Appendix D

Risk Evaluation for Activity-Based Sampling Results, Swift Creek site, Whatcom County, Washington
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(Wroble 2007)

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February 8, 2007

Reply to
Attn Of: OEA-095

MEMORANDUM

SUBJECT: Risk Evaluation for Activity-Based Sampling Results, Swift Creek
Site, Whatcom County, Washington

FROM: Julie Wroble
            Region 10 Toxicologist

TO: Denise Baker-Kircher
            Site Assessment Manager

Introduction

This memorandum presents a summary of the results of a risk evaluation using
activity-based sampling data collected by the U.S. Environmental Protection
Agency (EPA) at the Swift Creek site. EPA is concerned about exposures to
asbestos at the Swift Creek site because inhalation of asbestos fibers has been
associated with several diseases including mesothelioma, lung cancer,
asbestosis, and other respiratory illnesses.

The risk estimates presented in this memorandum include only intermittent
activities that individuals who live near the Swift Creek site may participate in. It
is possible that individuals are exposed to asbestos from dredged materials in
ways and from sources that are not addressed in this document. Actual
exposures could be higher or lower than those estimated herein.

Activity-Based Sampling Objectives

Workers dressed in appropriate personal protective equipment mimicked outdoor
activities conducted by residents and workers to determine whether asbestos
fibers in dredged material from the Swift Creek site could be released into the
breathing space of individuals conducting these activities. Further, the levels of
fibers measured in air were combined with information regarding exposure to
calculate potential excess lifetime cancer risks associated with specific activities.
The activities conducted included a site worker excavating and moving soil using
a front-end loader and dump truck; a nearby resident moving and spreading soil;
and a site visitor walking and biking along the banks of Swift Creek between

Goodwin Road and Oat Coles Road. EPA conducted the activity-based sampling consistent with the Quality Assurance Project Plan (QAPP) developed for the site (EPA 2006a).

Sampling Procedures
The Activity Based Sampling Plan (EPA 2006b) contains a detailed description of how sampling was to be conducted. During each activity, the participants wore level C personal protective equipment (PPE). Level C PPE means that workers had respirators to protect them from inhalation hazards (i.e., asbestos). For the recreational scenario, athletic shoes were substituted for work boots.

Loading Dredged Materials with a Front End Loader. This activity was designed to simulate an individual loading dredged material with a front end loader into a truck. The study area was roughly a 100-foot by 100-foot square-shaped area at the west end of the berm on the south bank of the creek. During this activity, one participant operated a front end loader to remove dredged material from the berm and place it into the bed of a dump truck. A second participant observed the activity and directed the operator. The activity consisted of moving loads of dredged material to the second sampling area. The duration of this activity was approximately 180 minutes in duration.

Shoveling and Raking Dredged Materials. This activity was designed to simulate an individual spreading dredged material on a flat surface such as a driveway or walking path. During this activity, two participants shoveled dredged material from a pile into a wheel barrow and spread the material on a surface covered with 10 millimeter (mil) plastic sheeting inside the study area. The dimensions of the study area were about 10 feet by 60 feet and were delineated with yellow caution tape during the activity.

Recreational Activity. This activity was designed to simulate a recreational activity such as jogging or bike riding. Two individuals were required to perform the activity, one trailing the other. During this activity, the participant(s) walked, jogged, and biked on the piles of dredged materials adjacent to Swift Creek. No stationary air monitoring samples were collected during this activity because this activity occurred over a relatively large area.

All Activities. Workers dressed in appropriate PPE wore personal pumps. Samples were collected on 0.8-micron pore size mixed cellulose ester filters fitted into standard sampling cassettes. In some cases, a worker wore two pumps so that a duplicate sample could be collected. In one case, the duplicate sample was submitted for transmission electronic microscopy (TEM) analysis. In the other cases, the duplicate sample was analyzed in the field by phase-contrast microscopy (PCM) to check the filter loading. Pumps were run at a flow rate of between 2.0 and 3.6 liters per minute.

Stationary samples were collected to determine air concentrations of asbestos near where activities were conducted using medium high-volume samplers placed around the work area. These samples were collected for between 3½ and about 8 hours at a flow rate of about 10 liters per minute.

