Health Consultation

Former W.R. Grace/Zonolite Company Site

12340 Conway Road
Prince Georges County, Beltsville, Maryland

EPA Facility Identification Number: MDD982565418

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Prepared by:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation

Foreword: ATSDR's National Asbestos Exposure Review

Vermiculite was mined and processed in Libby, Montana, from the early 1920s until 1990. We now know that this vermiculite, which was shipped to many locations around the U.S. for processing, contained asbestos.

The National Asbestos Exposure Review (NAER) is a project of the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is working with other federal, state, and local environmental and public health agencies to evaluate public health impacts at sites that processed Libby vermiculite.

The evaluations focus on the processing sites and on human health effects that might be associated with possible past or current exposures. They do not consider commercial or consumer use of the products of these facilities.

The sites that processed Libby vermiculite will be evaluated by (1) identifying ways people could have been exposed to asbestos in the past and ways that people could be exposed now and (2) determining whether the exposures represent a public health hazard. ATSDR will use the information gained from the site-specific investigations to recommend further public health actions as needed. Site evaluations are progressing in two phases:

Phase 1: ATSDR has selected 28 sites for the first phase of reviews on the basis of the following criteria:

- The U.S. Environmental Protection Agency (EPA) mandated further action at the site based upon contamination in place

- or -

- The site was an exfoliation facility that processed more than 100,000 tons of vermiculite ore from Libby mine. Exfoliation, a processing method in which ore is heated and "popped," is expected to have released more asbestos than other processing methods.

The following document is one of the site-specific health consultations ATSDR and its state health partners are developing for each of the 28 Phase 1 sites. A future report will summarize findings at the Phase 1 sites and include recommendations for evaluating the more than 200 remaining sites nationwide that received Libby vermiculite.

Phase 2: ATSDR will continue to evaluate former Libby vermiculite processing sites in accordance with the findings and recommendations contained in the summary report. ATSDR will also identify further actions as necessary to protect public health.

Background

Site Information

The former W.R. Grace (WRG) exfoliation facility is located at 12340 Conway Rd, Beltsville, Prince Georges County, Maryland, approximately 30 miles southwest of Baltimore, MD and 20 miles northeast of Washington DC. WRG records identified this site alternately as Zonolite Co., Beltsville and Muirkirk. This facility was listed as an EPA further action site and therefore, included in the ATSDR Phase 1 evaluations.

The site is in an industrial park area, near the Old Baltimore Pike. The coordinates for the site are 39º03'29.81" north latitude and 76º53'9.92" west longitude. The site encompasses approximately 1.74 acres and includes a 32,000 sq. foot L-shaped corrugated metal building where exfoliation processes occurred. It is bordered to the west by a railroad spur, by an additional building to the south, by gravel and asphalt parking lots to the east, and by a small building to the north. An abandoned railroad line runs from the western rail line southeast in an arc before ending parallel to the middle of the facility (see Map 1). A concrete pad is adjacent to the south side of the building where the vermiculite storage silos were located. There is a storm drain that runs under the western rail spur from the southwest corner of the building to the western edge of the property. The parking area outside the facility has all been resurfaced with gravel several times and the gravel is at least 18 inches deep in some areas.

The furnaces, equipment, and silos from the exfoliation process were removed by W.R. Grace (WRG) prior to vacating the property. No documentation of clean-up activities has been located for this facility. According to WRG, facilities would be cleaned before reselling them or terminating their lease (B. O'Connell, Grace Performance Chemicals, personal communication August 23, 2002). Clean-up could include power washing the facilities, sweeping, and HEPA vacuuming. Usually, air samples (non-aggressive) were collected after the facility was cleaned to verify the absence of airborne asbestos fibers. ATSDR has requested documentation of clean-up activities from WRG for this facility.

Approximately 93,000 total tons of Libby, Montana vermiculite were received at this facility during the years 1966–1988 (unpublished information from EPA's database of WRG invoices). Vermiculite from Libby was found to contain several types of asbestos fibers, including the amphibole asbestos varieties tremolite and actinolite and the related fibrous asbestiform minerals winchite, richterite, and ferro-edenite [1]. In this report, we will use the term *Libby asbestos* to refer to the characteristic composition of asbestos contaminating the Libby vermiculite. It is difficult to measure all the different mineral fibers in Libby asbestos specifically. In this document, sample results are reported as "tremolite," "tremolite asbestos" or "actinolite/tremolite" to indicate the presence of Libby asbestos.

Exfoliation operations at this facility occurred from 1966 until the early 1990s (unpublished personal email from EPA). WRG operated a gypsum and Portland cement manufacturing operation at the site until 1998 (B. O'Connell, Grace Performance Chemicals, personal communication August 23, 2002). This facility received No. 2, 3 and 4 grade vermiculite from Libby, MT and No. 3 and 4 grade from Enoree, SC (unpublished information from EPA database of WR Grace documents). The percent of tremolite found in the vermiculite from Libby, MT varies for the different grades. Libby #2 ranges from 1.67–7% tremolite; Libby #3 ranges from <1–5.12%; and Libby #4 ranges from 0.3–1% [2].

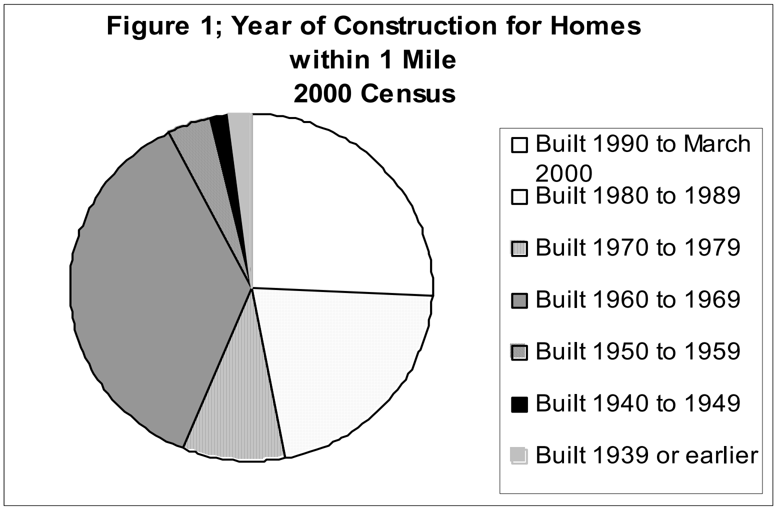
Vermiculite was delivered to the site via rail, and then fed into six silos by a belt conveyer for storage. The silos each held between 20–30 tons of vermiculite at one time. A belt conveyer would then feed the vermiculite into furnaces located within the building, where it was heated to over 1500° F, causing the vermiculite to expand or “exfoliate”. The expanded vermiculite would be conveyed to a stoner machine that would separate the product from any unexpanded vermiculite or “waste rock” [3]. A baghouse was used to limit air emissions from the facility [3]. At many vermiculite processing sites, before vermiculite and waste handling was automated, workers used shovels or forklifts to transport these materials. The date of installation of emission controls is not known for this site. Particulate control technologies were typically installed in the 1970s in response to stricter air emission regulations included in the Clean Air Act. The final product was bagged and trucked out for distribution. Exfoliated vermiculite from this facility was used for attic insulation, lightweight aggregates, agriculture products, and Monokote, a fireproofing material (unpublished information from EPA database of WR Grace documents) [3]. In addition to containing Libby asbestos, commercial asbestos (chrysotile) was added to the Monokote product [4]. Estimates from WRG indicate that some Monokote products contained between 12% and 19% commercial (chrysotile) asbestos (unpublished information from EPA database of WR Grace documents).

Estimates from historic WRG documents are that approximately 1 ton of waste was generated for every 6.7 tons of vermiculite processed (unpublished information from EPA database of WR Grace documents). These estimates therefore indicate that over the entire period of operation, approximately 13,900 tons of waste would have been generated. WRG records indicate that stoner rock contained between 2% and 10% Libby asbestos. Recent analysis of unweathered stoner rock material recovered from a source near the former Western Minerals site in Minneapolis, MN indicated a Libby asbestos content of 10% (personal communication, James Kelly, Minnesota Department of Health, August 12, 2002). Records provided by WRG state that wastes from this facility were taken to multiple landfills in the Beltsville/Baltimore area, including the Pottstown Landfill, Sandy Hill Disposal Area, Tappa Enterprises, Al Ray/Super Rubble Landfill, Meadow Fill Corp. and Shayne Brothers of Temple Hills, MD (unpublished information from EPA database of WR Grace documents) [5]. WRG analyzed 2 samples of stoner rock from the Sandy Hill Disposal Area in 1979. Results indicated that the samples contained 5–40% massive tremolite and <0.1% fibrous tremolite (unpublished information from EPA database of WR Grace documents). There are no obvious signs of waste material being dumped or used as fill at the site [6].

