PUBLIC HEALTH ASSESSMENT

Libby Asbestos NPL Site
OU4: Screening Plant, Export Plant, Town of Libby,
and Affected Libby Valley Residential and Commercial Properties
Lincoln County, Montana
EPA Facility ID: MT0009083840

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Summary

Libby is the county seat of Lincoln County, in northwest Montana. Vermiculite was mined from "Zonolite Mountain" near Libby from the early 1920s until 1990 and was processed for export in and around the town of Libby. The vermiculite mined in Libby is contaminated with amphibole asbestos fibers (Libby Asbestos, or LA). Mining and processing operations, as well as home use of Libby vermiculite products, resulted in the spreading of LA throughout the town. Unusually high numbers of people in Libby have been diagnosed with asbestos-related respiratory disease; deaths from asbestos-related respiratory diseases are also elevated. Since 1999, the Environmental Protection Agency's (EPA's) Emergency Response Branch has been conducting sampling and removals to address the most highly contaminated areas in the Libby valley. Since the proposal of the Libby Asbestos site to the National Priorities List (NPL), these activities have been transitioning over to the Superfund Branch for long-term cleanup.

People were exposed to LA by many different exposure pathways in the past, and as long as source materials are present, the possibility for further exposure remains. Source materials are defined as any material (including waste rock, soil, building materials, or insulation) containing LA which, when disturbed, could produce elevated levels of LA fibers in air. The size of source areas can range from the residential scale to the industrial scale. However, many of the largest and most highly contaminated areas have been or are being cleaned up. As of late fall 2002, characterization of contamination in Libby homes and businesses to prioritize cleanups through the EPA Superfund program is almost complete.

On the basis of available information, the Agency for Toxic Substances and Disease Registry (ATSDR) has concluded that:

- People in the Libby area were exposed to hazardous levels of asbestos in the past.
- People in the Libby area have elevated levels of disease, and death, associated with exposure to asbestos.
- People could still be exposed to hazardous levels of asbestos near current source areas. These levels could be especially hazardous to sensitive populations, including people who have been exposed for many years already, smokers, and young children.
- The exact level of risk associated with low-level exposure to asbestos cannot be determined due to uncertainties in the analysis and toxicology of Libby asbestos. Nevertheless, continuing exposures to Libby asbestos pose an unacceptable risk to residents and workers who have already been exposed for many years.
- The cleanup actions undertaken by EPA are protective of public health.

ATSDR makes the following recommendations:

- Continue to investigate and clean up the site to reduce or remove continuing sources of Libby asbestos.
- Conduct toxicological investigation of the risks associated with low-level exposure to asbestos, specifically with the chemical makeup and fiber size of Libby asbestos. This investigation is necessary to assure that site cleanup levels remain protective.
- Conduct health education for the community, especially concerning smoking and asbestos.

- Create a registry to track former workers, their household contacts, and residents exposed to Libby asbestos.
- Continue to provide information to the community about the hazards of Libby asbestos.
- Continue to provide information on how to diagnose and treat asbestos-related diseases to the local medical community.

Purpose and Health Issues

Libby Asbestos was proposed for the National Priorities List (NPL) on February 26, 2002 and listed on October 24, 2002. The Agency for Toxic Substances and Disease Registry (ATSDR) is required by Congress to conduct public health assessments (PHAs) on all sites proposed for the NPL. In this PHA, ATSDR evaluates the public health implications of the Libby Asbestos site using available environmental data, potential exposure scenarios, community health concerns, and health outcome data. This document also recommends actions to prevent, reduce, or further identify the possibility for site-related adverse health effects.

Background

The background, site description, and site operational history comes from Environmental Protection Agency (EPA) and ATSDR documents [1,2,3,4,5].

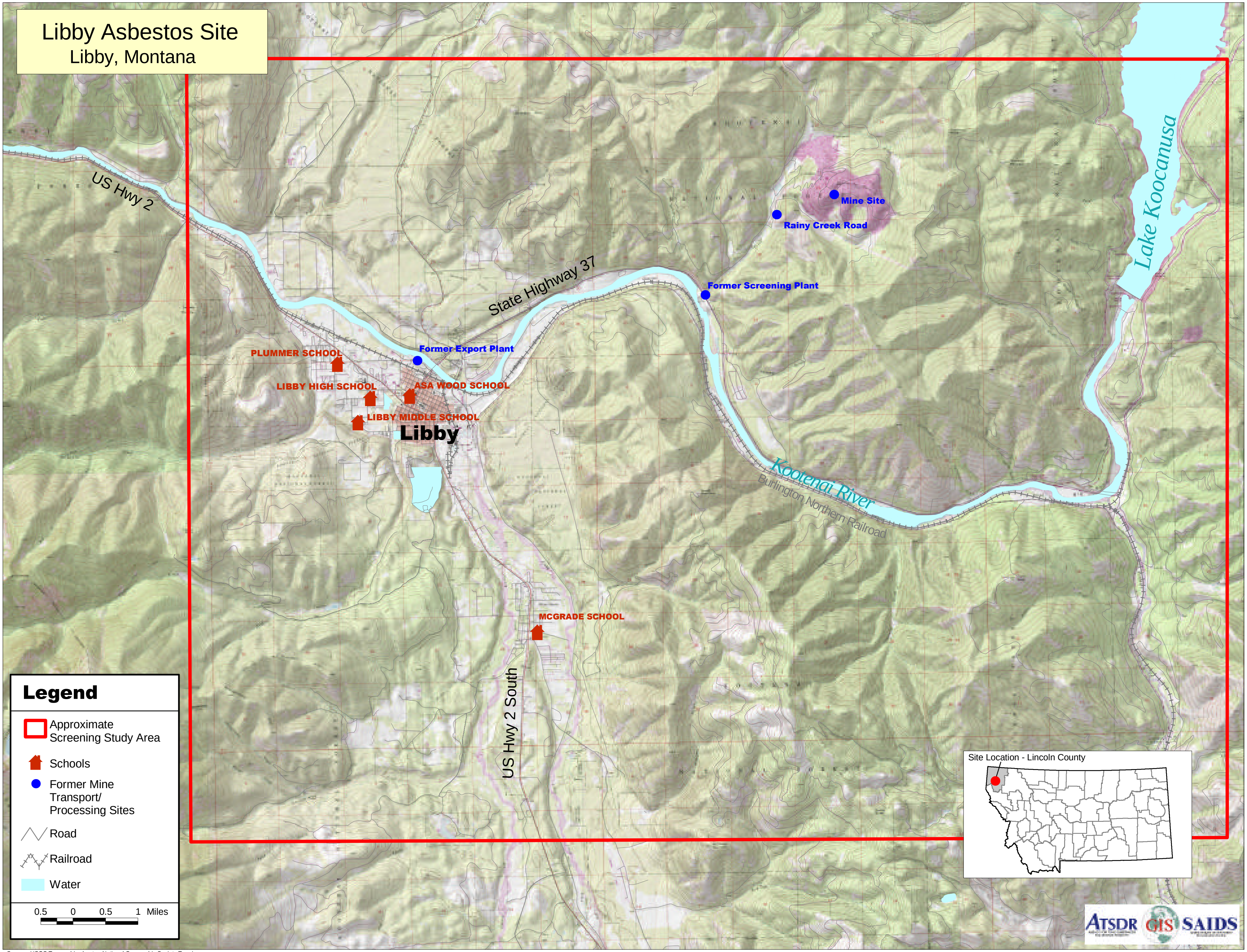
Libby is the county seat of Lincoln County, located in northwest Montana. In 1881 gold prospectors discovered vermiculite, a type of platy weathered mica mineral, on "Zonolite Mountain," 7 miles northeast of Libby. From the early 1920s until 1990, vermiculite was mined for use in a variety of products. Raw vermiculite ore is used in gypsum wallboard, cinder blocks, and many other products, and exfoliated vermiculite is used as loose fill insulation, as a fertilizer carrier, and as an aggregate for concrete. Exfoliated vermiculite is formed by heating the ore to approximately 2,000 degrees Fahrenheit (^oF), which explosively vaporizes the water contained within the mineral structure and causes the vermiculite to expand by a factor of 10 to 15. Direct export and exfoliation (expansion) prior to shipping occurred in locations in and around the town of Libby.

The vermiculite mined from Zonolite Mountain is contaminated with asbestos fibers, including the asbestos varieties tremolite and actinolite, and contains the related fibrous asbestiform minerals winchite, richterite, and ferro-edenite [6]. Collectively, the asbestiform minerals contaminating the vermiculite are referred to here as Libby asbestos (LA). Mining and processing operations, as well as home use of waste rock and products from the mine, resulted in the spreading of LA throughout the town. Hundreds of people in Libby, including former mine workers, their families, and other residents, have exhibited signs and symptoms of asbestos-related disease. Since 1999, in response to reports of widespread disease among Libby residents, EPA's Region 8 Emergency Response Branch has been conducting sampling and removals to address the most highly contaminated areas in the Libby valley. Since the Libby area was proposed for the NPL in February 2002, these activities are transitioning to EPA's Superfund Branch for long-term cleanup.

Site Description

The Libby Asbestos site (the site) is located in Libby, Montana. Figure 1 shows the site location and features. Libby lies in the northwest corner of Montana in Lincoln County approximately 35 miles east of the Idaho border and 65 miles south of the Canadian border. Libby is bounded to the north by the Kootenai River and surrounded to the south by the Cabinet Mountains and the Cabinet Mountain Wilderness area. The site lies within Sections 3 and 10, T30N, R31W of the Libby Quadrangle in Lincoln County, Montana.

Figure 1: Site Location and Features



Source: USGS Topograhic sheets - National Geographic Society Topo!

The site comprises the vermiculite mine on Zonolite Mountain, the former screening plant and the former export plant (two former vermiculite processing centers), the road between the former screening plant and the mine site (Rainy Creek Road), and homes and other businesses which could have become contaminated with LA fibers as a result of the mining and processing operations in and around Libby. For long-term management purposes, EPA has divided the site into two operable units (OUs). OU3 includes the mine site and Rainy Creek Road, and OU4 includes the remainder of the Libby valley [1].

Because OU4 includes homes and other areas where continuing exposure to asbestos fibers is likely, and because EPA is focusing its current remedial investigation (RI) activities on this unit, this PHA will consider only OU4. The mine and road in OU3 are of less concern at present because access is limited by a barricade at the lower entrance to Rainy Creek Road. OU3 will be considered at a later date.

Site Operational History

In the early 1920s, initial mining operations began on the vermiculite ore body 7 miles northeast of Libby. Full-scale operation began later that decade under the name of Universal Zonolite Insulation Company (Zonolite). The vermiculite ore was strip-mined using conventional mining equipment. The ore was processed onsite in a dry mill to remove waste rock and overburden material and then transported to the former screening plant at the foot of Zonolite Mountain, where it was sorted into size fractions. After the sorting process, the material was shipped throughout the United States, either for direct use in products or for expansion prior to use in products. Two expansion sites were also located in Libby: the former export plant immediately west of Highway 37 where it crosses the Kootenai River and the former expansion plant at the end of Lincoln Road, near 5th Street (this plant was shut down in the early 1950s).

In 1963, W.R. Grace purchased Zonolite and continued mining operations. In 1975, Grace added a wet milling process which operated in tandem with the dry mill until the dry mill was shut down in 1985. Expansion operations at the export plant ceased sometime before 1981, although the area was still used to bag and export milled ore until mining operations stopped in 1990. In the years of operation, the Libby mine produced millions of tons of vermiculite, providing about 80% of the world's supply.

Demographics

According to U.S. Census 2000 information, 10,362 persons live within the zip code area including Libby, Montana (59923) [7]. Figure 2 shows that the demographic profile of the population residing in the area around Libby selected for asbestos screening by EPA includes a population of 8,668. The population is mostly (95%) white. About 1.5% of the population is Native American, less than 1% is Black, Asian, Native Hawaiian or other Pacific Islanders or other, and about 2% of the population is two or more races.