Analytical Methods
Samples were field-screened using PCM (NIOSH Method 7400) to determine whether filters were too overloaded to be analyzed by a fixed lab using TEM, ISO Method 10312. Note that none of the field-screened filters appeared to be overloaded. TEM results were available for all samples and were reported for all fibers detected greater than 0.5 microns in length, according to the ISO 10312 method.

Results
Sampling results are available for 3 iterations each of the Front End Loader (Loading/Hauling) activity, the Shoveling and Raking activity, and the Recreational (Walking/Biking) activity. Results are also available for 5 stationary samples for the Front End Loader activity and 10 stationary samples for the Shoveling and Raking activity. No stationary samples were collected for the Recreational Activity as participants were moving along an approximately one-mile stretch of creek.

Table 1 shows the results of personal air samples for each of the three activities conducted as part of this field event. The table provides both individual results for each activity in units of asbestos structures per cubic centimeter (s/cc) and the average concentration for each activity. Table 2 shows the results of stationary air samples for the first two activities. These results were not used to estimate risks to individuals, but may be used to determine air concentrations of asbestos adjacent to where the activity was conducted. Results are provided as phase contrast microscopy equivalent (PCME) fibers, as this category of asbestos fibers is commonly used to estimate potential health risks. PCME fibers are asbestos fibers or bundles that measure greater than 5 microns in length, have a width of between 0.25 and 3 microns, and an aspect ratio of greater than or equal to 3-to-1. There are alternate fiber definitions and toxicity values that could be used to assess cancer risk that are under investigation; however, currently EPA uses the PCME fiber definition as presented in IRIS.

Table 3 presents assumptions about various activities that might be undertaken by individuals who reside near Swift Creek or contact material from Swift Creek. The frequency and duration of exposure information in Table 3 is used to generate a time-weighting factor, to relate intermittent exposures to excess lifetime cancer risk. The time-weighting factor provides an estimate of the fraction of an individual's lifetime during which the exposure occurs. EPA developed these time-weighting factors in consultation with the Washington State Department of Health and the Agency for Toxic Substances and Disease

Registry. Additional information about how these time-weighting factors were derived is included in Appendix A.

Excess lifetime cancer risk estimates were generated by combining information about exposure with a potency factor for asbestos. EPA currently uses the potency factor from EPA's Integrated Risk Information System (IRIS); the unit risk value is 0.23 per PCM fibers per milliliter (ml). The personal activity-based sampling results presented in Table 1 were used as the source of exposure information for the Swift Creek site. For each activity that was performed at the site, a mean and maximum concentration value were determined. These two concentrations were used in the risk estimation process. For each exposure activity that is anticipated to occur at the site, the activity-based sampling scenario that best matched the exposure was selected so that the data were appropriate for the exposure. For example, the gardening scenario was matched with the shoveling and raking activity, because these types of activities are likely to occur while gardening. Risks for farming and gardening are likely to be lower than presented in this report, as these activities are unlikely to occur in areas where undiluted Swift Creek sediments are present because nothing easily grows in these sediments.

Table 4 presents cancer risk estimates associated with the various exposure scenarios for mean and maximum results from the activity-based sampling. The representative or characteristic activities conducted at the site (front-end loading, shoveling/raking, and walking/biking) were developed in consultation with the Washington State Department of Health, Whatcom County Health Department, and the Agency for Toxic Substances and Disease Registry. These activities are representative of some, but not necessarily all potential exposures to Swift Creek dredged materials. Excess lifetime cancer risks were estimated by multiplying the exposure point concentration (i.e., PCME concentration measured from the personal samplers) by the time weighting factor and by the cancer potency factor for asbestos (see Appendix A). An alternative approach current being evaluated by EPA is presented in Appendix B. Note that the results of this alternate approach to estimating risk does not change the conclusions of this memorandum.

To understand the potential health significance of these results, consider that EPA typically considers cancer risks less than 1×10^{-6} as *de minimis*, while cancer risks greater than 1×10^{-4} generally require some level of response. An excess lifetime cancer risk of 1×10^{-4} is the upper bound of the range typically used by EPA's Superfund program to make decisions about the need to take action at contaminated sites. However, at the Swift Creek site, the source of the asbestos is from naturally-occurring materials, therefore, remedial decisions may not be straightforward. The use of 1×10^{-4} as a benchmark is consistent with other asbestos sites throughout the nation.