Since 1998, Atlantic Transportation Equipment, Ltd (ATEL) has leased the property and operated a maintenance and repair shop for large trucks and buses in the building that housed the exfoliation process. ATEL also operates in 3 other buildings at the industrial park—two adjacent to and one southeast of the former exfoliation facility (see Map 2).

Demographics

The nearest residences are located approximately ½ mile south and southwest of the site. According to 1990 census data, approximately 300 people live within 1 mile of the site (see Map 3) [7]. Nearly 75% of the houses within 1 mile of the site were constructed before 1989, when processing of Libby vermiculite stopped (see Figure 1) [8].



Site Environmental Data

The EPA conducted two sampling events at this site. The first round of sampling occurred in September 2000, when four bulk samples were collected from inside the building between a cinder-block inner office and the outer structure wall (2 samples); a canopy hanging over an outdoor shed attached to the southern wall of the building (1 sample); and soil at the base of the building directly south of the former exfoliation facility (1 sample). All four samples were sent to EMSL Analytical Inc., in Westmont, New Jersey and analyzed by Polarized Light Microscopy (PLM). The two samples collected inside the building were positive for trace levels of tremolite asbestos. The two samples collected outdoors were non-detect for tremolite asbestos [9].

The second round of sampling by EPA took place in May 2002. Nine additional bulk, dust, or soil samples, including one duplicate, were collected and analyzed by Transmission Electron Microscopy (TEM). One sample was collected from inside the building in the same area as the first 2 samples, between an inner and outer wall. Seven samples were collected outside: behind the facility on the west (2); between the facility and the building to the north (1); in the storm drain basin (1); beside a concrete pad adjacent to the building (2—including duplicate); in a parking lot east of the building, near railroad (1); and in subsurface in grass near a gravel parking lot south of building (1) (see Map 4). Surface soil samples were collected in the first 6 inches and the subsurface samples were collected at 18 inches below the surface [3]. Asbestiform structures were found in two samples: near the rail spur and in the subsurface sample. Non-regulated amphibole fibers were found in three additional samples: in soil north of the building, in the storm drain basin, and in the indoor sample. Non-regulated amphiboles include richterite and winchite, which were identified at the Libby, MT mine and are included in the term *Libby asbestos* [1].

Table 1. Summary of Sampling Results

Sample Location	Date	PLM 2000 (percent asbestos by volume)	TEM Asbestos Structures (million structures per gram)	TEM Non-regulated Asbestos Structures (million structures per gram)	PLM 2002 (percent asbestos by volume)
Inside—between walls	September 2000	<1% tremolite	NA	NA	NA
Inside—between walls 2	September 2000	<1% tremolite	NA	NA	NA
Outside—Canopy 2	September 2000	Non-detect	NA	NA	NA
Outside—soil at base of adjacent building	September 2000	Non-detect	NA	NA	NA
Inside—between walls	May 2002	NA	0	3	<1% actinolite/tremolite
Outside—west of facility	May 2002	NA	0	0	Non-detect
Outside—west of facility-2	May 2002	NA	0	0	Non-detect
Outside—north of facility	May 2002	NA	0	6	Non-detect
Outside—storm drain basin	May 2002	NA	0	2	Non-detect
Outside—concrete pad	May 2002	NA	0	0	Non-detect
Outside—parking lot east	May 2002	NA	9	0	Non-detect
Outside—near gravel parking lot	May 2002	NA	1	0	Non-detect

NA = Not Analyzed

Additionally, one air sample was collected inside the inner office/storage room. The sample was collected using a high volume air pump capable of drawing 5–20 liters/minute of air through a 0.45–1.2 µm filter [3]. No asbestos fibers were detected in the air sample. There are no WRG clean-up records or sampling results to confirm adequate cleanup of this facility.

Asbestos Overview

Asbestos is a general name applied to a group of silicate minerals consisting of thin, separable fibers in a parallel arrangement. Asbestos minerals fall into two classes, serpentine and amphibole. Serpentine asbestos has relatively long and flexible crystalline fibers; this class includes chrysotile, the predominant type of asbestos used commercially. Amphibole asbestos minerals are brittle and have a rod- or needle-like shape. Amphibole minerals regulated as asbestos by OSHA include five classes: fibrous tremolite, actinolite, anthophyllite, crocidolite, and amosite. However, other amphibole minerals, including winchite, richterite, and others, can exhibit fibrous asbestiform properties [10].

Asbestos fibers do not have any detectable odor or taste. They do not dissolve in water or evaporate and are resistant to heat, fire, and chemical and biological degradation.

The vermiculite mined at Libby contains amphibole asbestos, with a characteristic composition including tremolite, actinolite, richterite, and winchite; this material will be referred to as Libby asbestos. The raw vermiculite ore was estimated to contain up to 26% Libby asbestos as it was mined [11]. For most of the mine's operation, Libby asbestos was considered a byproduct of little value and was not used commercially. The mined vermiculite ore was processed to remove unwanted materials and then sorted into various grades or sizes of vermiculite that were then shipped to sites across the nation for expansion (exfoliation) or use as a raw material in manufactured products. Samples of the various grades of unexpanded vermiculite shipped from the Libby mine contained 0.3-7% fibrous tremolite-actinolite (by mass) [11].

The following sections provide an overview of several concepts relevant to the evaluation of asbestos exposure, including analytical techniques, toxicity and health effects, and the current regulations concerning asbestos in the environment. A more detailed discussion of these topics will also be provided in ATSDR's upcoming Summary Report for the national review of vermiculite sites.

Methods for Measuring Asbestos Content

There are a number of different analytical methods used to evaluate asbestos content in air, soil, and other bulk materials. Each method varies in its ability to measure fiber characteristics such as length, width, and mineral type. For air samples, fiber quantification is traditionally done through phase contrast microscopy (PCM) by counting fibers longer than 5 µm and with an aspect ratio (length:width) greater than 3:1. This is the standard method by which regulatory limits were developed. Disadvantages of this method include the inability to detect fibers thinner than 0.25 µm in diameter and the inability to distinguish between asbestos and non-asbestos fibers [10].

Asbestos content in soil and bulk material samples is commonly determined using polarized light microscopy (PLM), a method which uses polarized light to compare refractive indices of minerals and can distinguish between asbestos and non-asbestos fibers and between different types of asbestos. The PLM method can detect fibers with lengths greater than ~1 µm, widths greater than ~0.25 µm, and aspect ratios (length to width ratios) of greater than 3. Detection limits for PLM methods are typically 0.25-1% asbestos.

Scanning electron microscopy (SEM) and, more commonly, transmission electron microscopy (TEM) are more sensitive methods and can detect smaller fibers than light microscopic techniques. TEM allows the use of electron diffraction and energy-dispersive x-ray methods, which give information on crystal structure and elemental composition, respectively. This information can be used to determine the elemental composition of the visualized fibers. SEM does not allow measurement of electron diffraction patterns. One disadvantage of electron microscopic methods is that it is difficult to determine asbestos concentration in soils and other bulk materials [10].

For risk assessment purposes, TEM measurements are sometimes multiplied by conversion factors to give PCM equivalent fiber concentrations. The correlation between PCM fiber counts and TEM mass measurements is very poor. A conversion between TEM mass and PCM fiber count of 30 micrograms per cubic meter per fiber per cubic centimeter (μg/m3)/(f/cc) was adopted as a conversion factor, but this value is highly uncertain since it represents an average of conversions ranging from 5 to 150 (μg/m3)/(f/cc) [12]. The correlation between PCM fiber counts and TEM fiber counts is also very uncertain, and no generally applicable conversion factor exists for these two measurements [12]. Generally, a combination of PCM and TEM is used to describe the fiber population in a particular air sample.

EPA is currently working with several contract laboratories and other organizations to develop, refine, and test a number of methods for screening bulk soil samples. The methods under investigation include PLM, infrared (IR), and SEM (personal communication, Jim Christiansen, U.S. Environmental Protection Agency, November 2002).

Asbestos Health Effects and Toxicity

Breathing any type of asbestos increases the risk of the following health effects.

Malignant mesothelioma – Cancer of the lining of the lung (pleura) and other internal organs. This cancer can spread to tissues surrounding the lungs or other organs. The great majority of mesothelioma cases are attributable to asbestos exposure [10].

Lung cancer – Cancer of the lung tissue, also known as bronchogenic carcinoma. The exact mechanism relating asbestos exposure with lung cancer is not completely understood. The combination of tobacco smoking and asbestos exposure greatly increases the risk of developing lung cancer [10].