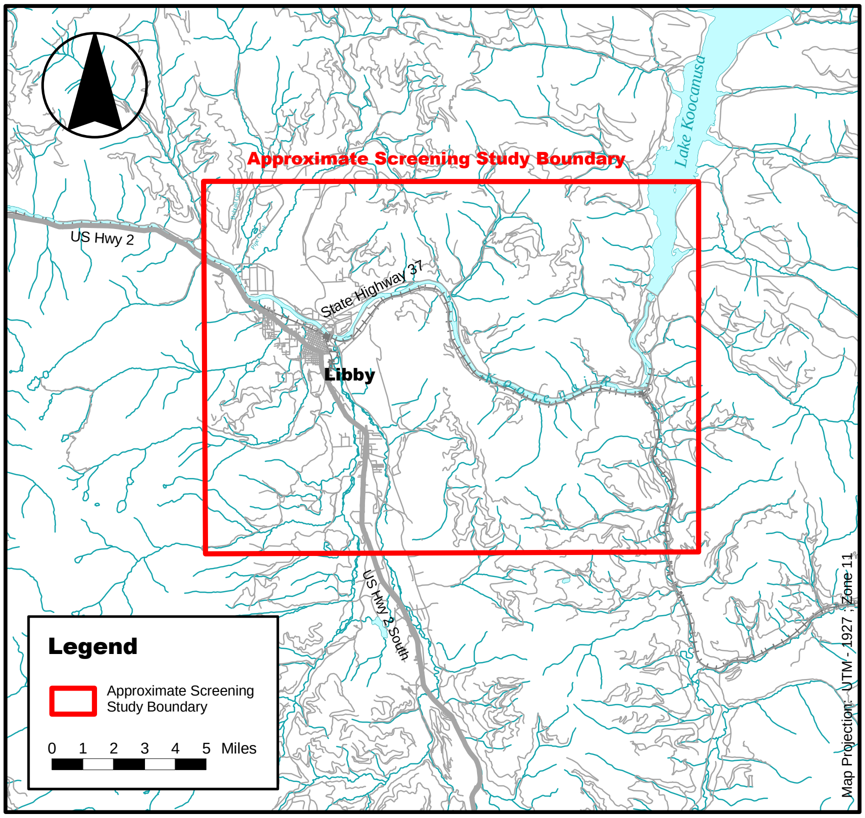
It should be noted that some mine workers lived in the smaller towns of Troy and Eureka, Montana. Also, some mine workers moved to the town of Elko, Nevada, after the Libby mine

Libby Asbestos Site

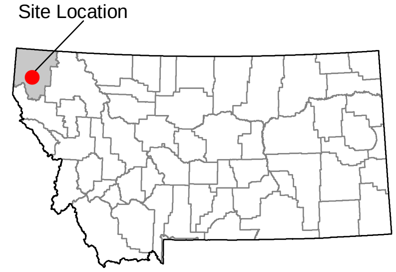
Libby, Montana

EPA Facility ID MT0009083840

FIGURE 2. Demographic Map



Base Map Source: 1995 TIGER/Line Files



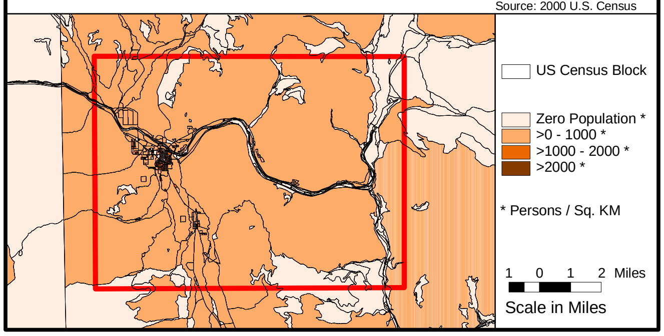
Lincoln County, Montana

Demographic Statistics Within site boundary*	
Total Population	8668
White alone	8286
Black alone	8
Am. Indian and Alaska Native alone	122
Asian alone	33
Native Hawaiian and Other Pacific Islander alone	2
Some other race alone	39
Two or More races	180
Hispanic or Latino	121
Children Aged 6 and Younger	652
Adults Aged 65 and Older	1369
Females Aged 15 - 44	1566
Total Housing Units	3954

Demographics Statistics Source: 2000 US Census
*Calculated using an area-proportion spatial analysis technique

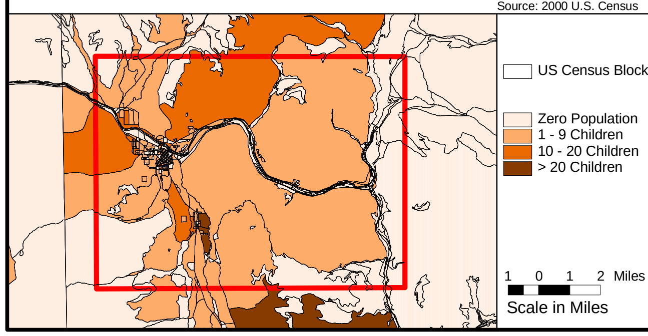
Population Density

Source: 2000 U.S. Census



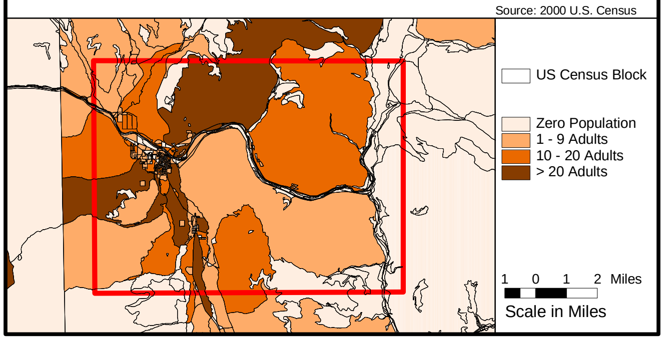
Children 6 Years and Younger

Source: 2000 U.S. Census



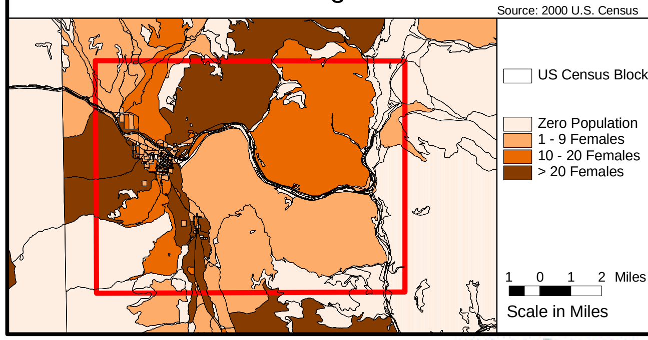
Adults 65 Years and Older

Source: 2000 U.S. Census



Females Aged 15 - 44

Source: 2000 U.S. Census



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shut down. The demographics of people affected in these communities are expected to be similar to those of Libby.

Land and Natural Resource Use

Located in the far northwestern corner of Montana, Libby lies in a valley carved by the Kootenai River on the northeastern edge of the Cabinet Mountain Range. Libby's elevation is 2,066 feet, and it is surrounded by the Kootenai National Forest. The Libby Dam confines the Kootenai River about 17 miles north of town to create the 90-mile long Lake Koocanusa, which extends north into Canada. Montana Highway 37 parallels the Kootenai River and Lake Koocanusa and connects Libby to U.S. Highway 93 to the north. U.S. Highway 2 runs through Libby and connects Libby to the nearest towns of Kalispell, 90 miles to the southeast, and Troy, 18 miles to the northwest. The Burlington Northern Railroad maintains the railroad that runs through Libby connecting Libby to Whitefish, Montana and Spokane, Washington. Freight service runs daily and Amtrak service is available 4 days a week. Libby also has a small airport with a 5,000 foot runway [8].

Libby contains neighborhoods and commercial and industrial areas in relative proximity to each other. Outside the town the terrain quickly becomes mountainous, forested, and rural. Away from the two main roads, population is sparse. Major area industries include forestry, forest products, and tourism.

People in Libby engage in typical residential activities as well as activities related to work at commercial and industrial facilities in town. The areas outside of town are used for hiking, fishing, hunting, and other recreational activities. Logging also takes place in the forested areas.

Drinking water for the city of Libby comes from the Flower Creek reservoir, which is approximately 3 miles southwest of town. [1] People in the area surrounding Libby might use groundwater wells for their drinking water.[1]

In some areas the Libby valley has a vertical relief as high as 4,000 feet and is subject to severe temperature inversions during many times of the year. These physical characteristics can result in the trapping of particulates and other air pollutants in the Libby valley [3].

Previous Reports and Studies

This PHA builds on the many previous studies and reports already in existence regarding Libby asbestos and the impact asbestos has had on health in Libby and the surrounding area. The information in the following documents was used as background for this report:

- Articles began appearing in the scientific literature in the late 1970s and 1980s reporting elevated levels of asbestos-related diseases in workers of the Libby vermiculite mine [9,10,11,12]. In 1999, concern for the workers, their families, and residents of Libby was brought to the public's attention in the media [13]. ATSDR became involved with Libby at this time.

[1] Jim Christiansen, EPA Remedial Project Manager, personal communication [July, 2002].

- To address public health concerns regarding asbestos exposure in Libby, ATSDR has cooperated with EPA, the Montana Department of Public Health and Human Services (MDPHHS), the Lincoln County Environmental Health Department, and the Montana Department of Environmental Quality in the Libby Community Environmental Health Project.
- In December 1999, ATSDR published a health consultation regarding EPA Region 8's proposal to use an asbestos sampling protocol developed by EPA Region 1 to assess levels of contamination in Libby [2]. ATSDR concurred with the use of this protocol.
- In May 2000, ATSDR published a health consultation regarding the health hazards associated with asbestos contamination at the former screening plant and at the former export plant [4]. ATSDR concluded that the contamination posed a public health hazard and that time critical removals by EPA were warranted.
- In November 2000, ATSDR published a health consultation evaluating proposed plans for the removal of asbestos contamination at the former screening plant and the former export plant [5]. ATSDR found the plans to be protective of public health. ATSDR also made recommendations to minimize the chances of asbestos exposure to workers or the community during the removal.
- In August 2001, ATSDR and cooperative partners in the Libby Community Environmental Health Project released a report on the results of the first round of medical testing of Libby residents and former residents for asbestos-related health effects [14]. The testing program was undertaken in cooperation with other agencies to identify the asbestos-related health effects of participants exposed to asbestos and to refer these individuals for additional medical evaluation as needed. Results were combined with later testing results and are discussed below.
- In September 2001, ATSDR released a chemical-specific health consultation on tremolite asbestos and other related types of asbestos [15]. This consultation served as an addendum to ATSDR's toxicological profile on asbestos and was produced to address public health concerns regarding the fibrous amphibole found in Libby vermiculite.
- In December 2001, an EPA toxicologist published a memorandum to the Libby on-scene coordinator which included a discussion of potential risks from exposure to LA in residential settings [16]. The memo concluded that "amphibole mineral fibers in source materials in residential and commercial areas of Libby pose an imminent and substantial endangerment to public health."
- In May 2002, EPA published a sampling and analysis plan for its contaminant screening study, part of the RI activities for OU4 [1]. This report outlines EPA's plan for screening each property in the Libby valley for potential sources of LA. ATSDR was given the opportunity to comment on a draft of this document and agreed that the proposed plan was reasonable.
- In August 2002, ATSDR published a health consultation updating results of a December 2000 analysis of Libby area mortality statistics [17,3]. This review was conducted to generate an accurate representation of mortality potentially associated with historical asbestos exposure in the Libby area. For the period reviewed in the report (1979–1998), mortality in Libby resulting from asbestosis was 40 to 80 times higher than expected, and lung cancer was 20% to 30% higher than expected. Mesothelioma mortality was also elevated, but it could not be quantified. State and national statistics on this disease are not routinely published. Still, because the disease is so rare, any cases are viewed as an

elevation. Most of the asbestosis and mesothelomia deaths (11/12 and 2/3, respectively) were among former workers of the vermiculite mine and processing operations.

- In September 2002, ATSDR provided preliminary results of combined medical testing performed in 2000 and 2001 [18]. Of the 6,668 participants who received chest x-rays in the two rounds of testing, 18% showed pleural abnormalities. Fifty-one percent (51%) of the 365 former workers showed pleural abnormalities. By comparison, in the United States the rate of pleural abnormalities in non-asbestos exposed groups ranges from 0.2% to 2.3%.
- In conjunction with the medical testing performed in 2000 and 2001, ATSDR conducted a study on the usefulness of computed tomography (CT) scans in identifying lung problems associated with asbestos exposure for people whose chest x-rays were indeterminate (e.g., those where only 1 of 3 B-readers found abnormalities). The preliminary results of this study showed that CT scans identified pleural abnormalities in some people whose chest x-rays were indeterminate [19]. The study did not indicate whether CT scans are better than chest x-rays in detecting pleural abnormalities.

Discussion

Data Used

The preparation of this report involved the review and summary of numerous previous studies and data summaries. Generally, the conclusions reached herein are based on three types of data:

1. Analytical data—reported in several documents available in EPA's administrative record (AR) for the site [20].
2. Community concerns—collected by ATSDR representatives in Libby. Also, some community concerns were obtained during a public availability session held in Libby on September 27 and 28, 2002.
3. Health outcome data—as reported in ATSDR's mortality statistics review and in the ATSDR report on the community medical testing program [3,17,14,18].

All the above data were considered in determining conclusions and recommendations for the site.

Contaminant of Concern

The Libby vermiculite contains a characteristic profile of asbestiform minerals, including tremolite, actinolite, winchite, richterite, and ferro-edenite. The contaminant of concern, comprising the various types of asbestiform minerals detected in vermiculite from the Libby mine, is referred to here as Libby Asbestos (LA). The following sections give more information about asbestos in general and the materials making up LA specifically.

This document is atypical compared to most PHAs in that only one contaminant is considered. If, in the course of the RI activities for this site, other contaminants are identified that could contribute substantially to health risks in the community, they will be evaluated in an addendum to this document.

Asbestos Overview

This description comes mostly from ATSDR's toxicological profile for asbestos [15]. Asbestos is a general name applied to a group of silicate minerals consisting of thin, separable fibers in a parallel arrangement. Different criteria are used to identify asbestos fibers, depending on the context. In general, the Occupational Safety and Health Administration (OSHA) regulates as fibers those particles of the regulated mineral classes (see below) longer than 5 μm in length, with aspect ratios (length: width) of at least 3:1, and which are not "cleavage fragments," i.e., crystalline particles exempt from regulation [6].

Asbestos minerals fall into two classes: serpentine and amphibole. Serpentine asbestos has relatively long and flexible crystalline fibers and includes chrysotile, the predominant type of commercial asbestos. 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.

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—referred to here as Libby asbestos (LA). The raw ore was estimated to contain up to 26% LA [21]. For most of the mine's operation, LA was considered a byproduct of little or no value and was not used commercially. Nevertheless, the mining and processing of LA-contaminated vermiculite resulted in the contamination of many areas in and around Libby with LA.

Asbestos Health Effects

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

> *Malignant mesothelioma*—Cancer of the lining of the lung (pleura) and abdominal cavity. This cancer can spread to tissues surrounding the lungs or other organs. Virtually all mesothelioma cases are attributable to asbestos exposure [15].
>
> *Lung cancer*—Cancer of the lung tissue. 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 [15].
>
> *Noncancer effects*—these include 1) *asbestosis*, where asbestos fibers lodged in the lung cause scarring and reduce lung function; 2) *pleural plaques*, localized or diffuse areas of thickening of the pleura (lining of the lung); 3) *pleural thickening*, extensive thickening of the pleura which restricts breathing; 4) *pleural calcification*, calcium deposition on pleural areas thickened from chronic inflammation and scarring; and 5) *pleural effusions*, fluid buildup in the pleural space between the lungs and the chest cavity [15].

