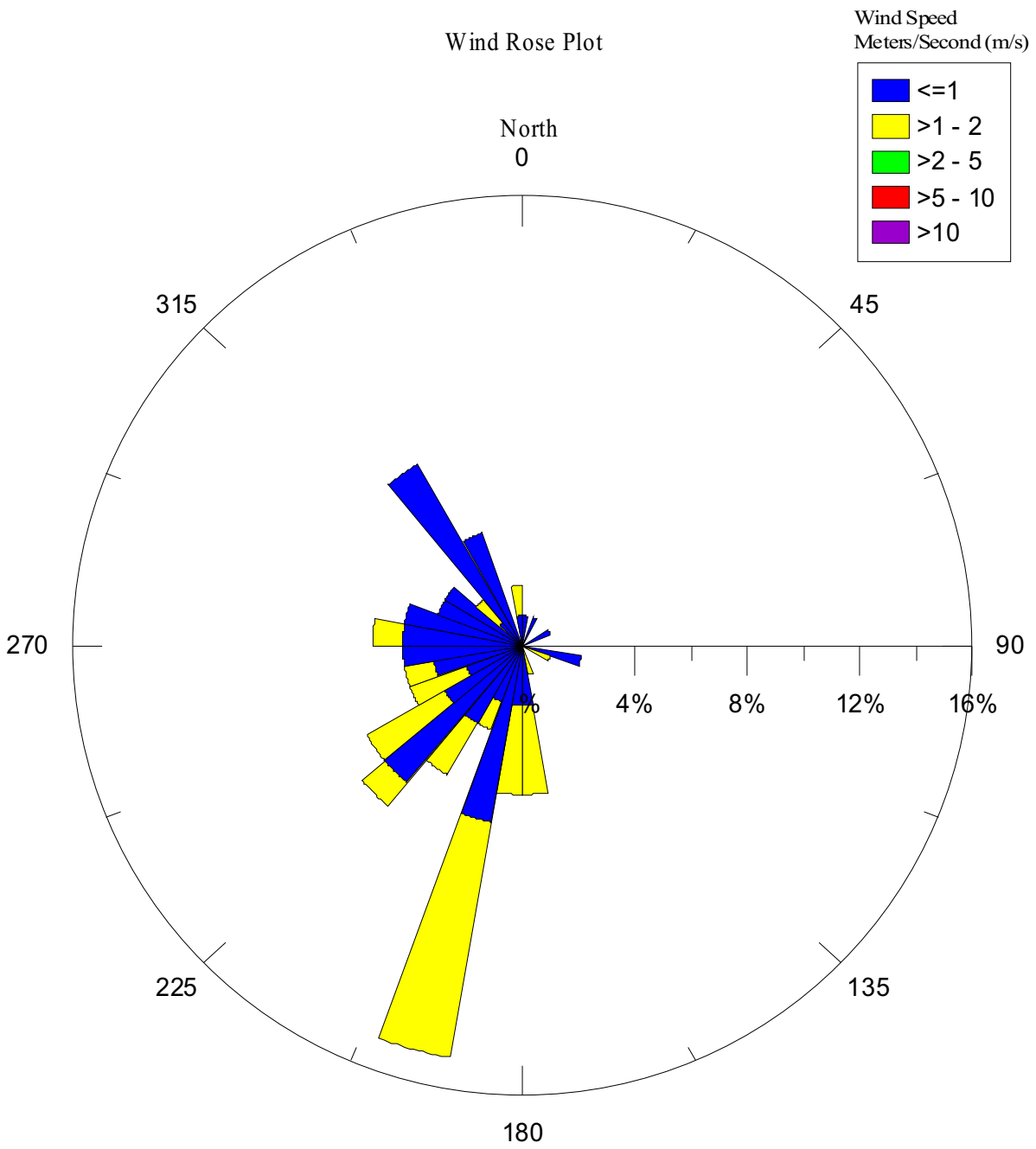
Weather Data – ABS 2 REP 2



Date: August 23, 2006	**Time:**	**Start** - 02:53 PM **Stop** – 04:22 PM	**Average wind speed**: 1.47 m/s **Range:** 0.3 m/s to 3.5 m/s
Average Air Temperature: 20.38° C **Range:** 19.7° C to 21.2° C	**Average Relative Humidity:** 60.46% **Range:** 58% to 64%		**Data collected by:** Jed Januch U.S. EPA Region 10 - OEA