Noncancer effects – these include asbestosis, scarring and reduced lung function caused by asbestos fibers lodged in the lung; pleural plaques, localized or diffuse areas of thickening of the pleura (lining of the lung); pleural thickening, extensive thickening of the pleura which may restrict breathing; pleural calcification, calcium deposition on pleural areas thickened from chronic inflammation and scarring; and pleural effusions, fluid buildup in the pleural space between the lungs and the chest cavity [10].

There is not enough evidence to conclude whether inhalation of asbestos increases the risk of cancers at sites other than the lungs, pleura, and abdominal cavity [10].

Ingestion of asbestos causes little or no risk of non-cancer effects. However, there is some evidence that acute oral exposure might induce precursor lesions of colon cancer and that chronic oral exposure might lead to an increased risk of gastrointestinal tumors [10].

ATSDR considers the inhalation route of exposure to be the most significant in the current evaluation of sites that received Libby vermiculite. Exposure scenarios that are protective of the inhalation route of exposure should be protective of dermal and oral exposures.

There is general acceptance in the scientific community of correlations of asbestos toxicity with fiber length as well as fiber mineralogy. Fiber length may play an important role in clearance and mineralogy may affect both biopersistence and surface chemistry.

ATSDR, responding to concerns about asbestos fiber toxicity from the World Trade Center disaster, held an expert panel meeting to review fiber size and it's role in fiber toxicity in December, 2002 [13]. The panel concluded that fiber length plays an important role in toxicity. Fibers with lengths less than 5 µm are essentially non-toxic when considering a role in mesothelioma or lung cancer promotion. However, fibers less than 5 µm in length may play a role in asbestosis when exposure duration is long and fiber concentrations are high. More information is needed to definitively make this conclusion.

In accordance with these concepts, it has been suggested that amphibole asbestos is more toxic than chrysotile asbestos, mainly due to physical characteristics which allow chrysotile to be broken down and cleared from the lung, whereas amphibole is not removed and builds up to high levels in lung tissue [14]. Some researchers believe the resulting increased duration of exposure to amphibole asbestos significantly increases the risk of mesothelioma and, to a lesser extent, asbestosis and lung cancer [14]. However, OSHA continues to regulate chrysotile and amphibole asbestos as one substance, as both types increase the risk of disease [15]. EPA's Integrated Risk Information System (IRIS) assessment of asbestos also treats mineralogy (and fiber length) as equipotent.

Evidence suggesting that the different types of asbestos fibers vary in carcinogenic potency and site specificity is limited by the lack of information on fiber exposure by mineral type. Other data indicate that differences in fiber size distribution and other process differences can contribute at least as much to the observed variation in risk as does the fiber type itself [16].

Counting fibers using the regulatory definitions (see below) does not adequately describe risk of health effects, as fiber size, shape, and composition contribute collectively to risks in ways that are still being elucidated. For example, shorter fibers appear to preferentially deposit in the deep lung, but longer fibers might disproportionately increase the risk of mesothelioma [10,16]. Some of the unregulated amphibole minerals, such as the winchite present in Libby asbestos, can exhibit asbestiform characteristics and contribute to risk. Fiber diameters greater than 2-5 µm are considered above the upper limit of respirability (that is, too large to inhale) and do not contribute significantly to risk. Methods are being developed to assess the risks posed by varying types of asbestos and are currently awaiting peer review [16].

Current Standards, Regulations, and Recommendations for Asbestos

In industrial applications, asbestos-containing materials are defined as any material with greater than 1% bulk concentration of asbestos [17]. It is important to note that 1% is not a health-based level, but instead represents the practical detection limit in the 1970s when OSHA regulations were created. Studies have shown that disturbing soils containing less than 1% amphibole asbestos can suspend fibers at levels of health concern [18].

Friable asbestos (asbestos which is crumbly and can be broken down to suspendable fibers) is listed as a Hazardous Air Pollutant on EPA's Toxic Release Inventory [19]. This requires companies that release friable asbestos at concentrations greater than 0.1% to report the release under Section 313 of the Emergency Planning and Community Right-to Know Act.

OSHA has set a permissible exposure limit (PEL) of 0.1 f/cc for asbestos fibers longer than 5 µm and with an aspect ratio (length: width) greater than 3:1, as determined by PCM [15]. This value represents a time-weighted average (TWA) exposure level based on 8 hours a day for a 40-hour work week. In addition, OSHA has defined an excursion limit in which no worker should be exposed in excess of 1 f/cc as averaged over a sampling period of 30 minutes [15]. Historically, the OSHA PEL has steadily decreased from an initial standard of 12 f/cc established in 1971. The PEL levels prior to 1983 were determined based upon empirical worker health observations, while the levels set from 1983 forward employed some form of quantitative risk assessment. ATSDR has used the current OSHA PEL of 0.1 f/cc as a reference point for evaluating asbestos inhalation exposure for past workers. ATSDR does not, however, support using the PEL for evaluating community member exposure, as the PEL is based on an unacceptable risk level.

In response to the World Trade Center disaster in 2001 and an immediate concern about asbestos levels in homes in the area, the Department of Health and Human Services, EPA and the Department of Labor formed the Environmental Assessment Working Group. This work group was made up of ATSDR, US Environmental Protection Agency, National Institute of Occupational Safety and Health, CDC National Center for Environmental Health, Occupational Safety and Health Administration, New York City Department of Health and Mental Hygiene, the New York State Department of Health, and other state, local, and private entities. The workgroup set a re-occupation level of 0.01 f/cc after cleanup. Continued monitoring was also recommended to limit long-term exposure to this level [20].

The National Institute of Occupational Safety and Health (NIOSH) set a recommended exposure limit of 0.1 f/cc for asbestos fibers longer than 5 µm. This limit is a TWA for up to a 10-hour workday in a 40-hour work week [21]. The American Conference of Government Industrial Hygienists (ACGIH) has also adopted a TWA of 0.1 f/cc as its threshold limit value [22].

EPA has set a maximum contaminant level (MCL) for asbestos fibers in water of 7,000,000 fibers longer than 10 µm per liter, based on an increased risk of developing benign intestinal polyps [23]. Many states, including Maryland, use the same value as a human health water quality standard for surface water and groundwater [24].

Asbestos is a known human carcinogen. Historically, EPA has calculated an inhalation unit risk for cancer (cancer slope factor) of 0.23 per f/cc of asbestos [12]. This value estimates additive risk of lung cancer and mesothelioma using a relative risk model for lung cancer and an absolute risk model for mesothelioma. This quantitative risk model has significant limitations. First, the unit risks were based on measurements with phase contrast microscopy and therefore cannot be applied directly to measurements made with other analytical techniques. Second, the unit risk should not be used if the air concentration exceeds 0.04 f/cc, since above this concentration the slope factor might differ from that stated [12]. Perhaps the most significant limitation is that the model does not consider mineralogy, fiber size distribution, or other physical aspects of asbestos toxicity. EPA is in the process of updating their asbestos quantitative risk methodology given the limitations of the current assessment and the knowledge gained since it was implemented in 1986.

Discussion

The vermiculite processed at this site originated from the mine in Libby, MT known to be contaminated with asbestos. Studies conducted in the Libby community indicate health impacts that are associated with asbestos exposure [25, 26]. The findings at Libby provided the impetus for investigating this site, as well as other sites across the nation that received asbestos-contaminated vermiculite from the Libby mine. It is important to recognize, however, that the asbestos exposures documented in the Libby community are in many ways unique and will not collectively be present at other sites that processed or handled Libby vermiculite. The site investigation at Beltsville, MD is part of a national effort to identify and evaluate potential asbestos exposures that may be expected at these other sites.

Exposure Assessment and Toxicological Evaluation

Evaluating the health effects of exposure to Libby asbestos requires extensive knowledge of both exposure pathways and toxicity data. The toxicological information currently available is limited and therefore the exact level of health concern for different sizes and types of asbestos remains controversial. Site-specific exposure pathway information is also limited or unavailable.

- There is limited information on past concentrations of Libby asbestos in air in and around the plant. Also, as described in the preceding section, significant uncertainties and conflicts in the methods used to analyze asbestos exist. This makes it hard to estimate the levels of Libby asbestos people may have been exposed to.
- There is not enough information known about how and how often people came in contact with the Libby asbestos from the plant, because most exposures happened so long ago. This information is necessary to estimate quantitative exposure doses.
- There is not enough information available about how some vermiculite materials, such as waste rock, were handled or disposed. This makes it difficult to identify and assess both past and present potential exposures.

Given these difficulties, the public health implications of past operations at this site are evaluated qualitatively. Current health implications are likewise evaluated qualitatively. The following sections describe the various types of evidence we used to evaluate exposure pathways and reach conclusions about the site.

