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Dr. Spear is expected to testify to the following information as it relates to the exposures of Mr. Boswell and Ms. Kenworthy during their employment at the Libby Lumber Mill.

Dr. Spear is also expected to testify that both plaintiffs were exposed to both chrysotile and amphibole asbestos during their work at the Mill, and that because of the large volume of asbestos-contaminated vermiculite and other ACM present at the Mill, together with the work activities that disturbed and re-suspended asbestos fibers into the air, Mr. Boswell and Ms. Kenworthy's exposure at the Mill was a substantial factor in the development of their disease.

Dr. Spear is also expected to testify that because of the large volume of asbestos contained within the trees coming into and being processed at the mill, and the constant soil disturbance by heavy equipment around the areas Mr. Boswell and Ms. Kenworthy worked, in addition to the vermiculite and other asbestos containing material in the mill, the Plaintiffs had a complete pathway of exposure to fibers released from asbestos-containing materials (ACM) and Libby Amphibole Asbestos (LA) through their work at the Lumbermill. There were multiple sources of ACM and LA at the Lumbermill, and the disturbance of vermiculite contaminated with LA through their work activities dispersed asbestos fibers into the air and into their breathing zones.

Dr. Spear is also expected to testify regarding the specific exposures of Ms. Kenworthy and Mr. Boswell, and how their employment exposed them to significant levels of asbestos fibers and how they worked in and around many dust producing operations from the various activities of the Lumbermill and worked around and disturbed asbestos containing material, and how they were exposed to LA contaminated dust emanating from the log processing activities, soil disturbing activities from heavy equipment, and from the friable asbestos containing material in the Lumbermill buildings.

Dr. Spear is also expected to testify that any asbestos that the Plaintiffs were exposed to at work that was carried home on their clothing would lead to contamination of their living space and serve as an additional work-related exposure away from the job site.

Dr. Spear is also expected to testify to the following information regarding Industrial Hygiene, the contamination of the lumbermill and how it relates to the exposures of Mr. Boswell and Ms. Kenworthy.

Dr. Spear is expected to testify regarding the knowledge of the lumbermill of the conditions at the plant, practices and working conditions maintained by Defendants and the duties that Defendants owed to exercise reasonable care towards Plaintiffs and in their operation of the Mill.

1. Dr. Spear holds a Ph.D. in industrial hygiene. Dr. Spear is a Professor Emeritus of industrial hygiene at Montana Tech of the University of Montana in Butte where he formerly taught courses in industrial hygiene and served as the head of the Safety, Health, and Industrial Hygiene Department. His Curriculum Vitae is Attachment #1 to this expert report.

2. Dr. Spear has extensive experience in the field of industrial hygiene pertaining to asbestos and asbestos exposure in the occupational setting. He has provided testimony regarding asbestos exposure during mining activities, railroad activities, Lumbermill activities, construction/maintenance work and during the use of asbestos-containing products. He also testified in cases involving asbestos exposure in Libby at the former Vermiculite mine, Libby Lumbermill, as well as logging and road work cases. He has visited Libby on many occasions and has visited the former Vermiculite mine and the Libby Lumbermill. He has spoken with scores of citizens of Libby including former miners, Lumbermill workers, loggers, railroad workers, road workers, landfill workers, asbestos remediation workers and those who have worked in various other jobs and careers in Libby. He has reviewed thousands of records from W.R. Grace, Zonolite, Champion, Stimson, governmental agency records, records of third parties, and relevant industrial hygiene literature. He has also reviewed the depositions of many workers who engaged in various employments in the Libby area. All of these materials are the type of documentation typically relied upon by professional industrial hygienists in the performance of their profession. Dr. Spear is also co-author on seven peer-reviewed publications pertaining to asbestos, including several studies on the presence of Libby asbestos fibers in the bark of trees in the Libby area.

3. Industrial hygiene (IH) is the science and art devoted to the anticipation, recognition, evaluation, and control of those workplace environmental factors that may cause sickness, impaired health and well being, or significant discomfort and inefficiency among workers or among citizens of the community. The scope of IH activities encompasses the "cradle-to-grave" concept (research of industrial processes from initiation all the way through the final waste disposal stage). Industrial hygiene is both an aspect of preventative medicine and in particular occupational medicine, in that its goal is to prevent industrial disease, using the science of risk management, exposure assessment.

   Reasonable and prudent industrial hygiene practice since the early 1900s requires workplaces be evaluated for potential employee exposure to toxic materials and that controls be implemented on any worksite where there are employees with potential exposure to toxic dust, such as asbestos. Ultimately, the central purpose of industrial hygiene is to: (1) study; (2) warn; and (3) protect, and these are duties owed specifically by Defendants in this case.