This sampling event demonstrated that asbestos fibers in dredged materials from the Swift Creek site are released into the breathing zone when certain outdoor activities are conducted. In most cases, the detected levels of fibers are not associated with risks greater than 1×10^{-4}; however, for some activities (e.g., dredging hauling, farm-related soil work, and gardening), risks generally exceed this range. Sampling was intentionally conducted during the warmer and drier summer months; consequently, concentrations of fibers in air may be higher than during other times of the year. Also, note that EPA did not wet soils prior to dredging and hauling soils as is typically done by dredging contractors that work at the site. Wetting these materials prior to conducting work may help minimize exposures to airborne fibers; however the extent of exposure reduction is uncertain.

The stationary sampling results are generally about an order of magnitude (10 times) lower than the activity-based sampling results. This is consistent with measurements made at other sites. Risks were estimated for personal sampling results only as stationary sampling results do not adequately represent exposures to human receptors.

Asbestos was not readily observed in dredged materials from Swift Creek; however, on closer inspection using a hand lens, some fiber bundles could be observed. As stated in an earlier report (E & E 2006), asbestos concentrations as measured using polarized light microscopy (PLM) analysis of dredged materials ranged from about 0.1% to about 4.4 % with a mean of about 1.8%.

Moisture content results are presented in Table 5. The moisture content in samples collected from the piles where the raking/shoveling activity was conducted are presented in the top part of the table and moisture content in samples collected after raking are presented in the bottom part of the table. As you can see, in the unraked samples, moisture content ranges from 6.3% to 7.8% (mean 7.1%). These soils were observed to be damp. In the raked samples, moisture content ranges from 2.6% to 4.5% (mean 3.6%). These soils were still damp, but were lighter in color and seemed to be drying. These data demonstrate how the dredged materials dry out upon disturbance and spreading.

Uncertainty Discussion
The risk evaluation process is an uncertain process. At the Swift Creek site, there are several uncertainties that may result in over- or underestimation of risk. These uncertainties are briefly described below and the possible impact on the risk calculations is provided.

- Only fibers that meet the PCME size requirement were included. Presumably, risk based on this fiber category is protective of exposures to other size categories. The actual risk could be higher or lower depending on the relative proportion of PCME fibers to the total number of asbestos structures. In the samples collected at this site, PCME fibers made up

- about 1-10% of the total number of asbestos structures. Many fibers were shorter and thinner than the PCME category.
- Lifetime risk estimates from early life, less than lifetime exposures may be up to 3-fold higher (Nicholson, as cited in http://www.epa.gov/iris/subst/0371.htm). The calculations in Appendix B demonstrate this increase for some pathways.
- Increased respiration (e.g., breathing) while performing some activities could result in higher exposures than what was estimated for this risk evaluation. Also, the activities were selected to be representative of the types of exposures that may occur at the site and to site related media, but we recognize that other exposures may be occurring. Risks associated with other types of exposures not included in the present analysis may be higher or lower than those presented herein.
- This risk evaluation did not estimate risks from exposures to materials that may have originated at Swift Creek but that have been taken off site to other locations. It is possible that exposures to material that has been moved off site also could result in risks that exceed EPA's risk management range.
- The risk evaluation considered only intermittent exposures for some activities. It is possible that individuals that live near the Swift Creek site have exposures to asbestos from the dredged materials that have not been assessed in this memorandum. Additional exposure pathways may result in increases in excess lifetime cancer risk.
- The type of asbestos detected in samples collected at this site is predominantly chrysotile. A few samples had small amounts of amphibole, but these amounts comprised only a very small percentage of the total number of fibers observed. Chrysotile asbestos may be a less potent carcinogen than amphibole; however, the unit risk for asbestos does not differentiate between fiber type.