Insufficient evidence exists to conclude whether inhalation of asbestos increases the risk of cancers at sites other than the lungs, pleura, and abdominal cavity [15].

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 [22]. The resulting increased duration of exposure to amphibole asbestos is thought to significantly increase the risk of mesothelioma and, to a lesser extent, asbestosis and lung cancer [22]. OSHA, however, continues to regulate chrysotile and amphibole asbestos as one substance, because both types increase the risk of disease [23].

Evidence suggesting that 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 [24]. 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 [24].

Ingestion of asbestos causes little or no risk of noncancer effects [15]. However, some evidence suggests that acute oral exposure can induce precursor lesions of colon cancer, and that chronic oral exposure can lead to an increased risk of gastrointestinal tumors [15]. ATSDR found no elevation in the number of deaths from gastrointestinal cancers in the Libby area compared to Montana and the United States [17].

Asbestos, Immunological Changes, and Autoimmune Disease

Community members expressed concerns about autoimmune diseases such as rheumatoid arthritis, lupus, or fibromyalgia being caused by asbestos exposure. ATSDR's toxicological profile for asbestos reviews information in the literature about possible immunological effects of exposure to asbestos. The toxicological profile summarizes its findings in the following excerpted passage [15]:

> Studies of workers suffering from asbestos-related diseases such as asbestosis or mesothelioma indicate that the cellular immune system in such patients can be depressed. This is an effect of particular interest and concern since impaired immune surveillance may contribute to the increased incidence of cancer in asbestos-exposed people. Moreover, variation in immune system functional capability might be an important determinant of why some people develop cancer or asbestosis while others, with approximately equal exposures, do not. However, it is very difficult to distinguish whether the alterations in immune function noted in such studies are the cause or the result of asbestos-induced disease. The frequency of impaired cellular immunity in exposed workers without clinically-apparent disease is generally low, although some studies have noted alterations in lymphocyte distribution and impairment of natural killer (NK) cells. This could mean that the immunological changes do not occur until the disease develops (i.e., the changes are the result of the disease). Alternatively, it could mean that workers with immune systems that are not impaired by asbestos do not get serious disease, while workers whose immune systems are injured by asbestos do tend to develop disease (i.e., effects on the immune system are the cause of the disease). Available data do not allow a firm distinction between these alternatives at present, but the possible immunotoxic effects of asbestos are of clear concern. Results from animal studies provide supporting evidence of direct and indirect effects of asbestos on the immune system, although the specific roles of these effects in the etiology of asbestos-induced pulmonary diseases are not well understood and are under current investigation. For example, experiments with mice indicate that asbestos exposure decreases the number and cytotoxic activity of interstitial

> pulmonary NK cells and that genetically impaired cell-mediated immunity may be a predisposing factor in asbestos fibrosis.

Also, according to the toxicological profile, "concentrations of autoantibodies (rheumatoid factor, antinuclear antibodies) tend to be abnormally high in asbestos-exposed workers. . . . In some cases, increased autoantibodies can lead to rheumatoid arthritis (Caplan's Syndrome), although this is more common in coal miners and workers with other pneumoconioses than in workers with asbestosis. . . . Immunological abnormalities are usually mild or absent in asbestos-exposed workers who have not developed clinical signs of asbestosis. . . ." [Note: secondary references have been omitted for brevity. Further information and secondary references are given in the toxicological profile, which is available online at: http://www.atsdr.cdc.gov/toxprofiles/tp61.html .]

In summary, not enough evidence exists to say whether asbestos exposure or resulting asbestos-related disease could increase a person's likelihood of experiencing autoimmune disease. Still, the associations that have been discovered between immunological changes and asbestos exposure indicate that this question deserves further research.

Methods for Measuring Asbestos Content

Measuring asbestos content in air samples and in bulk materials that could become airborne involves both quantification of fibers and determination of mineral content of the fibers to identify whether they are asbestiform. 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 [15]. Disadvantages of this method include the inability to detect fibers smaller than 0.25 µm in diameter and the inability to distinguish between asbestos and nonasbestos fibers [15].

Asbestos content in bulk samples is often determined using polarized light microscopy (PLM), a method that uses polarized light to compare refractive indices of minerals and can distinguish between asbestos and nonasbestos fibers and between different types of asbestos. Fibers are quantified through PCM, and then mineral species are determined using polarizing elements added to the light path. The PLM method is also limited by resolution—fibers finer than about 1 µm in diameter cannot be identified by PLM.

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 [15]. 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 bulk asbestos concentration [15].

To compare SEM and TEM measurements with regulatory limits, they are 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 (µg/m3)/(f/cc) was adopted as a conversion factor, but this value is highly uncertain because it represents an average of conversions ranging from 5 to 150 (µg/m3)/(f/cc) [25]. 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 [25]. Generally, a combination of PCM and TEM is used to describe the fiber population in a particular sample.

Counting fibers using the regulatory definitions does not adequately describe risk of health effects, as fiber size, shape, and composition can contribute collectively to risks in ways that are still being elucidated. For example, shorter fibers appear to deposit preferentially in the deep lung, but longer fibers can disproportionately increase the risk of mesothelioma [15,24]. Some of the unregulated amphibole minerals can exhibit asbestiform characteristics and contribute to risk. Fiber diameters greater than 2 µm are considered above the upper limit of respirability and do not contribute significantly to risk [24]. Methods are being developed to assess the risks posed by varying types of asbestos and are currently awaiting peer review [24].

EPA is currently working with several contract laboratories and others to develop, refine, and test a number of methods for screening bulk soil samples. The methods under investigation include PLM, infrared (IR), and SEM.[2]

Current Standards, Regulations, and Recommendations for Asbestos

For industrial applications, OSHA has defined as an asbestos-containing material any material with greater than 1% bulk concentration of asbestos. It is important to note that 1% is not a health-based level, but instead represents the practical detection limit in the 1970s when the regulations were made.

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 [26]. This requires companies releasing friable asbestos at concentrations greater than a 0.1% de minimus limit 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 fibers per cubic centimeter (f/cc) for asbestos fibers greater than 5 µm in length and with an aspect ratio (length:width) greater than 3:1, as determined by PCM. 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 [27].

The National Institute of Occupational Safety and Health (NIOSH) set a recommended exposure limit (REL) of 0.1 f/cc for asbestos fibers greater than 5 µm in length. This REL is a TWA for up to a 10-hour workday in a 40-hour work week [27]. The American Conference of Government Industrial Hygienists (ACGIH) has also adopted a TWA of 0.1 f/cc as its threshold limit value [28].

[2] Jim Christiansen, EPA Remedial Project Manager, personal communication [November 2002].

EPA has set a maximum contaminant level (MCL) for asbestos fibers in water as 7,000,000 fibers longer than 10 µm in length per liter, based on an increased risk of developing benign intestinal polyps [29]. The state of Montana, and several other states, uses the same value as a human health water quality standard for surface water and groundwater [30].

Asbestos is a known human carcinogen. EPA has calculated an inhalation unit risk for cancer (cancer slope factor) of 0.23 per f/cc of asbestos. 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. Using this value, one can calculate average lifetime asbestos fiber air concentrations corresponding to specified risk levels. The concentration resulting in an increased risk of 1 in 10,000 is 0.0004 f/cc. The concentration resulting in an increased risk of 1 in 1,000,000 is 0.000004 f/cc. The unit risks were based on measurements with phase contract microscopy and should not be applied directly to measurements made with other analytical techniques. Also, the unit risk should not be used if the air concentration exceeds 0.04 f/cc, because above this concentration the slope factor can differ from that stated [25].

Exposure Pathways

An exposure pathway is the process by which an individual is exposed to contaminants originating from a contamination source. An 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. The following sections describe the exposure pathways identified at the site.

The highest risk at the site, both now and in the past, is from inhalation of asbestos fibers. Several inhalation exposure pathways were identified, and they are discussed briefly in the next section.

Present Inhalation Exposure Pathways

Residential indoor—Residents can inhale LA-contaminated household dust, LA-contaminated building materials or insulation disturbed during renovations or work in attics, or deteriorating LA-contaminated building materials or insulation falling into living areas.

Residential outdoor—Residents can inhale LA while gardening in soil amended with LA-contaminated vermiculite, driving over LA-contaminated fill in driveways, and/or playing in LA-contaminated soil.

Occupational—Cleanup workers can be exposed to LA during remedial activities through disturbing LA-contaminated vermiculite, soil, building materials, or insulation.

In a memorandum, EPA documented that 1) normal activities such as those listed above can suspend LA fibers into the breathing zone, 2) the level of exposure a person experiences is dependent on the level of activity as well as the level of LA in the soil, and 3) exposures resulting from the above activities can at times exceed OSHA or risk-based standards [16]. The calculations in this memorandum were for screening purposes only. However, given the uncertainties involved in the risk assumptions, measurement techniques, and toxicology of LA fibers, ATSDR considers this analysis adequate for demonstrating that a risk exists.

Potential present exposure pathways include breathing ambient air in the Libby area and breathing around undisturbed building materials or insulation. For these pathways, exposures are not expected to be high enough to cause significant additional health risks compared to the exposure pathways described above.

Past Inhalation Exposure Pathways

Occupational—Workers were exposed to high levels of LA in the air at the mine, during transport and handling operations, and during processing operations such as exfoliation. Asbestos levels in air at the mine were measured as high as 100 f/cc [16]. Anecdotal information indicates that workers did not often wear personal protective equipment such as respirators.

Household contact—Relatives of workers were exposed to LA from dirty clothing and cars of workers returning from the mine.

Vermiculite piles—Children played in open piles of LA-contaminated vermiculite, such as those near the ball fields and export plant.

Residential outdoor—Residents inhaled LA while gardening in soil amended with LA-contaminated vermiculite, driving over LA-contaminated fill in driveways, and/or playing in contaminated soil. This pathway includes inhalation of LA-contaminated fill used at local schools, because residents could also have been exposed there.

Residential indoor—Residents inhaled LA-contaminated household dust, LA-contaminated insulation being sprayed into attics and walls or disturbed during past renovations, or deteriorating LA-contaminated building materials or insulation falling into living areas.

Ambient air—Historical levels of asbestos in the ambient air in Libby were higher than the current OSHA standard of 0.1 f/cc [16]. These historical results are uncertain due to the scarcity of sampling, a lack of differentiation between asbestos and nonasbestos fibers, and the low sensitivity of the analytical method used. However, the results still indicate a potentially higher risk of health effects, especially for residents who were exposed continuously and through multiple pathways.

The limited information on historical concentrations of LA in air and appropriate exposure assumptions to make for activities that happened long ago make it even more difficult to determine quantitative risk for the past exposure pathways. Nevertheless, it is known that the likelihood of someone inhaling LA was much higher while the mine and processing facilities were in operation. Also, as described below, health outcome data shows that people exposed to LA have higher rates of asbestos-related disease. Therefore, no calculations are necessary to conclude that the risk of health effects was unusually high for the past exposures in Libby.

Pathways Eliminated From Consideration

Ingestion of Drinking Water

A ban on private wells is in place in the city of Libby because of groundwater contamination from a source unrelated to asbestos. The city of Libby's drinking water is drawn from Flower Creek Reservoir. This reservoir is southwest and upstream of town; thus it is not close to or downstream from Zonolite Mountain or the processing facilities associated with the vermiculite mine. In 2000, no asbestos fibers were detected in sampling of influent and effluent water at the water treatment plant [20]. In the areas outside Libby, some people drink groundwater from private wells. According to EPA officials, private wells in and around Libby have not been tested for asbestos[3]. Because asbestos fibers are not readily transported through soil, it is unlikely that contamination from waste piles, processing operations, or vermiculite in soil would reach the groundwater. Therefore, because site-related asbestos contamination is unlikely, and because the inhalation pathways described above are the major contributors to risk, in this PHA the drinking water pathway was eliminated from further consideration.

Soil and Waste Incidental Ingestion

Incidental ingestion of LA-contaminated soils, vermiculite, and/or wastes was not considered because the health risk from this pathway is minor in comparison to the inhalation pathways described above. This assumption is supported by the results of ATSDR's mortality review, which found deaths from lung diseases (related to inhalation) elevated, while at the same time no increase in gastrointestinal cancers (related to ingestion) was found.

Dermal Exposure Pathways

No dermal exposure (skin contact) pathways were considered. The health risks associated with this route of exposure are minor in comparison to the inhalation pathways described above.

Health Outcome Data

The Superfund law requires consideration of health outcome data in a public health assessment. Health outcome data can include mortality information (e.g., the number of people dying from a certain disease) or morbidity information (e.g., the number of people in an area getting a certain disease or illness). The Libby Asbestos site meets the four criteria necessary to perform a thorough evaluation of health outcome data:

(1) A completed human exposure pathway—as described previously, several completed human exposure pathways exist at the site, specifically those related to inhalation of asbestos fibers.
(2) Contaminant levels high enough to result in measurable health effects—many reports of measured health effects caused by exposure to asbestos exist and will be detailed below.
(3) Enough people in the completed pathway for the health effect to be measured—workers, their families, and residents in the Libby area were and are potential receptors for the asbestos inhalation pathway.

[3] Jim Christiansen, EPA RPM for Libby Asbestos, personal communication [July 10, 2002].

(4) A health outcome database in which disease rates for populations of concern can be identified—information used includes death certificate data and results of medical testing conducted by ATSDR and other agencies.

Both morbidity and mortality information have been evaluated in other ATSDR reports [14,17,3,18]. The conclusions of these reviews are summarized below.

Morbidity Information – Medical Testing Results

In response to the reports of asbestos-related illness in the Libby community, ATSDR developed a community-based medical testing program. The testing was a part of the Libby Community Environmental Health Project and was carried out with the cooperation of the Department of Health and Human Services Region 8 office, EPA, MDPHHS, the Lincoln County Environmental Health Department, and the Lincoln County Public Health Officer.