Swift Creek Asbestos Site

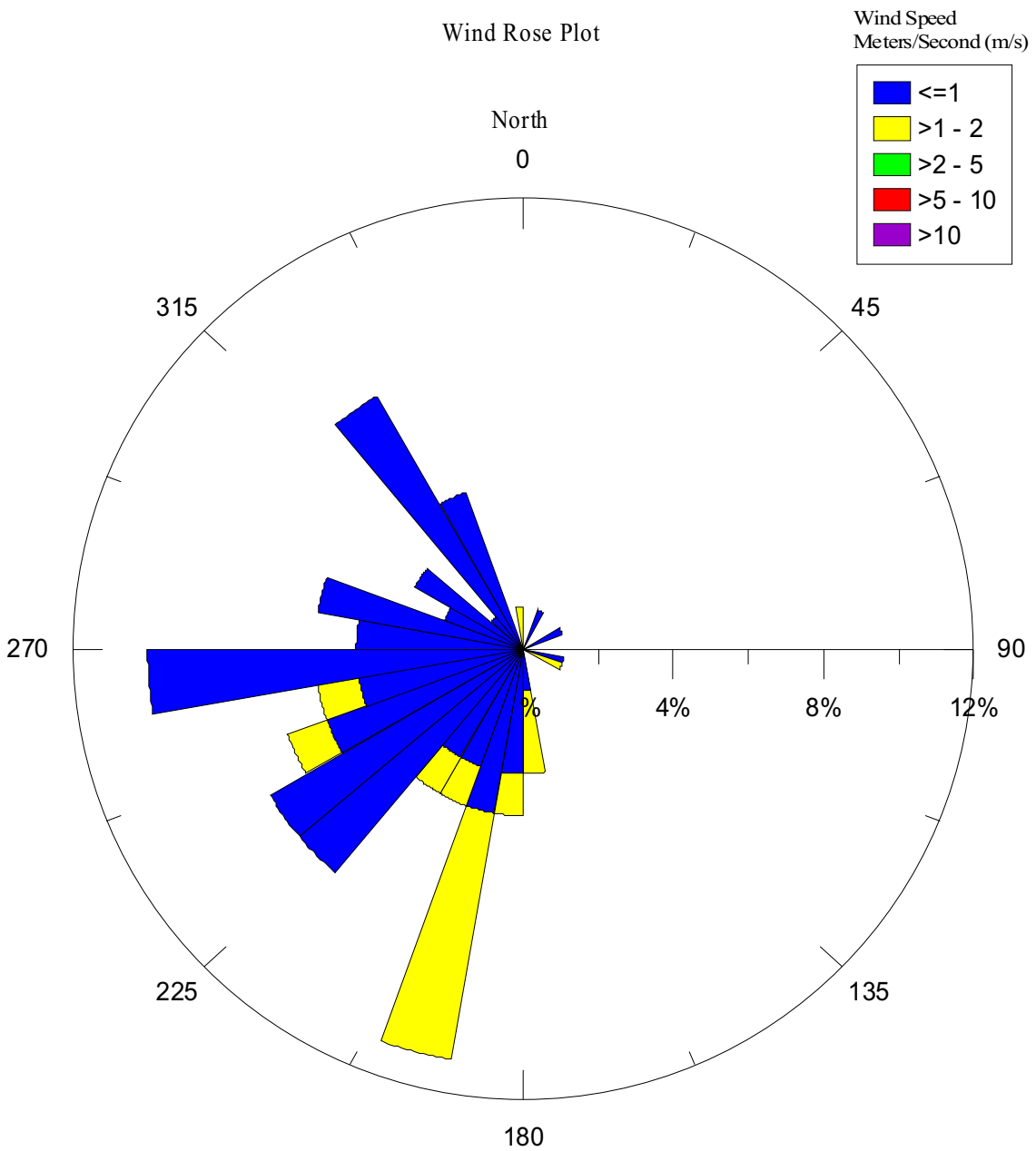
Weather Data – ABS 2 REP 3



Date: August 24, 2006	**Time:**	**Start** - 09:30 AM **Stop** – 12:36 PM	**Average wind speed**: 0.86m/s **Range:** 0.1 m/s to 2.0 m/s
Average Air Temperature: 17.45° C **Range:** 15.5° C to 19.3° C	**Average Relative Humidity:** 69.34% **Range:** 62% to 78%		**Data collected by:** Jed Januch U.S. EPA Region 10 - OEA