Exposure Pathway Analysis

An exposure pathway is how a person comes in contact with chemicals originating from a source of contamination. Every exposure pathway consists of the following five elements: 1) a *source* of contamination; 2) a *media* such as air or soil through which the contaminant is transported; 3) a *point of exposure* where people can contact the contaminant; 4) a *route of exposure* by which the contaminant enters or contacts the body; and 5) a *receptor population*. A pathway is considered complete if all five elements are present and connected. A pathway is considered potential if the pathway elements are (or were) likely present, but insufficient information is available to confirm or characterize the pathway elements. A pathway may also be considered potential if it is currently missing one or more of the pathway elements, but the element(s) could easily be present at some point in time. An incomplete pathway is missing one or more of the pathway elements and it is likely that the elements were never present and not likely to be present at a later point in time. An eliminated pathway was a potential or completed pathway in the past, but has had one or more of the pathway elements removed to prevent present and future exposures.

After reviewing information from Libby, Montana and from facilities that processed vermiculite ore from Libby, a list of possible exposure pathways for vermiculite processing facilities was developed. All pathways have a common source—vermiculite from Libby contaminated with Libby asbestos—and a common route of exposure—inhalation. Although asbestos ingestion and dermal exposure pathways could exist, health risks from these pathways are minor in comparison to those resulting from inhalation exposure to asbestos and will not be evaluated.

The exposure pathways considered for each site are listed in the following table. More detail on the pathways is included in Table 1 (Appendix A). Not every pathway identified will be a significant source of exposure for a particular site. An evaluation of the pathways for this site is presented in the following paragraphs.

Summary of Inhalation Pathways Considered for Former WR Grace/Zonolite Co. Plant

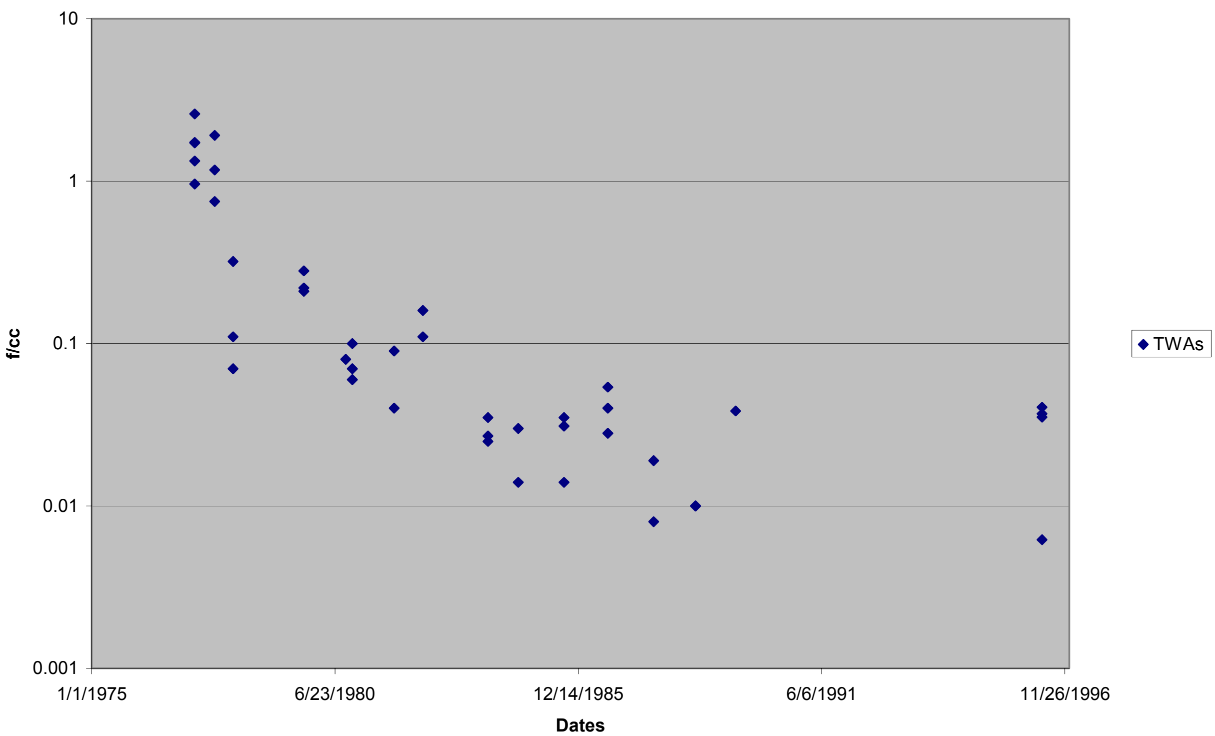
Pathway Name	Exposure Scenario(s)	Past Pathway Status	Present Pathway Status	Future Pathway Status
Occupational	Former workers exposed to airborne Libby asbestos during handling and processing of contaminated vermiculite	Completed	Not applicable	Not applicable
	Current workers exposed to airborne Libby asbestos from residual contamination inside former processing buildings	Not applicable	Eliminated	Potential
Household Contact	Household contacts exposed to airborne Libby asbestos brought home on workers' clothing	Completed	Eliminated	Eliminated
Waste Piles	Community members (particularly children) playing in or otherwise disturbing onsite piles of contaminated vermiculite or waste rock	Potential	Eliminated	Eliminated
Onsite Soils	Current onsite workers, contractors, or community members disturbing contaminated onsite soils (residual contamination, buried waste)	Not applicable	Incomplete	Potential
Ambient Air	Community members or nearby workers exposed to airborne fibers from plant emissions during handling and processing of contaminated vermiculite	Potential	Eliminated	Eliminated
Residential Outdoor	Community members using contaminated vermiculite or waste material at home (for gardening, paving driveways, fill material)	Potential	Potential	Potential
Residential Indoor	Community members disturbing household dust containing Libby asbestos fibers from plant emissions or residential outdoor waste	Potential	Eliminated	Eliminated
Consumer Products	Community members, contractors, and repairmen disturbing consumer products containing contaminated vermiculite	Potential	Potential	Potential

Occupational

WRG records indicate that former workers were exposed to significant levels of Libby asbestos in air at the Beltsville facility. Limited personal air monitoring sample results are available for the years 1977–96. Results, expressed as time weighted averages (TWAs), ranged from <0.0062 to 2.59 f/cc (unpublished information from EPA database of WR Grace documents) [5]. Approximately 36% (15/42) of the TWAs were above the current OSHA limit of 0.1 f/cc (see Figure 2). The OSHA personal exposure limits (PELs) for occupational exposures to asbestos have been lowered over time. When the asbestos PEL was first introduced in May 1971, it was set at 12 f/cc. It was later amended to 5 f/cc (December 1971), 2 f/cc (July 1976), 0.2 f/cc (June 1986), and finally to the current PEL of 0.1 f/cc (August 1994).

Additionally, engineering sample results taken during this period (1977-96) ranged from 0.00 to 9.42 f/cc (unpublished information from EPA database of WR Grace documents) [5]. These results were for the years of operation after pollution control equipment had been installed in the early 1970s. In general, air monitoring results indicate that airborne asbestos concentrations decreased over time as a result of improvements in pollution controls and dust suppression methods. Worker exposures may have been higher in the years previous to pollution control installations. Industrial hygiene surveys from 1983 and 1984 indicate variability in employees wearing personal protective equipment (PPE) (unpublished information from EPA database of WR Grace documents). Past occupational exposures represent the most significant exposure pathway for the former W.R.Grace/Zonolite Co. Beltsville facility.

Figure 2: Personal Monitoring Results as Time Weighted Averages from 1977 to 1996



Current workers at the former WRG facility are not exposed to Libby asbestos contamination. Results from air and dust sampling within the facility do not indicate asbestos contamination except in one area. The area that tested positive for asbestos fibers is a small space located between the outer wall of the facility and a cinder block inner office/storage room. Results from two different sampling events indicate that there are trace amounts (<1%) of actinolite/tremolite asbestos in dust samples taken from this area. The space is too small for a person to work in and is currently used to store extra materials. It is a dusty area that is hard to access because of its size. Current workers at the Beltsville facility are not being exposed to asbestos from this area. If a worker disturbs the dust in the storage space, they could potentially be exposed to significant amounts of airborne asbestos.

Household contact

Household contacts of former workers were exposed to Libby asbestos. Former workers most likely transported Libby asbestos home from work on their clothing or hair and thus exposed household members. ATSDR did not find any information that indicated whether employees were required to shower or change clothes prior to leaving the facility at the end of the day. Because the operations were dusty and workers were significantly exposed, it is likely that worker take-home was a significant pathway of exposure in the past.