Recommendations/Conclusions

The results of this risk evaluation generally indicate that for some activities, risk levels may be elevated above the high end of EPA's risk management range of 1×10^{-6} to 1×10^{-4}; however, not all activities that occur in proximity to Swift Creek dredged materials were evaluated. An alternate risk approach was presented in Appendix B. This alternate approach varies from the IRIS approach because risk estimates are dependent on the age of first exposure. For exposures that begin in childhood, the risk estimates are increased as compared with using the IRIS unit risk value as described in Appendix A. For exposures that begin in adulthood, risks are moderately smaller as compared with risks calculated using the IRIS unit risk value.

Residents living near the Swift Creek site should practice measures to limit exposures to Swift Creek dredged materials and associated asbestos fibers. EPA is also concerned that people may contact materials that have been moved from

the Swift Creek dredge piles to other locations in Whatcom County. Contact with these materials may also result in exposures to asbestos fibers, but the extent of exposure is uncertain and activity dependent. Risk from asbestos exposure increases with higher concentration, greater frequency and duration of exposure, and time since first exposure. Additional sampling at other areas could be used to assess risks at locations remote from the Swift Creek site.

Given the ongoing exposures that may occur near the Swift Creek site and the demonstration that fibers are released into the breathing zone upon disturbance, I recommend that community education be considered to prevent or minimize ongoing exposures to the current and potential future residents in this community. Additional information on naturally occurring asbestos can be found on-line at the following locations:

- California Air Resources Board: http://www.placer.ca.gov/Air/NOA.aspx
- Agency for Toxics Substances and Disease Registry: http://www.atsdr.cdc.gov/asbestos/

References:

Contaminants of Potential Concern (COPC) Committee of the World Trade Center Indoor Air Task Force Working Group, May 2003, World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks.

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

International Organization for Standardization, 1995, Ambient Air – Determination of Asbestos Fibres – Direct-transfer Transmission Electron Microscopy Method, Reference No. ISO 10312:1995(E).

National Institute for Occupational Safety and Health, Method 7400, Asbestos and Other Fibers by PCM, Method 7400, Issue 2, NIOSH Manual of Analytical Methods (NMAM), Fourth Edition, 8/ 15/ 1994, http://www.cdc.gov/niosh/nmam/pdfs/7400.pdf.

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

U.S. EPA, August 2006b, Activity Based Sampling and Analysis Plan, Swift Creek, Whatcom County, Washington, Revision 1.

U.S. EPA, January 1998, Interim Final Guidance: Developing Risk-Based Cleanup Levels at Resource Conservation and Recovery Act Sites in Region 10, EPA 910/R-98-001, Seattle, Washington.

U.S. EPA, August 1997, Exposure Factors Handbook, National Center for Environmental Assessment, Office of Research and Development, http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=12464.

Weis, Christopher P. Ph.D., DABT, July 9, 2001, Memorandum to Paul Peronard, On-Scene Coordinator, Libby Asbestos Site, Fibrous Amphibole Contamination in Soil and Dust at Multiple Locations in Libby Poses an Imminent and Substantial Endangerment to Public Health: an Addendum to my Memorandum of May 10, 2000.

Table 1
Analytical Results Summary, Personal Samples
Swift Creek Activity-Based Sampling

Sample Number	Description	Number of PCME Fibers	Analytical Sensitivity (s/cc)	PCME concentration (s/cc)
	Loading/Hauling			
6346006	ABS1 Personal Rep1 Keven	1	0.0441	0.0441
6346007	ABS1 Personal Rep1 Doc	2	0.01619	0.03238
6346009	ABS1 Personal Rep2 Keven	4	0.01596	0.06384
6346010	ABS1 Personal Rep2 Doc	2	0.01628	0.03256
6346012	ABS1 Personal Rep3 Dave T.	5	0.04152	0.2076
6346013	ABS1 Personal Rep3 Keven	10	0.00867	0.0867
Mean				0.078
	Shovling/Raking			
6346019	ABS2 Personal Rep1 Julie	4	0.00604	0.02416
6346020	ABS2 Personal Rep1 Gary	1	0.00284	0.00284
6346022	ABS2 Personal Rep2 Grechen	1	0.00521	0.00521
6346023	ABS2 Personal Rep2 Rob	1	0.00865	0.00865
6346039	ABS2 Personal Rep3 Grechen	5	0.00806	0.0403
6346040	ABS2 Personal Rep3 Dave	4	0.00672	0.02688
Mean				0.018
	Walking/Biking			
6346032	ABS3 Personal Rep1 Julie	6	0.01557	0.09342
6346033	ABS3 Personal Rep1 Gary	0	0.0231	0
6346044	ABS3 Personal Rep2 Julie	0	0.0121	0
6346045	ABS3 Personal Rep2 Gary	1	0.01607	0.01607
6346047	ABS3 Personal Rep3 Dave	4	0.01417	0.05668
6346048	ABS3 Personal Rep3 Grechen	1	0.00898	0.00898
Mean				0.029