Those eligible for participation in the program included former workers and contractors of the vermiculite mine, household contacts of former workers, and people who had been in the Libby area for a 6-month period prior to December 31, 1990. The testing included a questionnaire, chest x-rays for adult participants, and lung function tests. Two rounds of testing were offered; the first round was in summer 2000 and tested 6,149 persons, and a second round was offered in summer 2001 to test people who had missed the first round; 1,158 persons were tested in this round.

In September 2002 a report was made available that summarized preliminary results of the combined 2000 and 2001 testing [18]. Eighteen percent of the participants had pleural abnormalities reported by at least 2 out of 3 certified B-readers who analyzed the x-rays. Of former mine workers, 51% showed pleural abnormalities. The factors most strongly related to having pleural abnormalities were being a former mine worker, being male, and being a female household contact of a former mine worker. Exposure to asbestos via multiple exposure pathways also increased the chances of finding pleural abnormalities. Pulmonary function testing showed that 1.8% of the participants had moderate to severe restriction in breathing capacity. The strongest risk factors for restrictive changes in pulmonary function included current cigarette smoking, being a former mine worker, chest surgery, having a high body mass index, and age.

Mortality Information – Death Certificate Review

As part of its response to reports of asbestos-related illnesses in Libby, ATSDR reviewed mortality statistics from the Libby area for the years 1979–1998. Death certificates were reviewed, and mortality rates and standard mortality ratios were determined for underlying causes of death associated with asbestos exposure. These included nonmalignant respiratory diseases, lung cancer, mesothelioma, digestive cancer, and pulmonary circulation diseases. The initial findings were released in a December 2000 health consultation [3]. Asbestosis mortality in the area was 40 to 60 times higher than expected, and mesothelioma cases were also elevated. The degree to which mesothelioma was elevated could not be quantitatively determined because state and national statistics on this rare disease are not routinely available. Other causes of death, including lung cancer, digestive cancer, and diseases of pulmonary circulation, were not significantly elevated over the time period studied.

Recently, it was discovered that several death certificates were inadvertently omitted from the initial review, due to differences in reporting procedures in certificates from before 1980. Therefore, ATSDR reanalyzed the statistics from 1979 to 1998, including the newly identified certificates. ATSDR released the updated health consultation in August 2002 [17]. The updated analysis showed that the elevation of asbestosis was even greater than previously found, with mortality in Libby 40 to 80 times higher than expected. In addition, lung cancer was found to be 20% to 30% higher than expected. Again, mesothelioma was elevated, but difficult to quantify. Other causes of death, including digestive cancer and diseases of pulmonary circulation, were not significantly elevated.

The updated mortality review included a comparison of death certificate data with employment information obtained from employee records from the mining and milling facilities in Libby. This analysis showed that 92% (11/12) of the asbestosis deaths, 17% (21/124) of the lung cancer deaths, and two out of three mesothelioma deaths were former employees of the vermiculite facility.

Death certificate reviews have inherent limitations. They tend to underestimate mortality for specific causes—contributing diseases are not always reported. Also, it is generally recognized that occupational and environmental diseases are under-reported. Thus, it is expected that mortality in Libby from asbestos-related disease is even higher than shown in the death certificate review.

Evaluation

Determining a quantitative risk of health effects to Libby community members from exposure to LA is difficult for two reasons: first, significant uncertainties and conflicts in the methods used to analyze asbestos exist, and second, the exact level of health concern for different sizes and types of asbestos remains controversial due to limitations in toxicological information currently available. Analytical techniques and toxicology issues specifically related to the LA from the Libby vermiculite mine are areas deserving substantial further research.

Despite these uncertainties, given the health outcome data presented above, it is likely that continuing exposure to LA increases the risk of malignant and nonmalignant respiratory disease.

The mortality review showed that almost all the deaths from asbestos-related disease occurred in former workers of the vermiculite facility or their household contacts. It is not surprising that the workers would show the highest mortality, as they were exposed to the highest concentrations of asbestos for the longest period of time. The greater level of exposure combined with the long exposure duration (average length of employment was close to 20 years) would increase the risk of disease and effectively reduce the latency period before onset of disease.

People who had lower exposures or shorter durations of exposure—or both—could exhibit longer latency periods before the onset of disease. For example, a recent case report described a patient who had a brief but high intensity exposure to LA. About 30 years later, the patient showed pleural abnormalities on chest x-rays but had no symptoms of asbestos-related disease for another 10 years, when fatal asbestosis quickly set in [31]. No direct causal relationship between pleural abnormalities and asbestos-related diseases has ever been demonstrated.

However, both conditions are associated with asbestos exposure, and it is reasonable to assume that people who exhibit pleural abnormalities could be at higher risk for asbestos-related diseases, including asbestosis and lung cancers. The elevated number of pleural abnormalities, in both former workers and other residents around Libby, suggests that additional cases of asbestos-related disease may occur in coming years.

Summary of Removal and Remedial Actions Completed and Proposed

Because risk is based on exposure level and duration, the risk of asbestos-related health effects can be effectively reduced by interrupting continuing exposures to LA. EPA has been and continues to perform emergency removal and remedial activities to interrupt major sources of LA and LA-contaminated materials in and around Libby. This section reviews these activities with respect to their effectiveness in protecting public health.

Mine Site—Because the mine site is in a remote area, it is unlikely that people will have large, continuing exposure to asbestos there. To minimize the chance of exposure, EPA has paved a portion of Rainy Creek Road, closed the entrance to Rainy Creek Road, and placed warning signs at the road entrance and around the mine. Although further investigation and cleanup of the mine site is expected, at this time these actions will be protective of public health.

Screening Plant / Export Plant—EPA provided ATSDR with plans for removal of contamination at these facilities. ATSDR reviewed the plans and determined that they would be protective of public health [5]. Remediation of both of these sites is ongoing [32].

Schools—Cleanup of school grounds has occurred. Cleanup of school running tracks is planned to be complete by the fall of 2002 [32].

Residential and Commercial Properties—EPA has published a Sampling and Analysis Plan for prioritizing residential and commercial properties for cleanup [1]. ATSDR reviewed this plan and found it would be protective of public health. To assure proper disposal of waste materials from the residential cleanup activities, EPA is constructing a special cell in the county landfill.

The contaminant screening study is almost complete. At the time of this report, 3,440 properties have been screened. Of the screened properties, approximately 6% have indoor visible vermiculite in insulation or building materials, about 31% have visible vermiculite outdoors in gardens or yards, and about 6% have both. Two hundred eighty-one property owners denied EPA access for screening. Residential cleanups are underway, but the final determination of how many properties will be cleaned is awaiting results of the soil samples collected during the contaminant screening study.[4]

ATSDR Child Health Initiative

ATSDR recognizes that infants and children might be more vulnerable to exposures than adults in communities faced with environmental contamination. Because children depend completely

[4] Jeff Montera of CDM and by Jim Christiansen of EPA, personal communications [November 18, 2002].

on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests at the site as part of the ATSDR Child Health Initiative.

The effects of asbestos on children are thought to be similar to adults. However, children could be especially vulnerable to asbestos exposures because:

- children are more likely to disturb fiber-laden soils or indoor dust while playing,
- children are closer to the ground and thus more likely to breathe contaminated soils or dust,
- children have faster breathing rates that may increase the level of exposure to asbestos, and
- children could be more at risk than those exposed later in life because of the long latency period between exposure and onset of asbestos-related respiratory disease.

Many of the most highly contaminated areas have been addressed through emergency removals. Thus, children today have a lower risk of health effects than children in the past.

Community Health Concerns

Community concerns about the health effects of asbestos exposure have been identified through ATSDR's activities in Libby. Concerns have been expressed during Community Advisory Group (CAG) meetings and other interactions with community members. ATSDR has also maintained a presence in Libby at EPA's Information Center and encouraged people to share their concerns. ATSDR held public availability sessions on September 27 and 28, 2002, to give community members a chance to share concerns about the site that they feel have not been addressed. Approximately 13 community members shared concerns at these public availability sessions.

The health-related concerns identified through these community interactions are listed and addressed below:

(1) Concern: *I have been diagnosed as having asbestosis. What can I do now to keep myself healthy and protect myself from a worsening condition?*

(1) Response: It is important for you to follow up with your personal physician on an ongoing basis. In addition, ATSDR has developed a brochure entitled "Living With Asbestos-Related Illness: A Self-Care Guide," which describes actions people can take to improve their health and quality of life. This brochure is included in Appendix B of this document.

(2) Concern: *What is the procedure for getting further x-rays done? Do I need a written order from my doctor?*

(2) Response: You should consult your doctor for a referral if, based on your occupational and/or medical history, he or she recommends a chest x-ray. You can also utilize the medical services at the Center for Asbestos-Related Disease (CARD) clinic in Libby. Periodic screening will also be performed for eligible persons. Contact Dr. Michael Spence, Montana State Medical Officer, for information on the testing program.

(3) Concern: *I would like a listing of board-certified pulmonologists in the area who would be able to treat my asbestosis. Will someone be setting up a practice in Libby? If I get sicker, I might not be able to drive as far as I do now.*

(3) Response: ATSDR staff performed a search on October 25, 2002 for medical doctors in Montana, Idaho, and Washington licensed in the subspecialty of pulmonary disease on the Web site of the American Board of Medical Specialties (www.abms.org). ATSDR received permission from ABMS to provide the search results as a community service with the understanding that the search results were for consumer use only.

The names and locations of licensed pulmonary disease physicians whose addresses were within 350 miles of Libby are included in Appendix C. ATSDR does not endorse any individual physician listed and will not pay for any services provided by the listed physicians. In addition, although the physician certification information in the ABMS database is updated periodically with data provided by its member boards, due to the possibility of reporting and processing delays, the accuracy and completeness of the list cannot be guaranteed. Neither ATSDR nor ABMS can be held responsible for incomplete or inaccurate information. For updated information, consumers can register to perform searches on the ABMS Web site, or they can verify the certification of a physician by calling 1-866-ASK-ABMS.

ATSDR does not know whether any pulmonologist will set up practice in Libby.

(4) Concern: *I have a general concern with the predominance of cancer here.*

(4) Response: As described earlier, ATSDR found that deaths from lung cancer and from mesothelioma were elevated in the Libby area when compared with the state of Montana and with the United States as a whole. Deaths from digestive cancers were not higher than expected. Past exposure of people to asbestos is associated with increased risk of mesothelioma and lung cancer. The removal of asbestos sources from the community is expected to eventually result in fewer cases of mesothelioma and lung cancer. However, the long latency period between exposure and onset of disease suggests that people who were exposed in the past could continue to develop asbestos-related cancers for some time to come.

Other types of cancer are not associated with exposure to asbestos. Risk factors that could contribute to a person's risk of developing cancer include genetics, age, lifestyle, diet, and smoking history. People who feel they have an elevated risk of cancer should consult their health care provider for additional information, precautions, or preventative measures.

(5) Concern: *More research needs to be done on treatments and a cure for asbestosis and other asbestos-related disease.*

(5) Response: Your comment is noted, and some potential resources for information on current research projects are listed in this response. Information on current research studies on many diseases, including asbestos-related diseases, can be found on the National Institutes of Health (NIH) Clinical Trials Database at URL http://www.clinicaltrials.gov. Another potential resource is the National Library of Medicine's PubMed search engine, available at URL http://www.ncbi.nlm.nih.gov/PubMed which allows searches by keyword of citations in the biomedical literature.

ATSDR does not perform or provide funding for clinical studies pertaining to the treatment of disease, but we do fund scientific research on mechanisms of toxicity. Results from these studies can eventually assist in the understanding of disease etiology, progression, and possible treatment. In addition, ATSDR *Toxicological Profiles* identify data needs for methods of reducing toxic effects, and we may support or fund future research in this area.

(6) Concern: *The CT study results prove that more than one B-reader is needed to make a determination on chest x-ray. The state of Montana has said it will use only one B-reader. ATSDR should maintain the lead for the ongoing medical screening to ensure that the same protocol is used for the ongoing screening as was used in the 2000 and 2001 testing.*

(6) Response: According to Montana State Medical Officer Dr. Michael Spence, at this time one B-reader is planned for ongoing screening [33]. The plan is to continue screening periodically those people who previously had negative screening results, as well as people who were not previously screened. Multiple readings over the period of several years should ensure that disease is detected even using only one B-reader. All other protocols and eligibility criteria will be identical to those used in the 2000 and 2001 medical screening.

(7) Concern: *Both x-ray and CT scans should be used for screening to identify the full extent of the problem.*

(7) Response: The chest x-ray is a standard screening test for workers exposed to asbestos dusts. Radiation dose to the patient from a CT scan is much greater than that from a chest x-ray. The periodic x-ray screening as proposed by the state of Montana should adequately identify the extent of asbestos-related disease in the community. However, CT scans may be considered to further screen high-risk persons who have questionable chest x-rays.

(8) Concern: *More health education on smoking cessation specifically targeted to the Libby community is needed. Programs should emphasize that a person's risk of developing lung cancer after asbestos exposure is greatly increased if he or she smokes. Program materials or information should be easily accessible to the community (for example, published in the local newspaper).*

(8) Response: Contact the state of Montana for information on their smoking cessation program.

(9) Concern: *Smoking cessation patches should be provided free of charge to smokers in the community.*

(9) Response: Your suggestion is noted. ATSDR agrees with the need to encourage people in Libby to stop smoking, as quitting would greatly reduce their risk of developing lung cancer. Patches cost about the same as cigarettes, so people can switch without financial assistance.

(10) Concern: *The Libby Center for Asbestos-Related Diseases needs the new, state-of-the-art cancer detection equipment I saw reviewed on a science program on television.*

(10) Response: ATSDR staff were unable to locate information on the cancer detection equipment the commenter mentioned. We found reference to several different types of blood tests for enzymes produced by cancerous cells that would allow early detection. It is possible that earlier detection of mesothelioma and lung cancers could increase survival rates. However, to our knowledge, no screening method exists that has been proven to increase survival rates.