Current workers are not being exposed to LA; therefore, present and future worker take-home is not a completed exposure pathway.

Waste piles

Past exposure of community members to waste piles at the former site are possible, but unlikely. Records indicate that wastes from the facility were disposed at area landfills (unpublished information from EPA database of WR Grace documents). It is possible that waste rock from the facility was temporarily stockpiled onsite. There are residences ½ mile from the site. However, it is unlikely that community members, including children, would have accessed the site because it is in an industrial park near a busy roadway, the Baltimore Pike. Additional information is needed to confirm past waste handling practices and potential community exposure to onsite waste piles.

No evidence of waste piles or waste material was observed at the site during visits by both the EPA and ATSDR. This is an incomplete pathway for present and future exposures. The pathway is indeterminate for past exposures.

Onsite

The sampling results for soil onsite do not indicate that there is significant residual Libby asbestos contamination. Sample results were all non-detect for PLM analysis, ranging from 0 to 9 total asbestos structures for TEM analysis. During the 2002 sampling event, EPA staff attempted to bore through approximately 18 inches of gravel to reach soil in the facility parking lot. However, the gravel was too compact to permit collection of a subsurface sample, and a sample was instead collected with a shovel in a grassy area nearby (unpublished information from personal email from EPA Reg 3). The sample did not indicate significant amounts of Libby asbestos in subsurface soil (1 asbestiform structure by TEM). However, if there is additional asbestos waste material under the gravel, it is currently well covered and not a completed exposure pathway. A visual inspection of the site indicates that approximately 75% of the former site area is covered with gravel. While there are no site restrictions such as fences or gates, the site is currently in use by ATEL and located in an industrial park; trespassers and residents are not likely to access the site and thereby be exposed.

Ambient air

The Beltsville facility may have released Libby asbestos fibers into the air via stack emissions or fugitive dusts. However, specific information concerning plant emissions was not available, so risk estimates from this exposure cannot be made. Even with emission data, it would be difficult to construct past exposures, given limited information on population in the area. The Minnesota Department of Health developed an air dispersion model for an expansion plant in Minneapolis, Minnesota, which suggested that areas very close (within one block) to an expansion plant could have had elevated fiber levels, but the levels were predicted to drop off rapidly as distance increased [27]. Site-specific emissions characteristics and meteorological conditions could affect results greatly. However, if a similar pattern existed at this former W.R. Grace facility, it is unlikely that any of the people living near the facility were exposed to significant levels of Libby asbestos fibers in ambient air. The closest homes to the former facility are ½ mile away and are south and southwest of the site. Wind rose data from Baltimore International Airport indicates that wind direction is primarily from the west and northwest (see Map 5). The primary receptor population for past air emissions from the facility would have been workers at neighboring businesses. These workers may have been exposed to Libby asbestos fibers in ambient air on a regular basis. However, without ambient air data, there is insufficient information to permit evaluation of the significance of this pathway of exposure.

Residential outdoor

According to available information, people living in the community around the plant face minimal risk of asbestos exposure from soils in their yards, either in the past or currently. The area immediately around the plant is industrial, with the nearest residences ½ mile away from the site. Past records indicate that wastes from the facility were disposed at area landfills (unpublished information from EPA database of WR Grace documents). There is no indication that people ever hauled LA-contaminated materials away for personal use, so it is doubtful that people could be currently exposed to vermiculite in the soil of their yards. However, there is not enough information to provide a complete evaluation of this pathway. This is an indeterminate exposure pathway.

Residential indoor

Residents could have inhaled Libby asbestos fibers from household dust, either from plant emissions that infiltrated into homes or from dust brought inside from waste products brought home for personal use. There is no information on past levels of contamination in ambient air; however, it is unlikely that past ambient air emissions would have been high enough to infiltrate significantly into houses about ½ mile away. No information has been gathered about community members using waste materials in their yards. It is unlikely that this was a common practice at this facility because wastes were disposed of at landfills. This is an indeterminate exposure pathway.

Consumer Products

People who purchased and used vermiculite products may be exposed to asbestos fibers from using those products in and around their homes. At this time, determining the public health implication of commercial or consumer use of vermiculite products (such as home insulation or gardening products) is beyond the scope of this evaluation. However, studies have shown that disturbing or using these products can result in airborne asbestos fiber levels higher than occupational safety limits [18, 28]. Additional information for consumers of vermiculite products has been developed by EPA, ATSDR, and NIOSH and provided to the public (see www.epa.gov/asbestos/insulation.html).

Future Pathways

Presently there are no completed exposure pathways at this site. Changes at the site may result in completed pathways in the future. In particular, changes in the access of the storage space area may create a completed exposure pathway for workers and future land use changes at the site may disturb soils that could contain Libby asbestos fibers. However, current sampling results and information on waste disposal practices do not indicate that there is significant residual Libby asbestos contamination onsite. Additional sampling may be required if excavation or construction activities occur at the site.

Health Outcome Data

Health outcome data can be used to give a more thorough evaluation of the public health implications of a given exposure. Health outcome data can include mortality information (for example, the number of people who have died from a certain disease) or morbidity information (for example, the number of people in an area who have a certain disease or illness). In Libby, Montana, the number of recorded deaths associated with asbestos-related diseases was significantly elevated (as compared with the state or the nation as a whole), especially among former workers of the vermiculite mine and their household contacts [25]. Former workers and their household contacts also showed higher rates than expected of pleural (lung lining) abnormalities, indicating higher exposure and a higher risk for developing asbestos-related disease [29]. Limited past data indicate that fiber levels in the processing areas of Libby and Western Minerals, Minneapolis, Minnesota were similar, suggesting that worker exposures might have also been similar.

The ATSDR Division of Health Studies, in cooperation with state partners, is conducting an ongoing effort to gather health outcome data from selected former vermiculite facilities. No review of the available health statistics data for this site has been completed at this time. It should be noted that the small number of potentially affected people around the site could make it difficult to detect if there are any community-level health effects. ATSDR will release annual reports summarizing health statistics review findings for selected sites for which data have been received. The first annual report is slated to be released in late summer 2003.

Child Health Considerations

ATSDR recognizes that infants and children might be more vulnerable to exposures than adults in communities faced with environmental contamination. Because children depend completely on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests at the site.

The effects of asbestos on children are thought to be similar to the effects on adults. However, children could be especially vulnerable to asbestos exposures because they are more likely to disturb fiber-laden soils or indoor dust while playing. Children also breathe air that is closer to the ground and may thus be more likely to inhale airborne fibers from contaminated soils or dust.

Furthermore, children who are exposed could be more at risk of actually developing asbestos-related disease than people exposed later in life because of the long latency period between exposure and onset of asbestos-related respiratory disease.

The most at-risk children are those who were household members of former workers while the plant was operating. Because the facility is no longer operating, children today are very unlikely to be exposed to Libby asbestos-contaminated vermiculite.

Conclusions

- Workers at the former W.R. Grace/Zonolite Co. site in Beltsville, Maryland were likely exposed to hazardous levels of Libby asbestos in the past; past occupational exposures were a public health hazard.
- Current workers at the site are not being exposed to Libby asbestos. Although an isolated area inside the facility contains trace levels, it is used to store extra materials and is isolated by two walls; therefore, it poses no apparent public health hazard. Future disturbances of this area could result in asbestos exposures to workers.
- Household members of former workers were likely to have been exposed to hazardous levels through Libby asbestos carried home on workers' hair and clothing; past exposures to household contacts were a public health hazard.
- Household contacts of current workers are not being exposed to Libby asbestos; current exposures to people living with current workers pose no apparent public health hazard.
- No available evidence suggests that waste piles were kept onsite or that community members accessed the site and were exposed to them in the past; however, additional information is necessary to confirm these data. In the past, waste piles at the site posed an indeterminate public health hazard.
- No available evidence indicates any waste piles or materials currently onsite, so waste piles do not pose a public health hazard now.
- Evidence suggests that very little residual Libby asbestos remains on the site, but future construction or excavation activities at the site may disturb soils containing trace amounts of LA. Currently, site conditions pose no public health hazard.
- Insufficient data are available to determine whether ambient or fugitive dust emissions from the plant were significant enough to expose neighboring workers or homes to Libby asbestos; past ambient air exposures pose an indeterminate public health hazard.
- No evidence indicates that community members ever used vermiculite or waste materials in their yards or driveways; however, additional information is necessary to confirm this. Residential outdoor exposures pose an indeterminate public health hazard.
- Insufficient information is available to determine if community members were exposed to residential indoor Libby asbestos contamination; therefore, past residential indoor exposures posed an indeterminate public health hazard. Current residential indoor exposures pose no public health hazard.
- Health outcome data for the community around the site may be useful in identifying potential health effects and the need for additional health studies in a particular community. Currently no evaluation of health outcome data has been completed for this site.