Key:

PCME - Phase-contrast microscopy equivalent

s/cc - structures per cubic centimeter

Table 2
Analytical Results Summary, Stationary Samples
Swift Creek Activity-Based Sampling

Sample Number	Description	Number of PCME Fibers	Analytical Sensitivity (s/cc)	PCME concentration (s/cc)
	Loading/Hauling			
6346000	ABS1 Stationary North	3	0.00939	0.02817
6346001	ABS1 Stationary South	1	0.00048	0.00048
6346002	ABS1 Stationary West	4	0.0002	0.0008
6346003	ABS1 Stationary East	4	0.00058	0.00232
6346005	ABS1 Downwind Hi Vol	2	0.00043	0.00086
Mean				0.006526
	Shovling/Raking			
6346015	ABS2 Stationary East	3	0.0001	0.0003
6346026	ABS2 Stationary Rep2 East	1	0.00345	0.00345
6346016	ABS2 Stationary North	1	0.00178	0.00178
6346017	ABS2 Stationary West	2	0.00026	0.00052
6346018	ABS2 Stationary South	2	0.00014	0.00028
6346025	ABS2 Stationary Rep2 South	1	0.00045	0.00045
6346035	ABS2 Stationary Rep3 North	2	0.00061	0.00122
6346036	ABS2 Stationary Rep3 South	1	0.00106	0.00106
6346037	ABS2 Stationary Rep3 East	1	0.00124	0.00124
6346038	ABS2 Stationary Rep3 West	4	0.00048	0.00192
Mean				0.001222

Key:

PCME - Phase-contrast microscopy equivalent

s/cc - structures per cubic centimeter

Table 3
Time Weighting Factors
Swift Creek Activity-Based Sampling

Scenario	Hours/day	Days/year	Years	TWF	Source
Walking	1	156	30	0.0076	Best professional judgment
Cross Country	1	30	4	0.00020	Best professional judgment
Dredger/Hauler (25 years)	8	30	25	0.0098	Best professional judgment
Dredger Hauler (1 year)	8	30	1	0.00039	Best professional judgment
Child Play	2	350	10	0.011	Table 15-58, EPA 1997
Farming	12	10	30	0.0059	Best professional judgment
Gardening	10	50	30	0.024	Table 15-62, EPA 1997

Key:

TWF - Time-weighting factor (fraction of lifetime during which exposure occurs)

Table 4
Estimated Risks for Scenarios using Personal Activity-Based Sampling Results and Single Unit Risk
Swift Creek Activity-Based Sampling

Activity-Based Sampling Task	PCME Concentration (s/cc)	Example Risk Scenario		
		Dredge/Haul (25-years)	Dredge/Haul (1-year)	Farm/Soil Work
Loading/Hauling				
Maximum Value	0.2076	5.E-04	2.E-05	3.E-04
Mean	0.078	2.E-04	7.E-06	1.E-04
Shoveling/Raking		Gardening	Child Play	
Maximum Value	0.0403	2.E-04	1.E-04	
Mean	0.018	1.E-04	5.E-05	
Walking/Biking		Walking	Cross Country	
Maximum Value	0.09342	2.E-04	4.E-06	
Mean	0.029	5.E-05	1.E-06	

Key:

PCME - Phase-contrast microscopy equivalent

s/cc - structures per cubic centimeter

Table 5

Moisture Content		
Swift Creek Activity-Based Sampling		
Sample Number	**Location**	**Result**
06344027	ABS 2 - Pile 1	6.3%
06344027 (dup)	ABS 2 - Pile 1	6.6%
06344030	ABS 2 - Pile 3	7.8%
06344042	ABS 2 - Pile 2	7.7%
Average, unraked		7.1%
06344028	ABS 2 - Raked Material From Pile 1	2.6%
06344029	ABS 2 - Raked Material From Pile 3	3.6%
06344043	ABS 2 - Raked Material From Pile 3	4.5%
Average, raked		3.6%