(11) Concern: *Twenty-three members of my immediate family had or have asbestos-related disease.*

(11) Response: ATSDR recognizes that the Libby community has faced a tragic and unfair burden due to the diseases caused by the exposure of people to asbestos over many years. The actions that have been and are being taken should prevent future contributions to cumulative exposures.

(12) Concern: *Anecdotal account of person dying from mesothelioma recently who had no occupational or household contact—only exposure from deteriorating insulation.*

(12) Response: Information about the histories of persons diagnosed with mesothelioma in the Libby community will further our knowledge about how the disease is caused. However, it is difficult to determine exactly how and how much people were exposed to LA in the past. Many other pathways, including ambient air and neighborhood waste piles, could have contributed to this person's exposure in the past.

(13) Concern: *Does asbestos cause autoimmune disorders such as lupus, rheumatoid arthritis, and fibromyalgia?*

(13) Response: Not enough information exists at this time to determine whether asbestos causes autoimmune diseases. A number of studies have shown that asbestosis is associated with immunological changes that could theoretically make a person more susceptible to autoimmune disorders. According to a recent allergy textbook, "immunologic abnormalities in animal models and patients with asbestosis include abnormal lymphocyte accumulation in the lower respiratory tract, abnormal T-lymphocyte subsets in BAL [bronchoalveolar lavage] fluid, evidence of decreased cell-mediated immunity, and diminished suppressor T cell function." The text continues, however, "Correlation of these abnormalities (systemic or local) with the clinical features of asbestosis . . . has not been clearly demonstrated" [34]. In other words, it is not known at this time whether the changes are causally linked to the asbestosis or exposure to asbestos. It is also possible that people who have autoimmune abnormalities could be more likely to develop asbestos-related disease. Please see page 12 of this document for a more detailed treatment of this subject.

(14) Concern: *I would like to see a discussion of the SV40 virus and other viruses known to affect development of cancers. Is there any record of whether SV40-contaminated vaccine was* *distributed in Libby? Please comment on additional risk to Libby in light of the latency periods involved.*

(14) Response: The information in this response comes from a number of review articles found through a search on the online database PubMed, a service of the National Library of Medicine which provides access to MEDLINE citations dating to the 1960s [35,36,37,38,39,40,41,42,43]. SV40 is a simian (monkey) virus that has known oncogenic (tumor-causing) properties, including causing mesothelioma in hamsters. SV40-infected monkey cells were inadvertently used to produce polio vaccines from 1954 to 1961, resulting in the exposure of wide populations to infectious SV40 until around 1963. The exact means by which SV40 initially entered the population and/or how it may have spread is unclear; SV40 has been detected in people who were either too old or too young to receive the infected vaccines.

When the polio vaccine contamination was first discovered, epidemiological studies did not indicate any short-or long-term effects in the humans exposed. SV40 became an important tool in molecular laboratories and contributed to the elucidation of many cellular mechanisms. The development of the polymerase chain reaction (PCR) allowed researchers to detect very small amounts of genetic material, and through the use of this technique it has been found that a significant fraction (up to 60%) of some cancers (especially mesotheliomas, brain, and bone cancers) contain SV40 DNA. Many scientists initially thought the detections were “false positives” caused by laboratory contamination, but further multi-laboratory studies using adequate controls have added strength to the finding. SV40 has been shown to cause the above rare cancers in animals.

Whether and how SV40 actually causes cancer in humans is under active investigation. SV40 is known to induce DNA alterations and interfere with programmed cell death of defective cells. The combination of (amphibole) asbestos with SV40 could synergistically increase the risk of mesothelioma. It has been postulated that asbestos has immunosuppressant properties that allow SV40 to replicate and cause mutagenic changes for a longer time without killing mesothelial cells, increasing the likelihood of a cell becoming cancerous.

The Immunization Safety Review Committee of the Institute of Medicine recently released an evaluation of the evidence on possible causal relationships between contamination of the polio vaccine with SV40 and cancer. The committee concluded that “the evidence is inadequate to accept or reject a causal relationship between SV40-containing polio vaccines and cancer” [44].

No research was found showing whether SV40 decreases the latency period of onset of mesothelioma (over 30 years on average). SV40 is not associated with lung cancer or other asbestos-related diseases.

For Libby, it is impossible to determine if an additional risk of mesothelioma might result from SV40. No known record exists of whether SV40-contaminated vaccines were actually distributed there. Time of vaccination does not necessarily prove exposure, because it is estimated that only 10 to 30% of the polio vaccine produced actually contained infectious virus. However, the possibility of additional risk does exist, since some people would have been vaccinated during the time that contaminated vaccines were in general distribution. Regardless of whether a person is infected with SV40, removing the sources of exposure to asbestos will even further reduce the very low risk of developing mesothelioma.

(15) Concern: *People in Libby were exposed to pollutants from drinking water contaminated by another Superfund site before it was cleaned up. Is there a relationship or synergistic effect between other carcinogens and mineral fibers or viruses?*

(15) Response: The commenter is referring to the Libby Groundwater NPL site, consisting of soil and groundwater contaminated with wood treating fluids at the former Champion lumber and plywood mill (now occupied by Stimson Lumber) [45]. The contamination at this site was discovered in 1979 when, shortly after installation of private wells in the area, homeowners noticed a strong creosote odor in their water. The groundwater contained pentachlorophenol (PCP), polycyclic aromatic hydrocarbons, and heavy metals. The site was listed on the NPL in 1983. Homeowners were connected to municipal water, existing private wells were plugged and abandoned, and the source-contaminated soils were excavated and treated. A city ordinance now prohibits the installation of new wells for drinking water or irrigation. ATSDR concluded in 1993 that the site poses no apparent public health hazard [46]. The main contaminant of concern in the groundwater was PCP, which is toxic to the liver, thyroid, immune and reproductive systems, and developing organisms. PCP is not expected to interact with asbestos, which affects a different target organ (the lungs and respiratory system). When inhaled, some PAHs and metals have the same target organs as asbestos; however, the major route of exposure for the Libby Groundwater site was ingestion, so no interactions are likely to have occurred.

Asbestos and smoking are known to increase the risk of lung cancer and asbestosis more than predicted by additivity. It is not known whether the effect is a result of synergistic interactions of asbestos and carcinogens inhaled in smoke, reduced lung clearance in smokers leading to higher lung burden of asbestos, or both [15]. The previous response discussed possible interactions of asbestos and the SV40 virus; no information was found on interaction of asbestos with other carcinogens or viruses.

(16) Concern: *ATSDR must follow through on their mandate as described on p. 181 of the Toxicological Profile for Asbestos, "Section 104(i)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of asbestos is available. Where adequate information is not available, ATSDR, in conjunction with the National Toxicology Program (NTP), is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of asbestos."*

(16) Response: ATSDR has met this requirement by producing the document Priority Data Needs for Asbestos, which also describes the ATSDR substance-specific applied research program for asbestos. We anticipate that this document will be available by the end of December 2002. Copies can be obtained by contacting ATSDR, Division of Toxicology, Mail Stop E-29, Atlanta GA 30333.

(17) Concern: *Initial contact with community members for participation in the registry should be done by someone locally, face-to-face, if possible. It is difficult to give confidential personal information over the telephone, and this reduces participation. We need full participation to get the best information from the study.*

(17) Response: Initial contacts for the registry are being made by telephone interviews. This registry is targeting all former workers and their household contacts, not just workers in Libby. Because the workers are located all over the country, telephone interviews are necessary to prevent any bias that might be introduced if some people were interviewed face-to-face and others by telephone. As of October 19, 2002, 1,171 workers and household contacts had been interviewed out of an estimated total of 6,000. It is anticipated that an excellent rate of participation will be achieved by the projected end of the contract in April 2003.

(18) Concern: *What is the risk to residents, children, and visitors from vermiculite insulation dust potentially sifting into living spaces?*

(18) Response: If the insulation does not contain asbestos, it poses no risk of asbestos-related illnesses. However, any vermiculite insulation in Libby can be assumed to contain asbestos. If the insulation remains undisturbed, it is not considered to pose a significant risk. However, if the insulation is creating dust, the dust may contain microscopic asbestos fibers which increase the risk of asbestos-related health effects when breathed in. The exact level of risk depends on how many fibers were breathed in and how long the exposure lasted. In addition, a person's response to exposure differs and could be based upon genetic makeup and certain lifestyle activities, particularly smoking. People who suspect they have been exposed to asbestos fibers, especially if the exposure was long-term, should consult a physician experienced in occupational and environmental medicine or pulmonary medicine.

(19) Concern: *I am very sick with asbestosis. Why was I not assigned a higher priority in EPA's testing and cleanup?*

(19) Response: The following information is taken from EPA's Question and Answer Web page on Libby (http://www.epa.gov/region8/superfund/libby/lbbyfaq.html).

> EPA must continue to clean up properties based on two primary factors:
> 1. Conditions at the property based on sample results and visual inspections. Homes will be generally prioritized using these criteria:
>
> (higher priority)
> - multiple sources of Libby asbestos and high levels detected
> - single source of Libby asbestos and high levels detected
> - potential for immediate contact with Zonolite
> - home sale pending on home with Zonolite or low levels detected
> - Zonolite present only
>
> (lower priority)
>
> 2. Location of the property. At times, homes with conditions dictating a lower priority may get cleaned up faster because it's near a higher priority home. This will cut cleanup time and is the only way EPA can clean so many properties in just a few years.

Until your home is cleaned up, EPA gives the following advice (also from EPA's Q&A web page):

> If you have or suspect that you have Zonolite insulation in your home, the safest course **of action is to leave the material alone**. Avoid any activities that may spread vermiculite and asbestos into your living space such as using the attic for storage. Likewise, seal any spaces, cracks or gaps in the ceiling or around light fixtures through which asbestos could escape from the attic. If you decide to remove or must otherwise disturb the material due to a renovation project, please consult with an experienced asbestos contractor.

(20) Concern: *Concern that there are no health-based risk values other than for cancer.*

(20) Response: ATSDR recommends in this document that toxicological investigation of the risks associated with low-level exposure to asbestos, specifically with the chemical makeup and fiber size of Libby asbestos, be performed. This research would allow development of more health-based risk values.

(21) Concern: *Concern that regulation of asbestos is not protective of public health because it is not regulated as an air pollutant.*

(21) Response: 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 [26]. This requires companies that release friable asbestos at concentrations greater than a 0.1% de minimus limit to report the release under Section 313 of the Emergency Planning and Community Right-to Know Act. Asbestos is not one of the six "criteria pollutants" used by EPA as indicators of air quality throughout the United States.

ATSDR, as an advisory health agency, does not make or enforce laws.

(22) Concern: *I think all the government agencies here are doing a terrific job.*

(22) Response: Thank you for your comment. We will continue to work with the local community and other agencies to address public health issues at this site.

(23-27) Economic Concerns

- *The community members who participate in research need to have coverage provided to protect them from complications that might arise due to their participation in the advancement of the science.*
- *My concern is with the progression of the disease and the care issues involved; I fear there will be no one to pay for care.*
- *I am not sick now, but I am concerned about the potential cost if I develop asbestos-related disease at a later date. Will Grace money be available until my Medicare starts? Will there be government funds available if Grace goes bankrupt?*
- *I have concerns regarding the long-term health care costs related to asbestosis, and additional diseases I have that have not been definitively linked to asbestos exposure.*
- *I am concerned on the economic impact this has had on the community.*

(23-27) Response: Your concerns are noted. ATSDR recognizes that the people of Libby have suffered economic as well as human losses. We are concerned that more people who have been exposed to asbestos may develop asbestos-related disease. ATSDR does not have the authority to pay for or provide medical care or to make judgments about who should pay for care.

Public Health Hazard Category

On the basis of known past exposures and resulting disease rates, to protect public health it is prudent to reduce known continuing exposures to LA. ATSDR concludes that locations where LA-contaminated vermiculite has the potential to become airborne during people's normal activities pose a *current public health hazard* to the people of Libby.

ATSDR has also evaluated the cleanup actions and plans for cleanup taken by EPA. These actions, provided confirmation testing indicates effective reduction of LA levels, have been and will be protective of public health by reducing continuing LA exposures. Areas that have been cleaned up as described are not likely to pose a hazard. Although very small amounts of asbestos could still be present, the potential for significant exposure is expected to be very small. Therefore, ATSDR characterizes these areas as *no apparent public health hazard*.

On the basis of historical information and current health outcome data, ATSDR concludes that the site was a *past public health hazard*. Workers at the mine, their household contacts, and people not occupationally exposed at the mine were exposed to airborne LA at unsafe levels. This exposure has resulted in significantly elevated levels of asbestos-related disease in the area.

Conclusions

- People in the Libby area were exposed to hazardous levels of asbestos in the past.
- People in the Libby area have elevated levels of disease, and death, associated with exposure to asbestos.
- People could still be exposed to hazardous levels of asbestos near current source areas. These levels could be especially hazardous to sensitive populations, including people who have been exposed for many years already, smokers, and young children.
- The exact level of risk associated with low-level exposure to asbestos cannot be determined due to uncertainties in the analysis and toxicology of Libby asbestos. Nevertheless, continuing exposures to Libby asbestos pose an unacceptable risk to residents and workers who have already been exposed for many years.
- The cleanup actions undertaken by EPA are protective of public health.

Recommendations

- Continue to investigate and clean up the site to reduce or remove continuing sources of Libby asbestos.
- Conduct toxicological investigation of the risks associated with low-level exposure to asbestos, specifically with the chemical makeup and fiber size of Libby asbestos. This investigation is necessary to assure that site cleanup levels remain protective.
- Conduct health education for the community, especially concerning smoking and asbestos.