Recommendations

- Identify former workers and their households contacts to investigate health effects from Libby asbestos exposure. Contact former workers and request information about waste disposal and operating practices at the facility to assist in exposure analysis and confirm that wastes were not disposed of onsite.
- Eliminate the potential for exposure to residual Libby asbestos contamination. A certified asbestos contractor should be used for any removal activities.

- Review new information that becomes available to evaluate indeterminate exposure pathways as applicable.
- Provide references upon request to community members concerned about products containing vermiculite.
- Conduct a health statistics review in accordance with the protocols developed by ATSDR for the former vermiculite facility site.

Public Health Action Plan

The purpose of the public health action plan is to ensure that public health hazards are not only identified, but also addressed. The public health action plan for this site describes actions that ATSDR and/or other government agencies plan to take at the site to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. ATSDR will also follow up on the plan to ensure implementation of the following public health actions:

Actions Completed

- ATSDR site visit August 23, 2002.
- EPA site visits: windshield tour March 31, 2000; site sampling September 22, 2000, May 21, 2001; site visit August 23, 2002.

Actions Ongoing

- ATSDR staff is researching unpublished information within the EPA database of WR Grace documents (estimated 3 million pages of information relating to Libby, Montana and other nationwide vermiculite processing sites).
- The ATSDR Division of Health Studies, in cooperation with state partners, is conducting an ongoing effort to gather health outcome data from selected former vermiculite facilities.

Actions Planned

- ATSDR will combine the findings from this health consultation with findings from other sites nationwide that received Libby vermiculite to create a comprehensive report outlining overall conclusions and strategies for addressing public health implications.
- ATSDR, in cooperation with state partners and other federal agencies, is researching and determining the feasibility of conducting worker and household contact follow-up activities.
- ATSDR will coordinate with the appropriate state and local health officials to evaluate the feasibility of conducting a health statistics review at this site.
- ATSDR Region 3 staff will follow up with the appropriate state or local health department to ensure that exposure to residual contamination is prevented or eliminated.

Site Team

Author
Amanda Gonzalez
Environmental Health Scientist
Division of Health Assessment and Consultation

Regional Representatives
Charles Walters
Public Health Advisor
Office of Regional Operations, Region 3, Philadelphia Office

Lora Werner
Environmental Health Specialist
Office of Regional Operations, Region 3, Philadelphia Office

EPA Representative
Deborah Carlson
On-Scene Coordinator
U.S. Environmental Protection Agency, Region 3, Wheeling Office

Reviewers

John Wheeler, Ph.D., DABT
Senior Toxicologist
Exposure Investigations and Consultation Branch (EICB), DHAC, ATSDR

Susan Moore, M.S.
Chief, Consultations Section
Exposure Investigations and Consultation Branch (EICB), DHAC, ATSDR

John E. Abraham, Ph.D., MPH
Branch Chief
Exposure Investigations and Consultation Branch (EICB), DHAC, ATSDR

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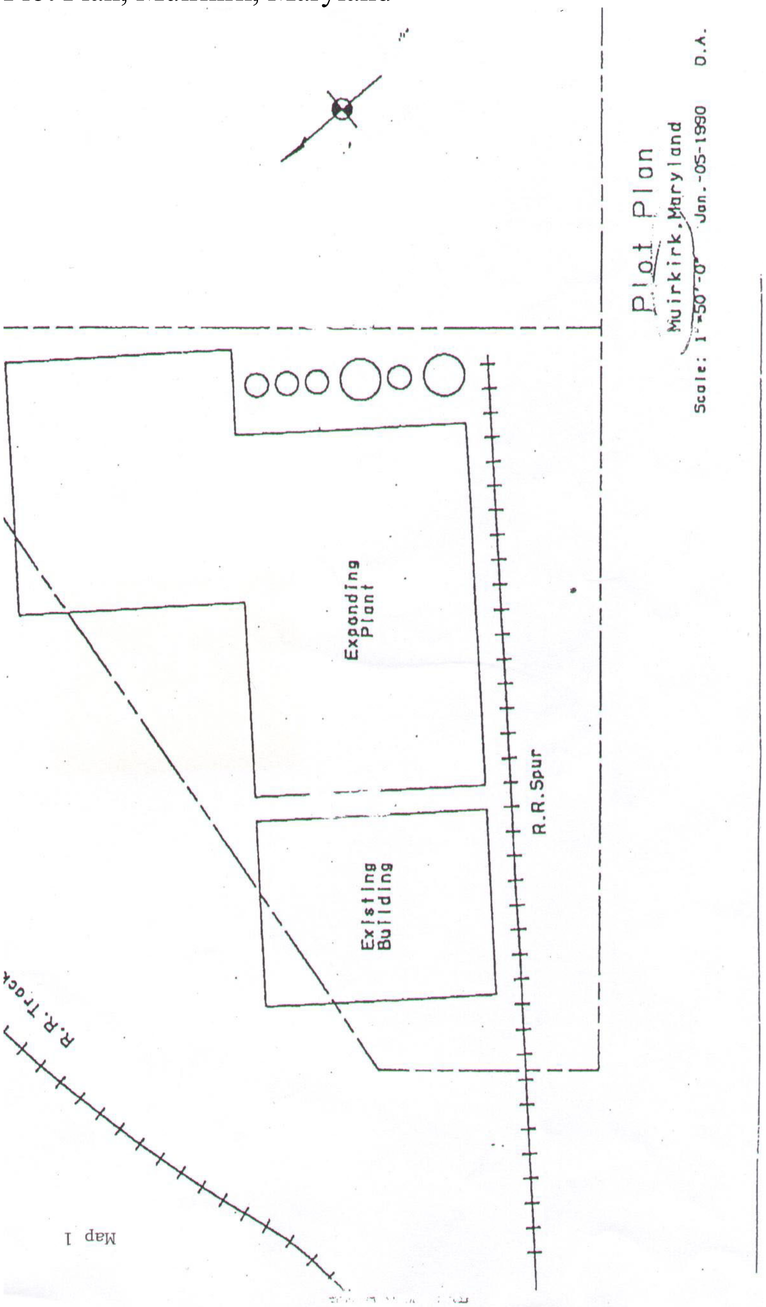
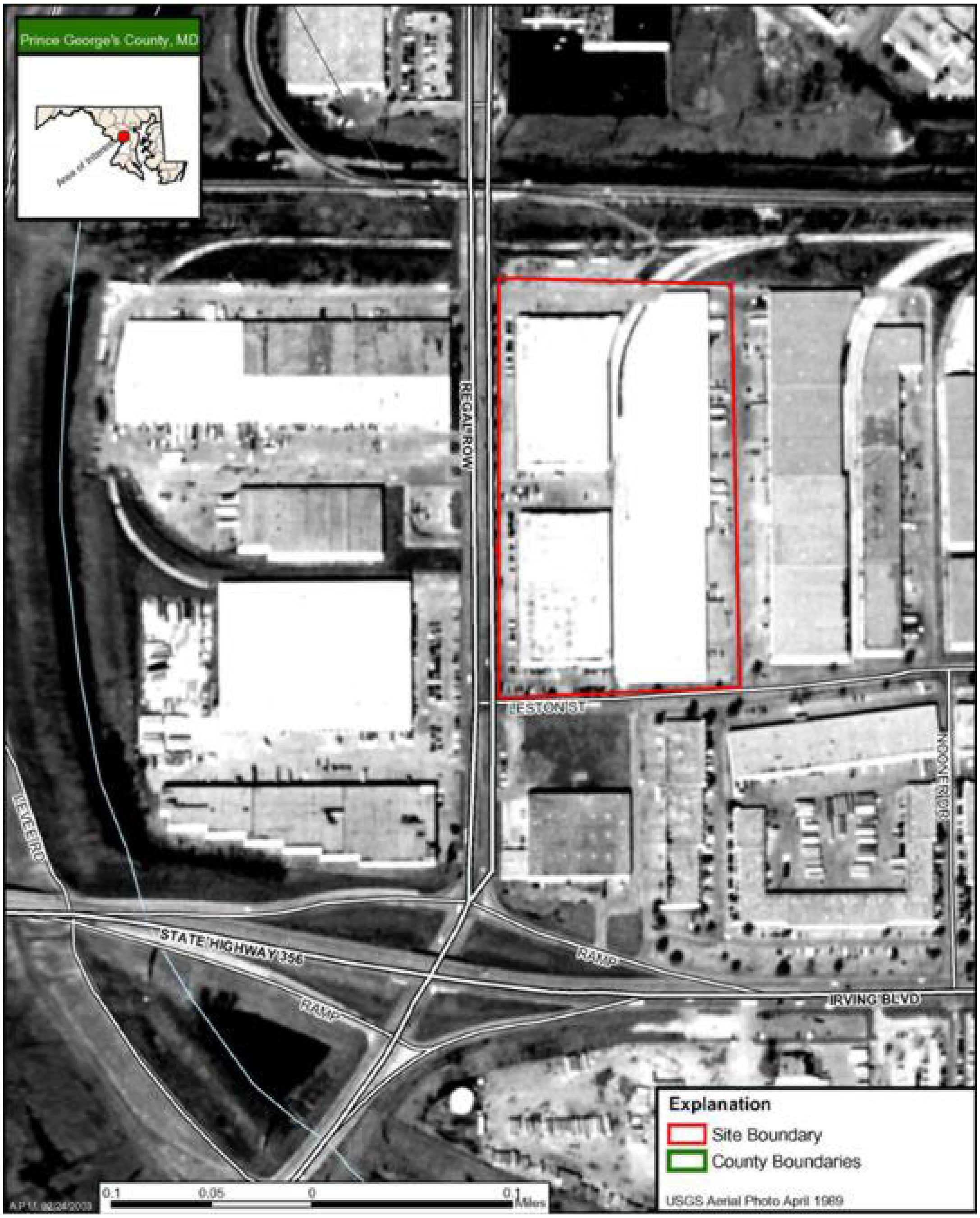
Maps