APPENDIX A

INPUTS FOR RISK CALCULATIONS
ACTIVITY-BASED SAMPLING ACTIVITIES

1.0   Basic Equations

Risk from inhalation exposure to asbestos fibers may be calculated using the following basic equation:

$$Risk = C * UR * TWF$$

Where:

C = Concentration of fibers in air (s/cc)
UR = Unit Risk (risk per f/ml or risk per s/cc)
TWF = time-weighting factor (fraction of lifetime during which exposure occurs)

2.0   Inputs for Calculation of Excess Lifetime Cancer Risk

Each of the three input parameters needed to calculate the excess lifetime cancer risk is discussed below, along with the resulting values.

Concentration
The concentration of asbestos fibers in air were determined based on activity-based sampling measurements made during August 2006 at the Swift Creek site. For each of three activities conducted, a mean and maximum concentration was determined. These concentrations were used to calculate risk for certain site-related activities.

Unit Risk
The unit risk is a measure of the cancer potency of a given substances For asbestos, EPA's integrated risk information system (IRIS) identifies a unit risk of 0.23 per PCM fiber per ml (http://www.epa.gov/iris/subst/0371.htm).

Time-Weighting Factor
The TWF is the fraction of a lifetime that exposure occurs. This depends on the assumed time, frequency, and duration of exposure. For the purposes of these calculations, the following assumptions were used:

Activity	Exposure Time (hr/day)	Exposure Frequency (d/year)	Exposure Duration (years)	Total hours	TWF
Total	24	365	70	613200	1.00
Walking	1	156	30	4680	0.0076
Cross Country	1	30	4	120	0.00020
Dredger/Hauler (25 years)	8	30	25	6000	0.0098

Dredger/Hauler (1 year)	8	30	1	240	0.00039
Child Playing in the Dirt	2	350	10	7000	0.011
Farming/Soil Work	12	10	30	3600	0.0059
Gardening	10	50	30	15000	0.024

Note that these assumptions may not be identical to the activities actually conducted at the site. Rather, these were selected to represent a conservative estimate of the actual exposures associated that may occur. These assumptions are based on upper percentile values presented in EPA's Exposure Factors Handbook (EPA 1997).

Briefly, the values selected for these scenarios were based on the following references:

Walking: Best professional judgment was used to estimate the time-weighting factor for walking. An individual was assumed to walk for one hour per day, 3 days per week, for the entire year. This seemed reasonable as people are known to walk for recreational purposes along Swift Creek between Goodwin Road and Oat Coles Road.

Cross Country: EPA learned that a high school cross country team used to train along Swift Creek. Therefore, EPA assumed that cross country runners trained along Swift Creek 1 hour per day, 5 days a week, for 6 weeks for 4 years (length of time in high school). These assumptions are based on best professional judgment.

Dredger/Hauler: EPA understands that the Swift Creek has been dredged regularly for the past several decades for flood control purposes. A worker was assumed to dredge Swift Creek for 8 hours per day for 30 days. Additionally, a dredger/hauler was assumed to do this activity for 25 years (EPA 1998) or one year (best professional judgment). The 25-year exposure duration assumption is appropriate if the same individual performs the dredging activity every year for their entire career. The 1-year exposure duration is appropriate if a different individual performs the dredging every year.

Child Playing in the Dirt: Exposure Factors Handbook, Table 15-58, the 90th percentile value of 120 minutes/d for children ages 1-11 was used for the exposure time. The exposure frequency of 350 days per year assumes children play out doors every day except for 2 weeks that they may be on vacation away from home. The entire span of the age group was used for exposure duration.

Farming: Based on best professional judgment, EPA assumed that a farmer may work soil contaminated with Swift Creek sediments for 12 hours per day, 10 days per year, for 30 years.

Gardening: This scenario is based on the 95th percentile value for hours per month that adults garden as provided in the Exposure Factors Handbook, Table 15-62, combined with the standard EPA residential exposure duration.