- Create a registry to track former workers, their household contacts, and residents exposed to Libby asbestos.
- Continue to provide information to the community about the hazards of Libby asbestos.
- Continue to provide information on how to diagnose and treat asbestos-related diseases to the local medical community.

Public Health Action Plan

The Public Health Action Plan for the site contains a description of actions that have been or will be taken by ATSDR and/or other government agencies at the site. The purpose of the Public Health Action Plan is to ensure that this public health assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ATSDR to follow up on this plan to ensure its implementation. The public health actions that have been completed are as follows:

- ATSDR published four health consultations evaluating public health implications related to Libby asbestos.
- ATSDR implemented two rounds of medical testing for signs of asbestos-related disease.
- ATSDR conducted a site visit to verify site conditions and gather pertinent information and data for the site.
- ATSDR and EPA maintained personnel in an information center in Libby to inform the community about site-related health and environmental activities.
- EPA conducted emergency removals of many contaminated areas in and around Libby.

The public health actions to be implemented follow:

- ATSDR will hold a public availability session to gather health concerns from the Libby community. These concerns will be addressed in the public comment release of this document.
- ATSDR will present results of the combined two rounds of medical testing performed in 2000 and 2001, the updated mortality review, and the computed tomography (CT) study to the Libby community. MDPHHS will provide ongoing medical testing in Libby to qualified individuals, with funding and technical assistance provided by ATSDR.
- ATSDR will work with MDPHHS to develop a registry to track former workers of the vermiculite mine and their household contacts. ATSDR will assess the feasibility of including other populations in the registry.
- EPA will continue investigating and cleaning up the site as needed.
- ATSDR will produce an addendum to this PHA evaluating the public health impact of the mine site (OU3). This addendum will be produced during EPA's RI activities for OU3.

ATSDR will reevaluate and expand this plan when needed. New environmental, toxicological, or health outcome data or the results of implementing the above proposed actions could determine the need for additional actions at this site.

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Appendix A. ATSDR Plain Language Glossary of Environmental Health Terms

Absorption	How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
Acute Exposure	Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.
Additive Effect	A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.
Adverse Health Effect	A change in body function or the structures of cells that can lead to disease or health problems.
Amphibole	A large group of silicate minerals with more than 40–50 members. The molecular structure of all amphiboles consists of two chains of SiO_4 molecules that are linked together at the oxygen atoms. In the earth's crust, amphibole minerals are mostly nonasbestiform; asbestiform amphiboles are relatively rare. See definitions of asbestiform, mineral, and mineral habit.
Antagonistic Effect	A response to a mixture of chemicals or combination of substances that is **less** than might be expected if the known effects of individual chemicals, seen at specific doses, were added together.
Asbestiform	A habit of crystal aggregates displaying the characteristics of asbestos: groups of separable, long, thin, strong, and flexible fibers often arranged in parallel in a column or in matted masses. See definitions of mineral and mineral habit. Mineralogists call asbestiform amphibole minerals by their mineral name followed by "asbestos." Thus, asbestiform tremolite is called tremolite asbestos.
Asbestos	A group of highly fibrous minerals with separable, long, thin fibers often arranged in parallel in a column or in matted masses. Separated asbestos fibers are generally strong enough and flexible enough to be spun and woven, are heat resistant, and are chemically inert. See definitions of fibrous and mineral. Currently, U.S. regulatory agencies recognize six asbestos minerals: the serpentine mineral, chrysotile; and five asbestiform amphibole minerals, actinolite asbestos, tremolite asbestos, anthophyllite asbestos, amosite asbestos (also known as asbestiform cummingtonite-grunerite), and crocidolite asbestos(also known as asbestiform riebeckite). Proposals have been made to update asbestos

	regulations to include other asbestiform amphibole minerals such as winchite asbestos and richterite asbestos.
Asbestosis	Interstitial fibrosis of the pulmonary parenchymal tissue in which asbestos bodies (fibers coated with protein and iron) or uncoated fibers can be detected. Pulmonary fibrosis refers to a scar-like tissue in the lung which does not expand and contract like normal tissue. This makes breathing difficult. Blood flow to the lung can also be decreased, and this causes the heart to enlarge. People with asbestosis have shortness of breath, often accompanied by a persistent cough. Asbestosis is a slow-developing disease that can eventually lead to disability or death in people who have been exposed to high amounts of asbestos over a long period. Asbestosis is not usually of concern to people exposed to low levels of asbestos.
ATSDR	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level	An average or expected amount of a chemical in a specific environment, or amounts of chemicals that occur naturally in a specific environment.
Bioavailability	See **Relative Bioavailability**.
Biota	Used in public health, things that humans would eat—including animals, fish and plants.
Cancer	A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control
Cancer Slope Factor (CSF)	The slope of the dose-response curve for cancer. Multiplying the CSF by the dose gives a prediction of excess cancer risk for a contaminant.
Carcinogen	Any substance shown to cause tumors or cancer in experimental studies.
Chronic Exposure	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Cleavage Fragment	Microscopic particles formed when large pieces of nonasbestiform amphiboles are crushed, as could occur in mining and milling of ores. Within a population of nonasbestiform amphibole cleavage fragments, a fraction of the particles could fit the definition of a fiber adopted for

	counting purposes. Populations of asbestos fibers can be readily distinguished from populations of nonasbestiform cleavage fragments, but sometimes it can be difficult to distinguish an isolated nonasbestiform cleavage fragment from an isolated asbestos fiber. See definitions of asbestiform, fiber, fibrous, and mineral habit.
Completed Exposure Pathway	See **Exposure Pathway**.
Community Assistance Panel (CAP)	A group of people from the community and health and environmental agencies who work together on issues and problems at hazardous waste sites.
Comparison Value (CV)	Concentrations of substances in air, water, food, and soil which are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	Congress enacted **CERCLA** in 1980. The act is also known as **Superfund**. This act addresses releases of hazardous substances into the environment, the cleanup of these substances, and hazardous waste sites. This act created ATSDR and gave it the responsibility to look into health issues related to hazardous waste sites.
Concentration	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant	See **Environmental Contaminant**.
Delayed Health Effect	A disease or injury that happens as a result of exposures that occurred far in the past.
Dermal Contact	A chemical getting onto your skin (see **Route of Exposure**).
Dose	The amount of a substance to which a person might be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day."
Dose / Response	The relationship between the amount of exposure (dose) and the resultant change in body function or health.
Duration	The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.

Environmental Media Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

US Environmental Protection Agency (EPA) The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Epidemiology The study of the different factors that determine how often, in how many people, and in which people will disease occur.

Exposure Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see **Route of Exposure**.)

Exposure Assessment The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway A description of the way a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:
1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
3. Point of Exposure,
4. Route of Exposure, and
5. Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Fiber Any slender, elongated mineral structure or particle. For the purposes of counting asbestos fibers in air samples, regulatory agencies commonly count particles that have lengths ≥5 μm and length:width ratios ≥3:1 as fibers. For detecting asbestos fibers in bulk building materials, particles with length:width ratios ≥5:1 are counted as fibers.

Fiber-year/mL A cumulative exposure measure calculated by multiplying a worker's duration of exposure (measured in years) by the average air concentration during the period of exposure (measured in number of fibers/mL of air). Epidemiologic studies of groups of asbestos-exposed workers commonly express exposure in these units.

Fibrous A mineral habit with crystals that look like fibers. A mineral with a fibrous habit is not asbestiform if the fibers are not separable and are not long, thin, strong, and flexible.

Frequency How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

Hazardous Waste Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Indeterminate Public Health Hazard The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (see **Route of Exposure**).

Inhalation Breathing. It is a way a chemical can enter your body (see **Route of Exposure**).

Interstitial A term used as an adjective relating to spaces within a tissue or organ. Pulmonary interstitial fibrosis refers to fibrosis (scarring) developing within lung tissue.

LOAEL Lowest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

Malignancy See **Cancer**.

Mesothelioma Cancer of the thin lining surrounding the lung (the pleura) or the abdominal cavity (the peritoneum). Mesotheliomas are rare cancers in the general population.

Mineral Any naturally occurring, inorganic substance with a crystal structure. Naturally occurring, inorganic substances without a crystal structure (such as amorphous silica) are called mineraloids.

Mineral Habit The shape or morphology that single crystals or crystal aggregates take during crystal formation. Mineral habit is influenced by the environment during crystal formation. Habits of single crystals include prismatic, acicular, platy, and fiber. Habits of crystal aggregates include asbestiform, fibrous, lamellar, and columnar.

MRL Minimal **R**isk **L**evel. An estimate of daily human exposure—by a specified route and length of time—to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NPL The **N**ational **P**riorities **L**ist. Mandated by **Superfund**, the NPL is a list kept by the U.S. Environmental Protection Agency (EPA) of the most serious uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or at least looked at to see if people can be exposed to chemicals from the site.

NOAEL No **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, not causing harmful health effects in people or animals.

No Apparent Public Health Hazard The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals could have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

Parenchyma The functional cells or tissue of a gland or organ; for example, the lung parenchyma. The major lung parenchymal abnormality associated with exposure to asbestos is the development of scar-like tissue referred to as pulmonary interstitial fibrosis or asbestosis.

PHA Public **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Pleura A thin lining or membrane around the lungs or chest cavity. This lining can become thickened or calcified in asbestos-related disease.

Pleural	Having to do with or involving the pleura.
Pleural abnormalities	Abnormal or diseased changes occurring in the pleura. Pleural abnormalities associated with exposure to asbestos include pleural plaques, pleural thickening or calcifications, and pleural effusion.
Pleural calcification	As a result of chronic inflammation and scarring, pleura becomes thickened and can calcify. White calcified areas can be seen on the pleura by X-ray.
Pleural cavity	The cavity, defined by a thin membrane (the pleural membrane or pleura), which contains the lungs.
Pleural effusion	Cells (fluid) can ooze or weep from the lung tissue into the space between the lungs and the chest cavity (pleural space) causing a pleural effusion. The effusion fluid can be clear or bloody. Pleural effusions might be an early sign of asbestos exposure or mesothelioma and should be evaluated.
Pleural plaques	Localized or diffuse areas of thickening of the pleura (lining of the lungs) or chest cavity. Pleural plaques are detected by chest x-ray, and appear as opaque, shiny, and rounded lesions.
Pleural thickening	Thickening or scarring of the pleura that might be associated with asbestos exposure. In severe cases, the normally thin pleura can become thickened like an orange peel and restrict breathing.
Plume	A line or column of air or water containing chemicals moving from the source to areas farther away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).
Point of Exposure	The place where someone can come into contact with a contaminated environmental medium (air, water, food, or soil). Some examples include the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.
Population	A group of people living in a certain area; or the number of people in a certain area.
PRP	**P**otentially **R**esponsible **P**arty. A company, government, or person responsible for causing the pollution at a hazardous waste site. PRPs are expected to help pay for site cleanup.

Public Health Assessment(s)	See **PHA**.
Public Health Hazard	The category is used in PHAs for sites with certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.
Public Health Hazard Criteria	PHA categories given to a site which tell whether people could be harmed by conditions at the site. Each are defined in the Glossary. The categories are: – Urgent Public Health Hazard – Public Health Hazard – Indeterminate Public Health Hazard – No Apparent Public Health Hazard – No Public Health Hazard
Pulmonary interstitial fibrosis	Scar-like tissue that develops in the lung parenchymal tissue in response to inhalation of dusts of certain types of substances such as asbestos.
Receptor Population	People who live or work in the path of one or more chemicals, and who could come into contact with them (See **Exposure Pathway**).
Reference Dose (RfD)	An estimate, with safety factors (see **safety factor**) built in, of the daily, lifetime exposure of human populations to a possible hazard that is <u>not</u> likely to cause harm to the person.
Relative Bioavailability	The amount of a compound that can be absorbed from a particular medium (such as soil) compared to the amount absorbed from a reference material (such as water). Expressed in percentage form.
Route of Exposure	The way a chemical can get into a person's body. The three exposure routes are: – breathing (also called inhalation), – eating or drinking (also called ingestion), and – getting something on the skin (also called dermal contact).
Safety Factor	Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the unknown data. These factors and formulas can help determine the amount of a chemical that is <u>not</u> likely to cause harm to people.

SARA	In 1986 the **S**uperfund **A**mendments and **R**eauthorization **A**ct amended CERCLA (see **CERCLA**) and expanded the health-related responsibilities of ATSDR. CERCLA as amended by SARA directs ATSDR to look into the health effects resulting from chemical exposures at hazardous waste sites.
Sample Size	The number of people that are needed for a health study.
Sample	A small number of people chosen from a larger population (see **Population**).
Serpentinite	Igneous or metamorphic rock chiefly composed of serpentine minerals such as chrysotile or lizardite. Chrysotile, when found, can occur in localities with serpentinite rock.
Source (of Contamination)	The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.
Special Populations	People who could be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older persons are often considered special populations.
Statistics	A branch of mathematics involving collecting, looking at, and summarizing data or information.
Superfund Site	See **NPL**.
Survey	A way to collect information or data from a group of people (**population**). Surveys can be done by phone, by mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.
Synergistic Effect	A health effect from an exposure to more than one chemical, where one of the chemicals worsens the effect of another chemical. The combined effect of the chemicals acting together are greater than the effects of the chemicals acting by themselves.
Toxic	Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.
Toxicology	The study of the harmful effects of chemicals on humans or animals.

Tremolite asbestos A special form of the amphibole mineral, tremolite, that displays separable, long, thin fibers often arranged in parallel in a column or in matted masses. The fibers are generally strong enough and flexible enough to be spun and woven, are heat resistant, and are chemically inert.

Tumor Abnormal growth of tissue or cells that have formed a lump or mass.

Ultramafic rock Igneous rock composed chiefly of dark-colored ferromagnesian silicate minerals. Asbestiform amphiboles, when found, can occur in localities with ultramafic rock.

Uncertainty Factor See **Safety Factor**.