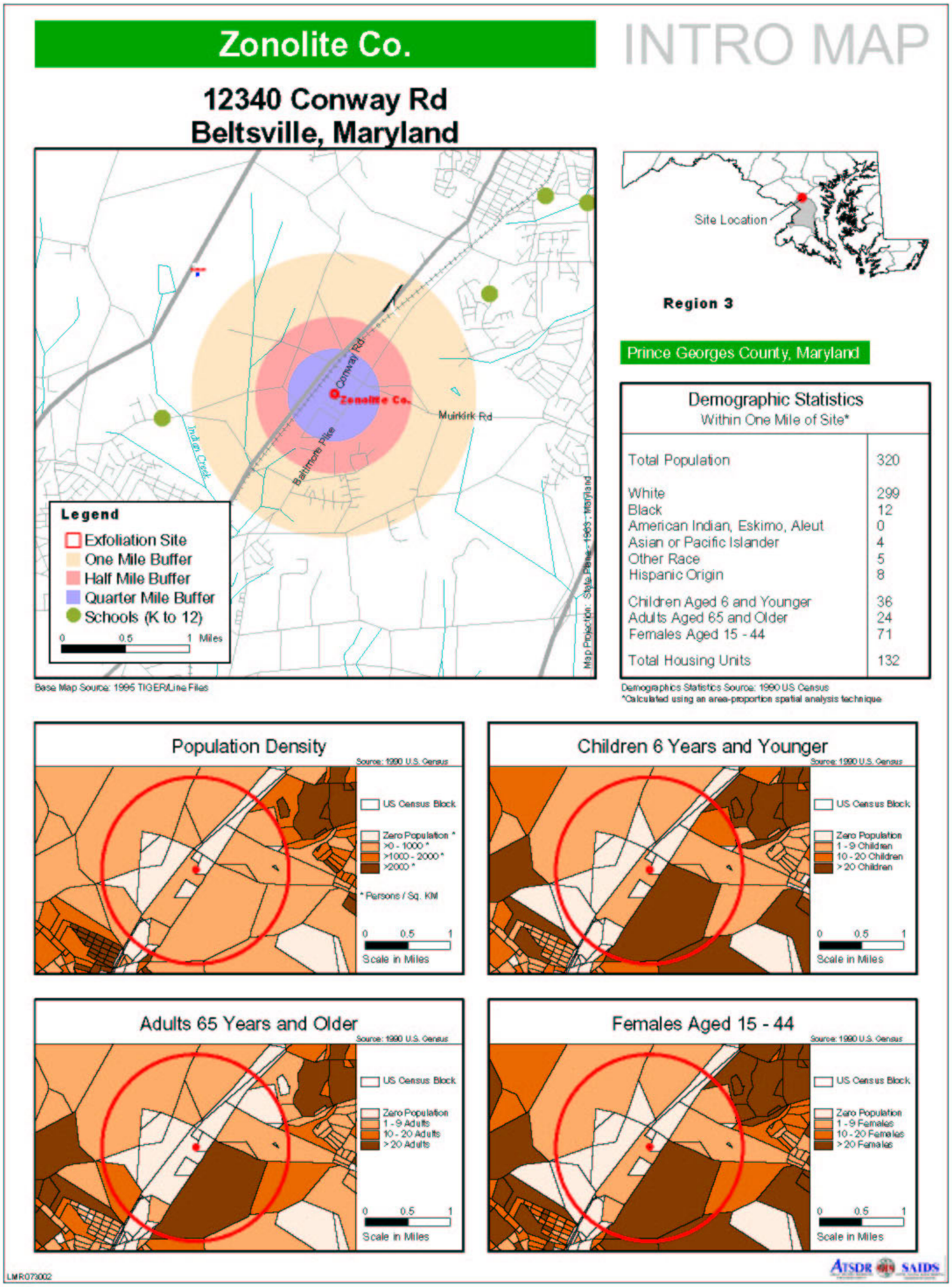
Plot Plan, Muirkirk, Maryland



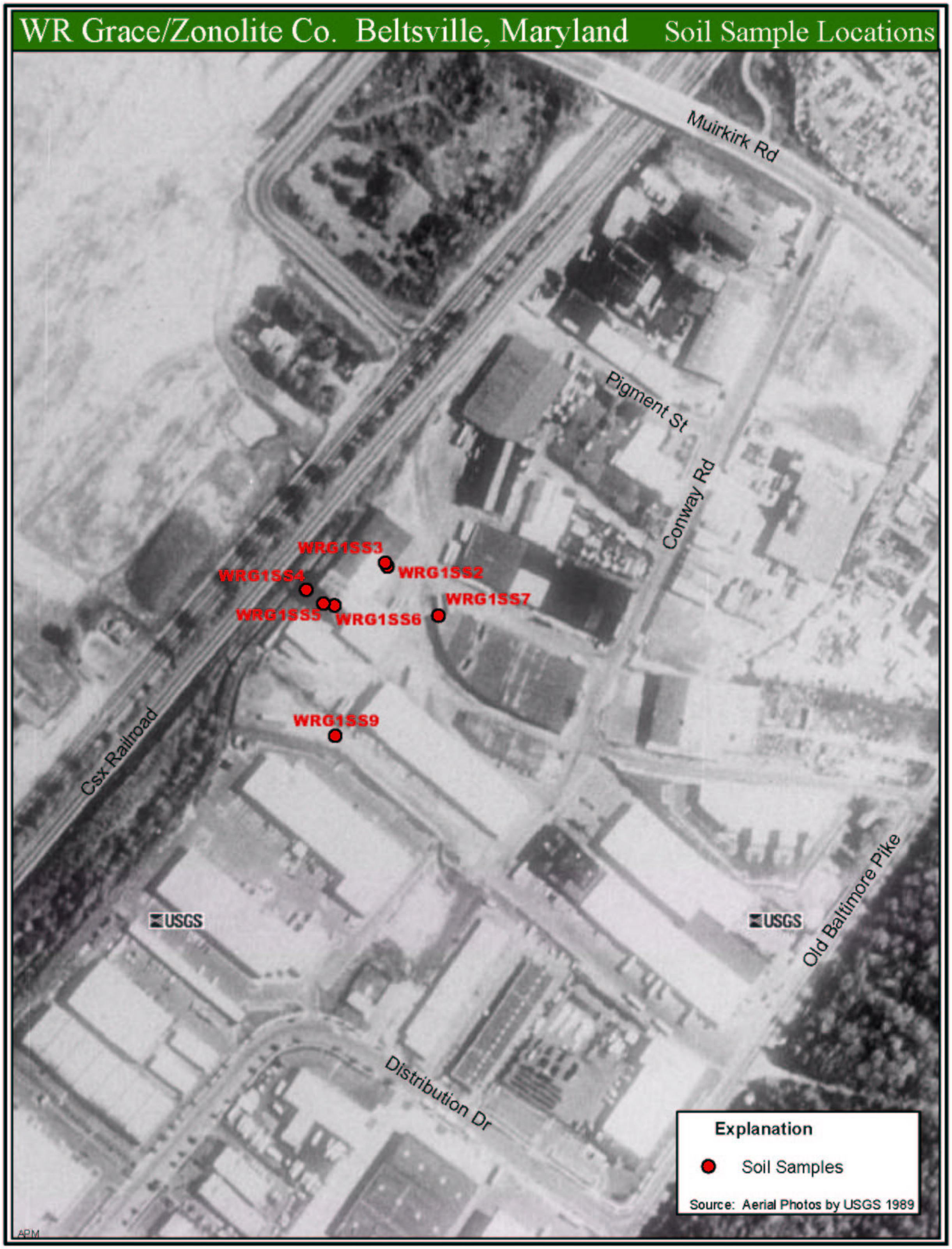
Vermiculite Facility Site Map

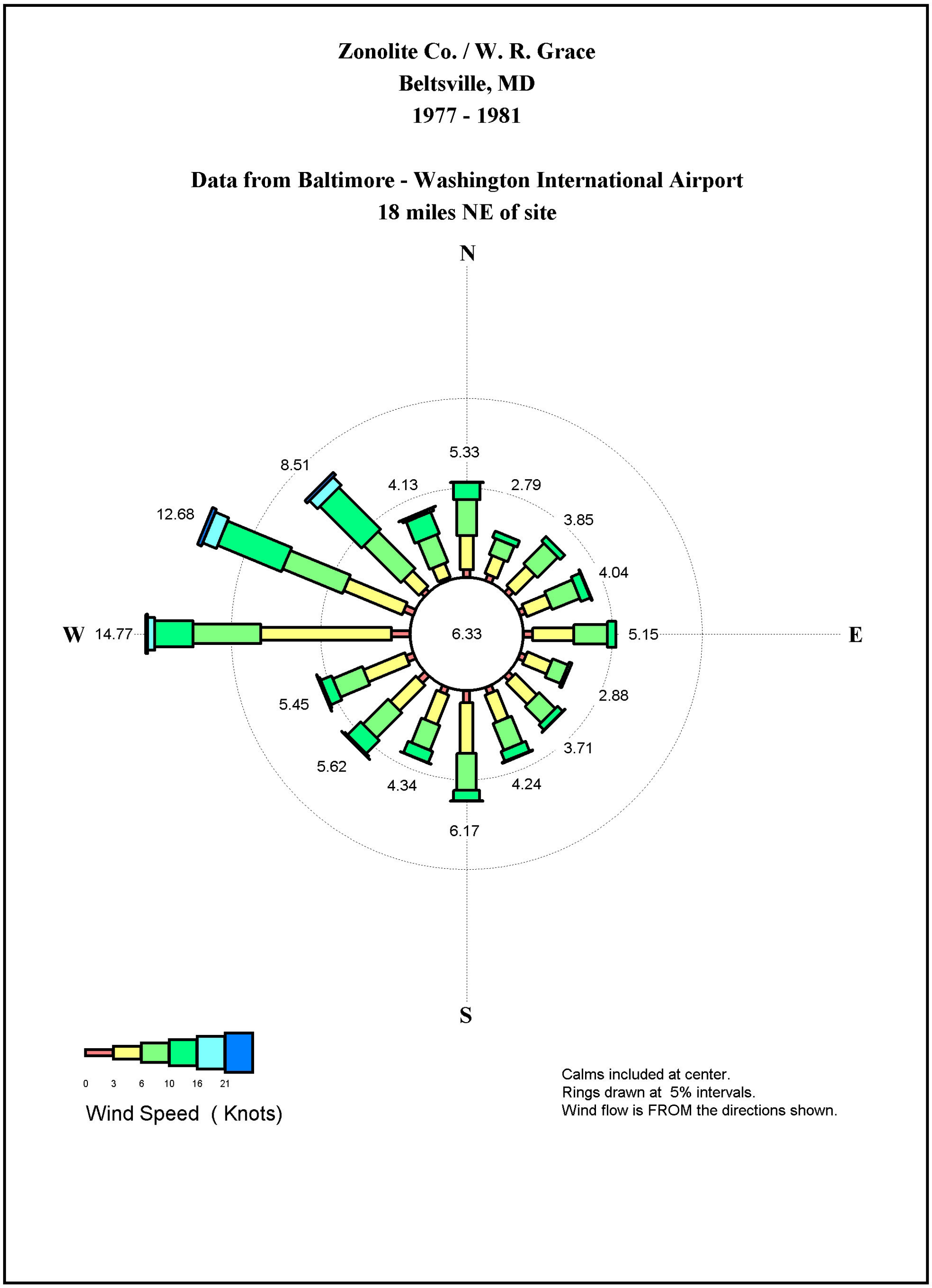


Intro Map


Zonolite Co.
INTRO MAP
12340 Conway Rd
Beltsville, Maryland
Conway Rd
Zonolite Co.
Muirkirk Rd
Baltimore Pike
Indian Creek
Legend
Exfoliation Site
One Mile Buffer
Half Mile Buffer
Quarter Mile Buffer
Schools (K to 12)
0 0.5 1 Miles
Map Projection: State Plane - 1983 - Maryland
Base Map Source: 1995 TIGER/Line Files
Site Location
Region 3
Prince Georges County, Maryland
Demographic Statistics
Within One Mile of Site*
Total Population 320
White 299
Black 12
American Indian, Eskimo, Aleut 0
Asian or Pacific Islander 4
Other Race 5
Hispanic Origin 8
Children Aged 6 and Younger 36
Adults Aged 65 and Older 24
Females Aged 15 - 44 71
Total Housing Units 132
Demographics Statistics Source: 1990 US Census
*Calculated using an area-proportion spatial analysis technique
Population Density
Source: 1990 U.S. Census
US Census Block
Zero Population *
>0 - 1000 *
>1000 - 2000 *
>2000 *
* Persons / Sq. KM
0 0.5 1
Scale in Miles
Children 6 Years and Younger
Source: 1990 U.S. Census
US Census Block
Zero Population
1 - 9 Children
10 - 20 Children
> 20 Children
0 0.5 1
Scale in Miles
Adults 65 Years and Older
Source: 1990 U.S. Census
US Census Block
Zero Population
1 - 9 Adults
10 - 20 Adults
> 20 Adults
0 0.5 1
Scale in Miles
Females Aged 15 - 44
Source: 1990 U.S. Census
US Census Block
Zero Population
1 - 9 Females
10 - 20 Females
> 20 Females
0 0.5 1
Scale in Miles
LMR073002
ATSDR SAIDS

Soil Sample Locations




Zonolite Co. / W. R. Grace
Beltsville, MD
1977 - 1981
Data from Baltimore - Washington International Airport
18 miles NE of site
N
E
S
W
6.33
5.33
2.79
3.85
4.04
5.15
2.88
3.71
4.24
6.17
4.34
5.62
5.45
14.77
12.68
8.51
4.13
0
3
6
10
16
21
Wind Speed (Knots)
Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.

Appendix A

APPENDIX A. EXPOSURE PATHWAYS- VERMICULITE PROCESSING FACILITIES

SOURCE FOR ALL PATHWAYS: Libby Asbestos-contaminated Vermiculite from Libby, Montana