Swift Creek Asbestos Site

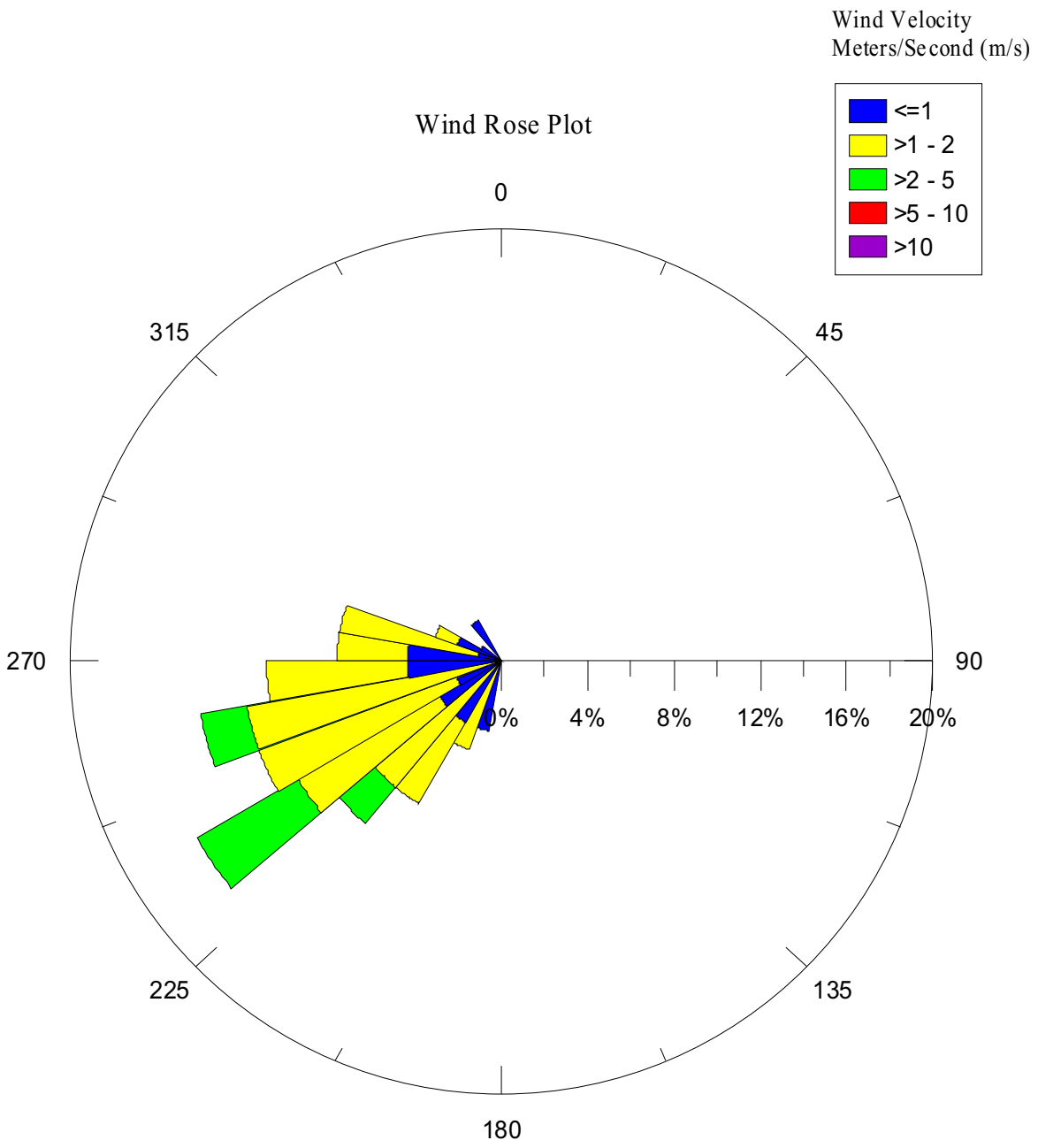
Weather Data – ABS 3 REP 1



Date: August 24, 2006	**Time:**	**Start** - 08:34 AM **Stop** – 11:32 AM	**Average wind speed**: 0.7 m/s **Range:** 0.1 m/s to 2 m/s
Average Air Temperature: 16..26° C **Range:** 14.6° C to 17.9° C	**Average Relative Humidity:** 74.03% **Range:** 66% to 81%		**Data collected by:** Jed Januch U.S. EPA Region 10 - OEA