4. Industrial hygienists commonly rely on literature published in the Industrial Hygiene field, the fields of Occupational Medicine, Toxicology, as well as general medical literature. Occupational hygienists rely on literature from industry, academia, governmental agencies and independent entities. It is important to assess available data from all sources, both qualitative and quantitative, to measure potential exposures and to utilize professional judgment in the application of industrial hygiene principles.

5. The first reported cases of asbestosis in the modern era were among asbestos textile workers. In 1924, W.E. Cooke in England discovered a case of asbestosis in a person who had spent twenty years weaving asbestos textile products (Cooke, 1924). An investigation into the problem among textile factory workers was undertaken in Great Britain in 1928 and 1929. In the United States, the first official claim for compensation associated with asbestos was in 1927 in the form of a Massachusetts worker's compensation claim (Lanza, 1936).

6. Asbestos exposure was recognized as a deadly hazard in industrial hygiene literature by the 1930s. In 1930, Dr. E.R.A. Merewether and Dr. C.W. Price published a study proving asbestos exposure causes deadly lung disease (Merewether and Price, 1930). The same year, the Journal of the American Medical Association reported a fatal case of asbestosis in an asbestos miner (Lynch and Smith, 1930). Throughout the 1930s, dozens of articles appeared in the scientific literature confirming that asbestos exposure causes fatal disease. Cases of asbestosis in insulation workers were reported in this country as early as 1933 (Ellman, 1933). The U.S. Public Health Service fully documented the significant risk involved in asbestos textile factories in 1938 (Dressen, 1938). The authors urged precautionary measures and the elimination of hazardous exposures.

7. The connection between asbestos exposure and lung cancer was established in the 1940s within the medical and industrial hygiene communities. The link between asbestos and cancer was referenced in an article by Kenneth M. Lynch and W. Atmar Smith in a widely disseminated journal in 1935 (Lynch and Smith, 1935). Several articles in the 1940s referenced the link between asbestos and cancer, including a 1949 article in the Journal of the American Medical Association (JAMA 1949). In 1955, a study published by Sir Richard Doll, conclusively proved asbestos causes cancer (Doll 1955).

8. Tremolite asbestos, like other forms of asbestos, was recognized in the industrial hygiene literature as highly toxic by 1951 (Vorwald, 1951). The Montana Supreme Court found asbestos dust was a well-known toxic inhalant prior to 1956 (*Orr v. State of Montana,* 2004).

   Traditionally, Libby Amphibole Asbestos ("LA") has been referred to as "tremolite." More recently, sophisticated analysis has shown that LA is 84% winchite, 11% richterite and 6% tremolite (Meeker, 2003). Winchite and richterite are close geo-chemical relatives to tremolite.

9. Drinker and Hatch, *Industrial Dust* is a standard authoritative industrial hygiene text. At page 39, the text notes the 1947 total of 160 deaths from asbestosis in Great Britain. At page 46, the text demonstrates a 10 times greater than normal incidence of lung cancer among those exposed to asbestos or among those with asbestos related disease (Drinker and Hatch, 1954).

10. In 1960, Dr. J.C. Wagner published a study concluding exposure to asbestos causes mesothelioma (Wagner et al., 1960). In 1964, Dr. Irving Selikoff published a landmark study further demonstrating that exposure to asbestos causes the fatal diseases of asbestosis, lung cancer and mesothelioma (Selikoff, 1964).

11. By the 1960's, hundreds of articles and studies published in the industrial hygiene and medical literature established that asbestos exposure is harmful and can be fatal. These materials were readily available to anyone interested in and capable of learning about the dangers of asbestos. As a standard practice, industrial hygienists review industrial hygiene literature, as well as occupational medicine literature.

12. The Occupational Safety and Health Act was promulgated in 1970, 29 U.S.C. § 651 et seq., 84 Stat. 1590. Because of the recognition of the grave occupational health problem posed by asbestos as a toxic and physically harmful substance, asbestos was the first toxic substance regulated under this Act. The Act gives the Secretary of Labor the authority to establish standards for permissible concentrations of airborne asbestos fibers. In the 1970s, OSHA

required employers to monitor the workforce for asbestos related disease. 29 CFR 1910.93a (1972)

13. It has been known since 1930 that bystanders are at risk of significant asbestos exposure. That is, people who do not themselves work directly with asbestos materials or dust are at risk of significant exposure caused by others who are working with or around with asbestos. For this reason, it was recommended in the 1930s that dusty processes involving asbestos be isolated from other work areas to avoid exposing people whose presence is not necessary in the dustier operations, or performing the dustier operations with asbestos at times when there is a minimum number of other workers present. See, e.g., (Hoffman, 1918); (Oliver, 1927); (Merewether, 1930); (Ellman, 1933).