PATHWAY NAME	ENVIRONMENTAL MEDIA & TRANSPORT MECHANISMS	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSURE POPULATION	TIME
Occupational	Suspension of Libby asbestos fibers or contaminated dust into air during materials transport and handling operations or during processing operations	Onsite	Inhalation	Former and/or current workers	Past, present, future
Household Contact	Suspension of Libby asbestos fibers into air from dirty clothing of workers after work	Workers' homes	Inhalation	Former and/or current workers' families and other household contacts	Past, present, future
Waste Piles	Suspension of Libby asbestos fibers into air by playing in or otherwise disturbing piles of vermiculite or waste rock	Onsite, at waste piles	Inhalation	Community members, particularly children	Past, present, future
Onsite Soils	Suspension of Libby asbestos fibers into air from disturbing contaminated material remaining in onsite soils (residual soil contamination, buried waste)	At areas of remaining contamination at or around the site	Inhalation	Current onsite workers, contractors, community members	Present, future
Ambient Air	Stack emissions and fugitive dust from plant operations into neighborhood air	Neighborhood around site	Inhalation	Community members, nearby workers	Past
Residential Outdoor	Suspension of Libby asbestos fibers into air by disturbing contaminated vermiculite brought offsite for personal uses (gardening, paving driveways, traction, fill)	Residential yards or driveways	Inhalation	Community members	Past, present, future
Residential Indoor	Suspension of household dust containing Libby asbestos fibers from plant emissions or residential outdoor waste	Residences	Inhalation	Community members	Past, present, future
Consumer Products	Suspension of Libby asbestos fibers into air from using or disturbing insulation or other consumer products containing Libby vermiculite.	At homes where Libby asbestos-contaminated products were/are present	Inhalation	Community members, contractors, and repairmen	Past, present, future

Appendix B

Appendix B:
Hazard Category Definitions

Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.