Swift Creek Asbestos Site

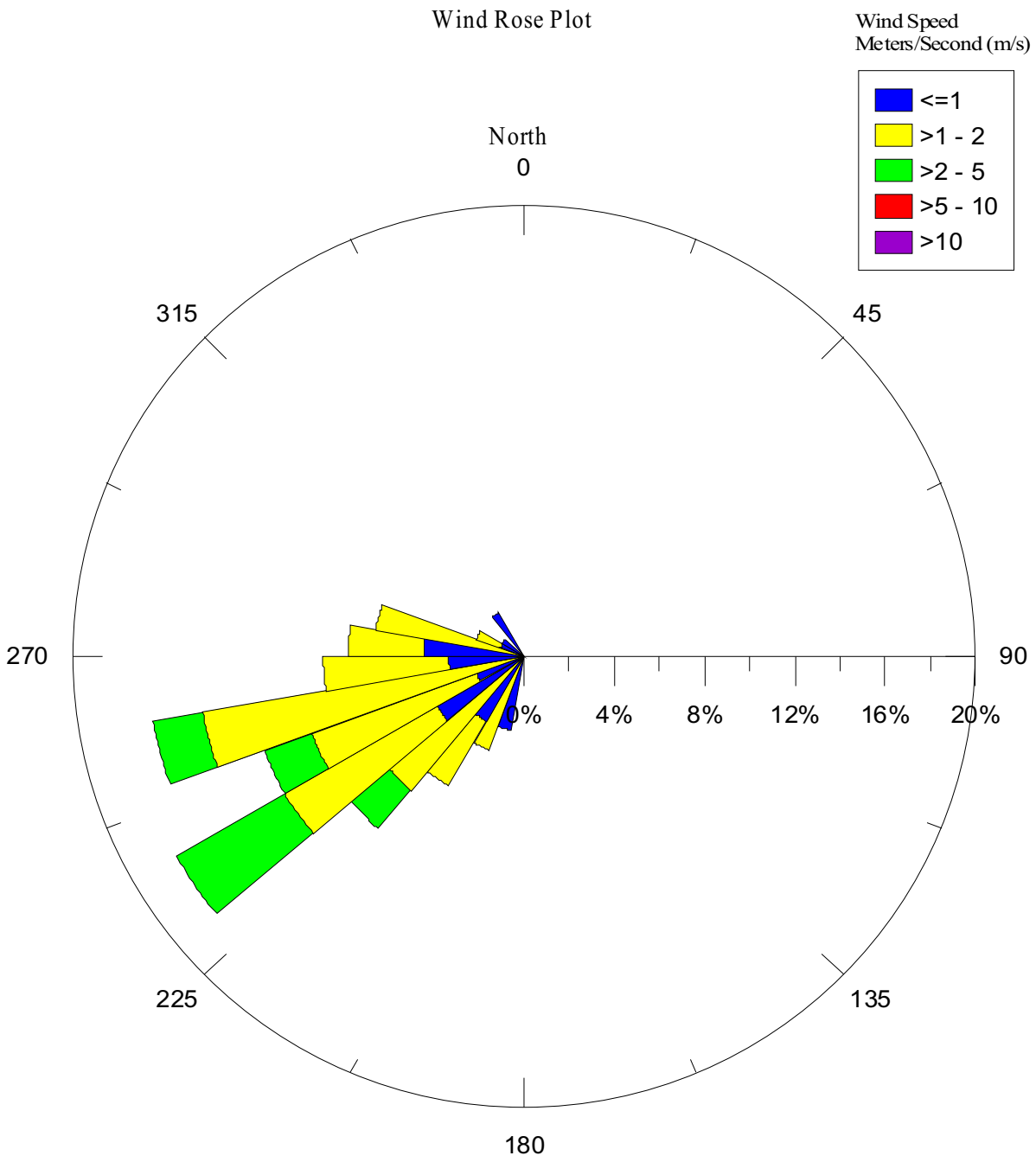
Weather Data – ABS 3 REP 2



Date: August 24, 2006	**Time:**	**Start** - 01:06 PM **Stop** – 04:08 PM	**Average wind speed**: 1.35 m/s **Range:** 0 m/s to 2.4 m/s
Average Air Temperature: 20.4° C **Range:** 18.7° C to 22.6° C	**Average Relative Humidity:** 60.8% **Range:** 53% to 66%		**Data collected by:** Jed Januch U.S. EPA Region 10 - OEA

Swift Creek Asbestos Site

Weather Data – ABS 3 REP 3



Date: August 24, 2006	**Time:**	**Start** - 01:36 PM **Stop** – 04:34 PM	**Average wind speed**: 1.36m/s **Range:** 0 m/s to 2.4 m/s
Average Air Temperature: 20.7° C **Range:** 19.2° C to 22.6° C	**Average Relative Humidity:** 59.92% **Range:** 53% to 66%		**Data collected by:** Jed Januch U.S. EPA Region 10 - OEA