Urgent Public Health Hazard This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects. This category requires quick intervention to stop people from being exposed.

Vermiculite A mineral belonging to the mica group of silicate minerals. Vermiculite has water molecules located between the silicate layers in the crystal structure. When heated, vermiculite expands to form a light-weight material that has been used for home and building insulation, as a soil amendment, and as a packing material. The process of heating and expanding vermiculite is called exfoliation or "popping." Raw vermiculite ore is processed to produce vermiculite concentrate, which is shipped to exfoliating plants to produce the finished vermiculite product.

Appendix B. Living With Asbestos-Related Illness: A Self-Care Guide

Living With Asbestos-Related Illness

A Self-Care Guide

ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

What Is Asbestos?

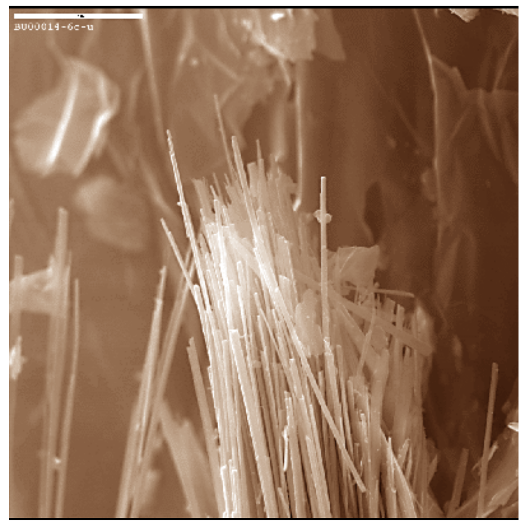
Asbestos is a rare, naturally occurring mineral with a chainlike crystal structure. Asbestos deposits can be found throughout the world. Deposits are still mined in Australia, Canada, South Africa, and the former Soviet Union. Asbestos is usually found mixed into other minerals. Asbestos is dangerous only if its broken crystal fibers float in the air after being disturbed.

Over the years, asbestos has had many uses. Pipe insulation, automotive brakes, shingles, wallboard, and blown-in insulation are just a few of the products that once contained asbestos. Although the federal government suspended production of most asbestos products in the early 1970s, installation of these products continued through the late 1970s and even into the early 1980s. Asbestos fibers can be released during renovations of older buildings.

Nearly everyone is exposed to asbestos at some time in their lives because asbestos fibers have been frequently used in modern industry and they are also found in nature. The fibers float freely. These lightweight fibers can remain in the air for long periods of time.

The risk of developing asbestos-related illness varies with the type of industry in which the exposure occurred and with the extent of exposure.

Generally, asbestos fibers are long, thin, tough, and so small that they cannot be seen. There are two types of asbestos, one is serpentine, which looks like a corkscrew and the other is amphiboles which have long, needle-like fibers. When the fibers float in the air, they are easily inhaled. In most cases the fibers must be breathed in high concentrations over a long period of time to be considered a concern for a person's health.



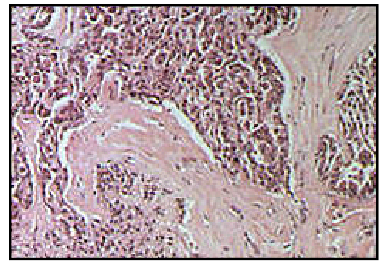
Scanning electron micrograph of asbestiform amphibole

Asbestos fibers can easily enter the lungs and become trapped in the lung tissues because they are so small. When these fibers are inhaled, they can penetrate and irritate the lungs. White blood cells attack the fiber, and eventually the site becomes scarred. Asbestos fibers break down extremely slowly over time. The fibers can remain in the body for many years and build up in the lungs. Because they attach to the lining of the lungs and airways, the fibers cannot be coughed out or washed out of the lung tissue. The area around the fiber becomes inflamed and, eventually, scarred. As a person's exposure to fibers increases by breathing more fibers, that person's risk of disease also increases. Diseases related to exposure to asbestos do not appear for several years, possibly 15 to 40 years after exposure.

Individuals who have been exposed (or suspect they have been exposed) to asbestos dust on the job or at home via a family contact should inform their physician of their exposure history and any symptoms. A thorough physical exam, including a chest x-ray and lung function tests, may be recommended. Interpretation of the chest x-ray may require the help of a specialist who is experienced in reading x-rays for asbestos-related illness. Other tests may be necessary.

Asbestos-Related Illnesses

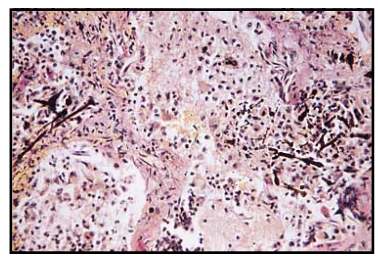
Lung cancer is a malignant tumor that invades and obstructs the lung's air passages. Cigarette smoking greatly increases the likelihood of a person developing lung cancer as the result of asbestos exposure. The most common symptoms of lung cancer are coughing, wheezing and labored breathing. Other symptoms of lung cancer include shortness of breath, persistent chest pain, hoarseness, and anemia as well as weight loss, fever, chills and night sweats. People who develop these symptoms do not necessarily have lung cancer, but they should consult a physician for advice.



Microscopic view of mesothelioma cells.

Mesothelioma is a very rare cancer of the lining of the chest or abdomen. Most mesotheliomas are caused by exposure to asbestos. By the time they are diagnosed, mesotheliomas are almost always fatal.

Asbestosis is a serious, progressive, long-term disease of the lungs that can get worse as time passes. Asbestosis is not a cancer. It is a disease that restricts how the lungs work, which makes it hard to breathe. Asbestosis is caused by inhaling asbestos fibers that irritate and inflame tissues, which creates scar tissue in the lungs. Along with scarring of the lung tissues, scarring can occur along the lining of the chest wall called the pleura. The scarring makes it hard to breathe and difficult for oxygen and carbon dioxide to pass through the lungs.



Microscopic view of lung tissue with asbestosis.

Signs and Symptoms of asbestosis include

- shortness of breath is the primary symptom
- a persistent and productive cough (a cough that expels mucus)
- chest tightness
- chest pain
- loss of appetite
- a dry, crackling sound in the lungs while inhaling.

Asbestosis generally progresses slowly, but the rate of progress can vary greatly from one asbestos exposed person to another. The advancement of symptoms may occur even without additional exposure. It may even speed up with continued exposure. Rapid progression after the first symptoms appear is not common, but it can occur in some people. It can become increasingly difficult to breath as the symptoms progress over time. Lung tissues and the lining of the chest wall can thicken and harden from the thinness and stretchiness of a ballon to that of an orange peel.

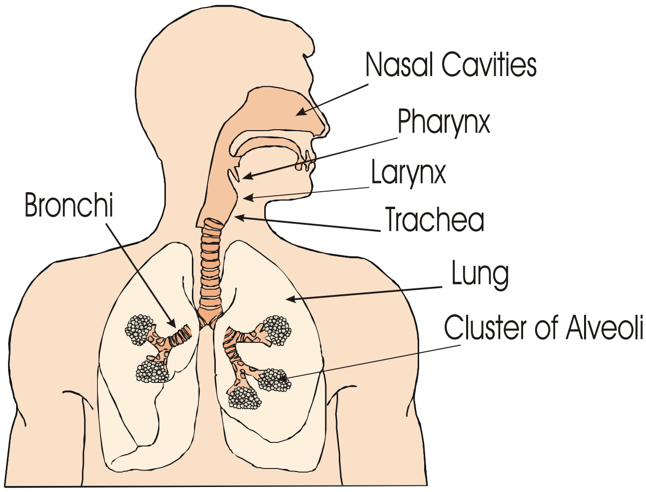
As the disease progresses, the individual's shortness of breath becomes more pronounced. The shortness of breath is usually noted first during heavy work or exercise. It will eventually interfere with the ability to carry out everyday activities and the individual may require oxygen. The end result of progression is failure of the lungs and eventual heart failure due to the stress being placed on the heart.

The Respiratory System

The body needs oxygen to grow and function. The respiratory system supplies oxygen to the individual tissue cells and removes carbon dioxide from the blood.

The respiratory system is an arrangement of spaces and passageways that bring air into the lungs. These spaces include the nasal cavities; the pharynx, which is used by both the digestive tract and the respiratory system; the voice box or larynx; the trachea or windpipe; and the lungs, which include the bronchial tubes and alveoli (or air sacs).

Nasal Cavities. It is better to breathe through the nose than the mouth because (a) foreign bodies such as dust particles are filtered out by the hairs of the nostrils or caught in the surface mucus, (b) air is warmed by the blood in the vascular membrane, and (c) air is moistened by the mucus in the nasal passage.

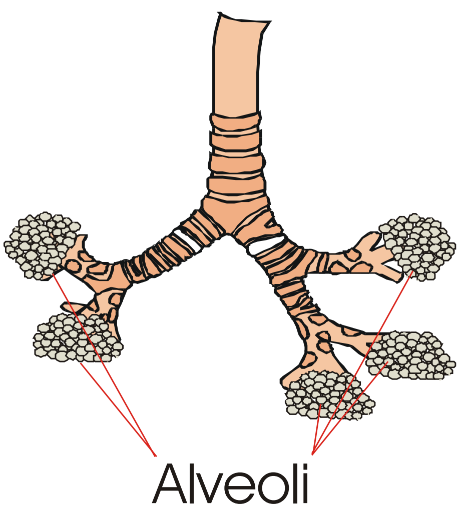


Pharynx. The muscular pharynx or throat carries air into the respiratory tract and also carries foods and liquids into the digestive tract.

Larynx. The larynx, or voice box, is between the pharynx and the trachea. The larynx is lined with little hairs attached to the mucous membranes. The hairs (cilia) trap dust and other particles and move them upward to the pharynx to be expelled by coughing, sneezing, or nose blowing. The cilia are the primary defense of the immune system in the respiratory tract.

Trachea. The trachea, or windpipe, is a tube that extends from the lower edge of the larynx to the upper part of the chest above the heart. The trachea has a framework of cartilage to keep it open. The trachea moves air between the larynx and the lungs.

Bronchi and Bronchioles. The trachea divides into two branches (bronchi), which enter the lungs. The right bronchus is considerably larger than the left and extends downward in a more vertical direction. Each bronchus enters the lung and immediately subdivides again and again, forming smaller divisions. The smallest of the divisions are called the bronchioles.



Alveoli. At the end of the smallest subdivisions of the bronchioles are clusters of air sacs that look like a bunch of tiny grapes. The sacs are called the alveoli. The average adult lung contains about 600 million alveoli. The exchange of oxygen and carbon dioxide in the blood takes place in the alveoli.

Oxygen-rich blood is sent to the heart, which pumps it through the body. The red blood cells carry carbon dioxide to the alveoli, and then the carbon dioxide leaves the body through exhaled breath.

Breathing that is too shallow, slow, or the result of reduced lung function is called hypoventilation. Hypoventilation results in inadequate oxygenation of the blood. Respiratory obstruction, lung disease, or exposure to toxicants can also cause this condition.

Amazing Facts About the Lungs

- The right lung is slightly larger than the left.
- Hairs in the nose help clean and warm the air we breathe.
- The surface area of the lungs is roughly the same size as a tennis court.
- The capillaries in the lungs would extend 994 miles (1,600 kilometers) if placed end to end.
- The highest record “sneeze speed” is 102.5 miles (165 kilometers) per hour.

Asbestos fibers enter the body from the air we breathe. Most of the small particles we breathe—like dust and pollen—are stopped or trapped by the mucous lining and nasal hairs before entering the small airways of the lungs. Because asbestos fibers are so small and thin, they pass all the way down to the small airways and alveoli (or air sacs), where the oxygen-carbon dioxide gas exchange occurs.

The immune system, the body’s defense system, considers asbestos fibers foreign invaders and tries to break them down and remove them from the lung.

Breakdown Process

Each alveolus has many cleaning cells, called macrophages, that destroy foreign invaders in the alveoli. Because asbestos fibers are too long and sharp, macrophages cannot destroy them. Macrophages then try to surround the fiber so that it cannot cause damage. In doing so, the macrophage is essentially cut open and its digestive molecules are spilled on the alveoli. This causes scar tissue to form in the spaces around the small airways and alveoli.

Scarring and thickening of the lung tissue decreases the ability of the lungs to exchange oxygen and carbon dioxide between the alveoli and the blood cells, so breathing becomes more difficult.

Treatment of Asbestos Related Illness

Unfortunately, no cure exists for asbestosis. Treatment involves preventing further complications of the disease and treating its symptoms. For information about cancer treatment, contact the National Cancer Institute’s Cancer Information Service, whose toll free number is 1-800-4-CANCER.

Respiratory Infections

People with chronic lung diseases such as asbestosis are more susceptible to respiratory infections because the lungs are already damaged. One of the most important preventative measures is to produce a productive cough, or a cough that brings up mucus.

It is important to cough effectively to clear out the air passages. An effective cough is moist and brings mucus up from the lungs and air passageways. An ineffective cough reduces airflow and causes respiratory muscle fatigue. If mucus and other foreign bodies remain in the respiratory tract, they can pool in the airways, making it difficult to expel bacteria and increasing the risk of infection.

Your doctor will probably recommend a humidifier, breathing therapies, and chest percussion to ensure a productive cough. Very dry air increases shortness of breath and thickens the mucus in your lungs. These steps loosen and thin out bronchial secretions, allowing them to be expelled by the cough.

Make an effort to prevent infection. People with asbestosis should receive aggressive medical care, including frequent use of antibiotics when warranted, for any respiratory infection.

Take Care of Yourself To Prevent Infection

Keep a diary of when you have trouble breathing. Note how often you have trouble, how bad it is, and what you were doing before you had trouble. The diary will help you recognize and avoid events that trigger breathing trouble.

Stay inside, if possible, when air pollution and pollen counts are high. An air-filtering machine can improve the indoor air quality in your home.