APPENDIX B

ALTERNATE APPROACH FOR ESTIMATING RISK FROM
ACTIVITY-BASED SAMPLING ACTIVITIES

1.0   Basic Equations

An alternate approach to calculating risk from inhalation exposure to asbestos fibers may be performed using a lifetable approach and using the following basic equation:

Risk = C * PV * hours/24 * days/365

Where:

C = Concentration of fibers in air (s/cc)
PV = Potency Value (risk per f/ml or risk per s/cc) taken from Table B-1
Hours = hours per day that exposure is estimated to occur
Days = days per year that exposure is expected to occur

This approach varies from the approach presented in Appendix A in that the age at which exposure starts and the duration of the exposure are included in the potency value that is assumed. In the case where the exact age at first exposure and duration are not available, then the value which best represents the exposure to be evaluated should be used.

2.0   Inputs for Calculation of Excess Lifetime Cancer Risk

Each of the four input parameters needed to calculate the excess lifetime cancer risk is discussed below, along with the resulting values.

<u>Concentration</u>
The concentration of asbestos fibers in air were determined based on activity-based sampling measurements made during August 2006 at the Swift Creek site. For each of three activities conducted, a mean and maximum concentration was determined. These concentrations were used to calculate risk for certain site-related activities.

<u>Potency Value</u>
The potency values for asbestos were generated from epidemiological data in humans, summed across lung cancer and mesothelioma, and adjusted for a conversion from worker exposure to residential exposure. The values presented in Table B-1 are presented assuming a different age at onset (i.e., start of exposure), and various durations of exposures. For walking, dredging/hauling (25 years), farming, and gardening, exposures were assumed to begin at age 20 and last for 20 years; consequently a potency value of 0.063 risk per f/cc was assumed. For the cross country scenario, exposure was assumed to begin at age 10, and last for 5 years; consequently, a potency value of 0.031 risk per f/cc was assumed. For dredging/hauling (1 year), exposure was assumed to begin at age 20 and last for 1 year; consequently, a potency value of 0.005 risk per f/cc was assumed. Finally, for the child play scenario, exposures were assumed to begin at age 0 and last for 10 years; consequently, a potency value of 0.084 risk per f/cc was assumed. The impact of these assumptions on the resulting risk estimates varies depending on the exposure. For exposures that begin in childhood, the risk estimates derived in this way are higher than those derived using the IRIS unit risk value as described in Appendix A.

Hours
The hours per day of exposure for each scenario included in the risk evaluation are provided in Table 3 of the main report. The basis for these assumptions is included in Appendix A.

Days
The days per year of exposure for each scenario included in the risk evaluation are provided in Table 3 of the main report. The basis for these assumptions is included in Appendix A.

Table B-1 Potency Values for Asbestos based on Age at Onset and Exposure Duration

Age at Onset (yrs)	Duration of Exposure (yrs)				
	1	5	10	20	LT
0	0.010	0.046	0.084	0.140	0.230
10	0.007	0.031	0.058	0.094	0.148
20	0.005	0.021	0.038	0.063	0.093
30	0.003	0.014	0.025	0.042	0.056
50	0.001	0.006	0.010	0.014	0.015

Potency values shown have units of $(PCM\ f/cc)^{-1}$

Table B-2
Estimated Risks for Scenarios using Personal Activity-Based Sampling Results and Variable Potency Values
Swift Creek Activity-Based Sampling

Activity-Based Sampling Task	PCME Concentration (s/cc)	Example Risk Scenario		
		Dredge/Haul (25-years)	Dredge/Haul (1-year)	Farm/Soil Work
Loading/Hauling				
Maximum Value	0.2076	4.E-04	3.E-05	2.E-04
Mean	0.078	1.E-04	1.E-05	7.E-05
Shoveling/Raking		Gardening	Child Play	
Maximum Value	0.0403	1.E-04	3.E-04	
Mean	0.018	6.E-05	1.E-04	
Walking/Biking		Walking	Cross Country	
Maximum Value	0.09342	1.E-04	1.E-05	
Mean	0.029	3.E-05	3.E-06	

Key:
PCME - Phase-contrast microscopy equivalent
s/cc - structures per cubic centimeter