Avoid breathing pollutants that can aggravate shortness of breath. Such pollutants include fumes from heavy traffic, smog, aerosol sprays, and products that produce chemical vapors (for example, paint, kerosene, and cleaning agents).

In cold weather, **breathe through your nose** and cover your mouth and nose with a scarf.

Exercise is important to increase the strength and endurance of the respiratory muscles. Increased physical activity increases respiratory muscle strength.

Drink lots of fluids—at least six glasses of water daily, unless your doctor tells you differently.

Eat healthy foods including lots of fruits and vegetables. Poor eating habits result in smaller muscle mass and are an enemy of the patient with respiratory disease.

Take measures to correct an anemic condition and/or electrolyte imbalance in your blood. Such measures could improve cardiopulmonary performance.

Watch your salt intake. Keep it low.

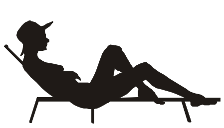
Breathe slowly.

To lower your risk of colds or flu, **wash your hands often**.

Get flu and pneumonia vaccinations every year (between September and December). Caregivers and all household members, whether or not they provide care, also should be vaccinated.

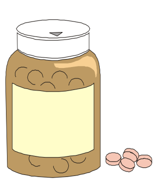
Avoid situations that might expose you to respiratory infections (for example, large crowds).

Follow your doctor's instructions on taking your medicines, oxygen therapy, and/or chest physiotherapy.



Sleep 7 or 8 hours every night.

Take several short rests during the day. Learn to conserve your energy and avoid getting too tired.



Take special precautions with your personal hygiene. Wash your hands before taking your medication or handling your oxygen equipment.

Do not try to treat yourself. Over-the-counter cold remedies might worsen the problem, so do not use them unless your doctor tells you it is okay.

- **Have regular chest x-rays** to screen for cancers associated with asbestos exposure.

- **Call your doctor** if any of the following signs occur:
    - Fever
    - Increased coughing, wheezing, or breathing
    - Changes in mucus (mucus is thicker; either more or less mucus is present than usual; mucus has a foul odor; or mucus is green, yellow, brown, pink, or red)
    - Stuffy nose, sneezing, or sore throat
    - Increased fatigue or weakness
    - Weight gain or loss of more than 6 pounds within a week
    - Swollen ankles or feet.

Symptoms of respiratory infections can appear suddenly and worsen quickly. When an infection develops, it is important to start treatment right away. Your doctor might prescribe antibiotics or other drugs to get the infection under control before it becomes serious. See your doctor as soon as you feel sick.

Self-Care

No cure exists for asbestosis, but taking care of yourself can help you maintain a more comfortable life. Some self-care tips and techniques follow.

- **Stay away from smoke and smokers.** If you smoke, now would be a good time to quit. Smoking can increase the rate of disease progression, and it also increases the risk of lung cancer. Even if you have been smoking for years—or you already have lung disease—quitting smoking now will greatly improve your health. The tracheal cilia will begin working again and help keep your lungs swept clean. The blood vessels will relax, allowing the blood to flow normally, so your heart will no longer have to work as hard. The lung tissue will become healthier and you will breathe easier.

  A structured program has a good chance of successfully helping smokers quit the habit. Recent trials using the nicotine patch and antidepressants have been shown to be more effective than counseling in helping smokers quit.

- **Participate in respiratory therapies (such as bronchial drainage) as recommended by your doctor.** Your doctor might recommend using an ultrasonic mist humidifier that assists in clearing secretions from the lungs. Respiratory treatments that remove secretions from the lung through postural drainage might also be used.

- Proper training and adherence to **decontamination techniques** can minimize the risk of infection associated with respiratory therapy devices.

    - Clean all reusable respiratory therapy equipment such as ventilator circuitry, nebulizers, aerosol tubing, and peak flow meters twice weekly. Consult your provider about cleansing routines for respiratory equipment.

- All cleaned devices must be allowed to air dry thoroughly before reassembling for use. Moisture trapped in the devices can be a potential reservoir for bacteria, viruses and fungi

- All ventilator filters should be cleaned and changed as often as the manufacturer recommends.

Oxygen. If your doctor has prescribed oxygen, you will have a liquid oxygen unit, an oxygen tank, or an oxygen concentrator. You will breathe the oxygen through either a mask or nasal cannulae (two short prongs that fit just inside your nostrils). The system will also have a humidifier to warm and moisten the oxygen.

It is a good idea to also have a small portable oxygen tank available in case of power failure.

Only your doctor can determine how much oxygen you need. You should never change the flow rate without instructions from your doctor. The medical supply company will show you how to set the flow rate and how to care for the equipment. Keep the supplier's telephone number handy so you can call if the system does not work properly.

Sometimes it is hard to tell whether oxygen is flowing through the tubes. If you have doubts, check to be sure that the system is turned on and the tubing does not have any kinks. If you still are not sure, place the nasal cannulae in a glass of water with the prongs up and watch for bubbles. If no bubbles appear, oxygen is not flowing through the tubes and you need to call your supplier.

Oxygen is very combustible. Be sure to keep your oxygen unit away from open flames and heat, including lit cigarettes, gas stoves, space heaters, or kerosene heaters.

When traveling around town, be sure to plan for an adequate supply of oxygen and know how much time you can safely travel between refills. Always allow for a 20%–25% safety margin to cover any unexpected delays. When traveling, keep the oxygen container upright and secure at all times.

Traveling With Oxygen

- Discuss your travel plans with your doctor to be sure it is all right for you to travel and to find out how long your trip can be.

- Contact your oxygen supply company about your travel plans. The company will recommend the equipment you need and help determine the time you can safely travel between refills. Get the oxygen equipment with which you will travel ahead of time so you can become familiar with how to operate it. Your supplier can also arrange to have oxygen supplied to you at your destination.

- Check with your insurance company. You may have to pay in advance for equipment and submit the insurance claims after you return home. Be sure to keep your receipts.

- Always keep your prescription with you throughout the trip.

Traveling by Bus

Bus lines do permit travel with oxygen equipment. However, to prevent any unexpected problems, check in advance. Most bus companies permit you to take one E cylinder onto the bus, but extra tanks are not allowed in the baggage compartment. You must be able to put your tank on and take it off by yourself.

Traveling by Train
Make reservations with Amtrak at least 4 days in advance, even for short trips. You may bring two cylinders, either size E or F, and the oxygen unit must be self-contained and not on wheels. On overnight trips, you must have a sleeper compartment, where you are required to stay while using oxygen. Meals can be sent to your sleeper.

Traveling by Ship
Cruise line regulations differ and are subject to change, so you must contact the cruise line regarding current rules. Some cruise lines permit you to travel only with oxygen cylinders and limit the number you may bring on board. Be prepared to supply the following information from your doctor: a prescription stating the quantity of oxygen and the flow rate, a letter describing your diagnosis, and a statement that you are approved for travel.

Traveling by Plane
Regulations vary from one airline to another and are subject to change. Always call ahead of time to inquire about current rules. Some airlines will not permit passengers to use oxygen. Others airlines are willing to provide oxygen if you make advance arrangements, but you must use their oxygen supply. Airlines do not allow passengers to bring oxygen on board the plane. Always bring your own nasal prongs: some airlines use only simple oxygen masks, which allow carbon dioxide buildup. Also bring a nipple adapter that fits all tubing.

You must make reservations 2 to 5 days in advance, depending on the individual airline's rules. Be sure to ask what documents you will need to supply. Airline documentation requirements are similar to those of cruise lines, and some airlines also have special forms that must be filled out by your doctor. You might have to sign a liability statement. In a few cases, you are required to bring a companion with you on the flight. Additional charges vary, but expect to pay about $50 extra.

Allow at least 1 hour between connecting flights. Remember that you must arrange for oxygen for the time between flights. Local oxygen suppliers will provide this service for layovers between flights. Whenever possible, use small airports because they usually have fewer delays and their boarding gates are closer together.

Lodging
Hotels and motels are usually very accommodating about special needs. Someone is usually available to transport your oxygen tank. Contact your local supply company about arranging for a supply company at your destination to set up the equipment in the room before you arrive.

Relaxation and Breathing Techniques
The feeling of not being able to get enough air into your lungs is frightening. Breathing training is aimed at controlling the respiratory rate and breathing pattern, thus decreasing the risk that used air will not stay in your lungs. Breathing training also attempts to improve the position and function of the respiratory muscles and effectiveness of coughs.

You can do exercises to help you breathe more easily. Practice the exercises daily so that when you are having problems with shortness of breath, you will do them naturally and not panic.

- **Pursed-Lip Breathing**: Pursed-lip breathing will slow down your breathing so that it is more efficient (breathing fast only worsens shortness of breath). Pursed- lip breathing can be done anywhere.
    1. Breathe in slowly through your nose. Hold your breath for 3 seconds.
    2. Purse your lips as if you are going to whistle.
    3. Breathe out slowly through your pursed lips for 6 seconds.

- **Abdominal/Diaphragm Breathing**: Abdominal breathing also slows down your breathing and helps relax your entire body.
    1. Lie on your back in a comfortable position with a pillow under your head and knees.
    2. Rest one hand on your abdomen just below your rib cage. Rest the other hand your chest.
    3. Slowly breathe in and out through your nose using your abdominal muscles. The hand resting on your abdomen will rise when you breathe in and fall when you breathe out. The hand on your chest should be almost still. Repeat three or four times before resting.

- **Active Cycle of Breathing Technique (ACBT)**: <u>ACBT should be discussed with your doctor before implementation.</u> ACBT is a series of breathing techniques that help clear secretions and improve aeration (the delivery of air to the alveoli [air sacs]). ACBT can be done sitting upright. This technique combines breathing exercises with the huff cough and has three components in a set cycle. The cycle is repeated until the huff becomes dry or nonproductive, or when 20 minutes have passed. Ask your doctor for instructions on this therapy

Pulmonary Rehabilitation

Patients with advanced lung disease may have emotional disorders, mainly depression and anxiety. In addition to appropriate medical therapy for theses disorders, exercise such as a pulmonary rehabilitation program can help lessen these feelings.

Talk to your doctor about participating in a pulmonary rehabilitation program. Pulmonary rehabilitation uses different therapeutic components for persons with pulmonary disease. The goal of pulmonary rehabilitation is achieving and maintaining the patient's maximum level of independence and functional ability in the community.
Pulmonary rehabilitation is becoming a crucial component of the overall therapy of many patients. It offers the best treatment option for patients with chronic respiratory illnesses. Pulmonary rehabilitation has helped people achieve increased exercise capacity and endurance; improved health-related quality of life; decreased shortness of breath; and fewer hospital admissions, even among patients with the most severe degree of lung disease.

The goals of a pulmonary rehabilitation program are to

- Reduce work of breathing
- Improve pulmonary function
- Alleviate shortness of breath
- Increase efficiency of energy use
- Correct nutrition deficiencies
- Improve exercise performance and daily activities
- Restore a positive outlook
- Improve emotional state
- Decrease health-related costs
- Improve survival.

If you are interested in pulmonary rehabilitation, ask your doctor to help you design a program that will work for you.

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This guide provides the patient living with asbestos-related illnesses and his or her family with skills and information to help them adapt and cope with their illness.

For more information, contact ATSDR's toll-free information line:

(888) 42-ATSDR. . . that's (888) 422-8737

ATSDR's Internet address is www.atsdr.cdc.gov

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

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Appendix C. List of Regional Physicians Certified in Pulmonary Disease

A community member requested ATSDR to provide a list of board-certified pulmonologists in the Libby area. ATSDR performed a search on the American Board of Medical Specialties' (ABMS') database at www.abms.org. to locate physicians in Montana, Idaho, and Washington who were board-certified in the subspecialty pulmonary disease. Listed below are those certified physicians whose address at the time of the search was within 350 miles of Libby, Montana. This information is provided with the permission of ABMS solely for the convenience of the Libby community. ATSDR does not endorse any individual physician listed and will not pay for any services provided by the listed physicians.

The search was performed on October 25, 2002. Due to the possibility of reporting and processing delays, and because the list might have been updated since the search, the accuracy and completeness of the information cannot be guaranteed. Neither ATSDR nor ABMS can be held responsible for incomplete or inaccurate information. Physician certification information in the ABMS database is updated periodically with data provided by its member boards. For updated information, consumers can register to perform searches on the ABMS Web site, or they can verify the certification of a physician by calling 1-866-ASK-ABMS.

Name	City	State
William Bernard Bekemeyer Jr	Missoula	Montana
Richard Dyer Blevins	Great Falls	Montana
Ryland P. Byrd	Butte	Montana
Thomas Shull Lemire	Missoula	Montana
C. Paul Loehnen	Missoula	Montana
Brent Parker Pistorese	Kalispell	Montana
Keith Janes Popovich	Butte	Montana
Sripathi Ramakrishna	Helena	Montana
Henry Dominic Covelli	Coeur D'Alene	Idaho
Hugh Franscisco Haegelin	Lewiston	Idaho
Luke Anthony Pluto	Lewiston	Idaho
Paul Albert Allen	Richland	Washington
Scot Llewellyn Bradley	Spokane	Washington
Timothy Edward Bruya	Spokane	Washington
Richard B. Byrd	Spokane	Washington
Timothy Michael Chestnut	Spokane	Washington
Richard Wayne Felt	Walla Walla	Washington
Todd Robert Green	Spokane	Washington
Samuel Greg Joseph	Spokane	Washington
William Scott Klipper	Kennewick	Washington
Lawrence Edward Klock	Spokane	Washington
Richard James Lambert	Spokane	Washington
Robert Edward Moss	Spokane	Washington
John Naylor	Spokane	Washington
Robert Paul Stevens	Wenatchee	Washington
Donald Duncan Storey	Spokane	Washington
Gladson M. Vaz	Pasco	Washington
Alan Coombs Whitehouse	Spokane	Washington