    More generally, the dangers of exposure to workers' families and the community from workers bringing home toxic dusts on work clothing has been recognized since the early 1900's. The 1913 textbook by Tolman, Safety, Methods for Preventing Occupational and other Accidents and Disease, states:

    > The importance of wearing suitable clothing on the premises should be strongly impressed upon workers in dangerous trades. The ordinary street clothes should be taken off and replaced by special suits to be worn during working hours. It is not sufficient for a working-suit, jacket or apron to be put on <u>over</u> the ordinary clothing. The working suit should be taken off before the midday meal and before leaving the factory and exchanged for the street-clothes. Working garments should be cut perfectly plain, without folds or pockets, and should be made of strong, smooth, washable materials. By removing the working-clothes before meals and before leaving the factory, the poison is not carried into lunchrooms or into the homes of the workers (Tolman, 1913).

    In 1934, The International Labor Office (ILO) published its Standard Code of Industrial Hygiene. In addition to advising to avoid the escape of dust into workrooms or adjacent premises, the 1934 ILO Code also provides that, "In dusty trades, cloakrooms, washing accommodations, and eventually douche-baths, separate from the workrooms, should be provided for the workers" (ILO, 1934).

14. Workers who took home clothing contaminated with asbestos provided an exposure pathway to the members of their household and employees of business establishments in Libby. As early as 1949, reports of asbestos disease among housewives exposed to dust brought home on their husband's work clothes appeared in the medical literature (Wyers, 1949). The studies by Newhouse and Thompson, Wagner et al., and Dr. Selikoff in the 1960's further documented asbestos disease among family members exposed to asbestos dust carried home on clothing (Newhouse, 1965; Wagner et al., 1960; Selikoff, 1964).

    Studies investigating secondary exposures from work clothing contaminated with asbestos concluded (1) the shaking of typical work clothes that are contaminated from the use of asbestos will cause amosite fibers to be released into the breathing zone of the individual who is performing this work resulting in a significant exposure to airborne amosite fibers, and (2) also caused the surfaces in the area to become contaminated with amosite fibers (as measured by the passive dust samplers) providing another potential source of exposure through re-entrainment from such activities as sweeping, vacuuming or other cleaning projects (Hatfield and Longo, 1999).

In another study, a laundry operation was examined because of its relevance to household exposures in cases of malignancies in families of asbestos workers. Airborne asbestos concentrations during general laundry activities showed a mean of 0.4 f/cc and a maximum of 1.2 f/cc (Sawyer, 1977).

According to Kotin (1977), there are data that suggest that the risk to asbestos-related disease is not exclusively limited to the workplace. "There are neighborhood cases of asbestos-related disease demonstrated by research and studies in the States, and research and studies in the United Kingdom. Again, these neighborhood cases reflect exposures to effluents in the days of virtual non-regulation and in the days of high (I wouldn't know how to define high precisely) – excessive exposure is perhaps a better description. Another group that has been identified as being at risk to asbestos-related disease at a site other than the workplace are the instances of the asbestos-related disease in family members of asbestos workers, conjugal cases. Two important things need to be said about neighborhood cases and conjugal cases. There are no data, despite the oft repeated statement…that these represent minimal exposures." Actually, the exposures, and let us say the conjugal cases, represent maximal exposures. They are exposures that are 24 hours a day, certainly day-long exposures. They are resuspended exposures to asbestos brought home by the worker. You have a spectrum of susceptibilities." Transcript of Remarks by Paul Kotin, M.D. Senior Vice President, Health Safety & Environment, Johns-Manville Corporation before Consumer Product Safety Commission June 9, 1977.

Exposure to indoor dust that is contaminated with asbestos is a potentially important exposure pathway for residents. This is because most people spend a large fraction of time indoors, and a wide variety of routine and indoor activities may cause the asbestos in dust to become suspended in air where it can be inhaled into the lung. One potential source of asbestos contamination in indoor dust is asbestos in outdoor soil (EPA 2007a). \

15. The Mill has been designated as Libby Asbestos Superfund Operable Unit 5 or OU5 by the United States Environmental Protection Agency (EPA). Asbestos was introduced into the Lumbermill in various ways: 1) Asbestos containing products were installed as commercial insulation and construction materials, 2) Libby vermiculite which contained amphibole asbestos was used in the nursery, central maintenance, the dryers in the Plywood plant, and in other places throughout the Lumbermill, 3) Railroad cars which contained Libby vermiculite contaminated with amphibole asbestos were cleaned at the Mill, 4) W.R. Grace carried out vermiculite processing activities at their facility located on the current Lumbermill site, and Libby vermiculite contaminated with amphibole asbestos was present in piles on the Mill property, and 5) Logs brought into the Mill from forests around the W.R. Grace mine were heavily contaminated with amphibole asbestos (Ward et.al. 2006; Hart et.al. 2007).

16. The Mill had asbestos-containing materials (ACM) throughout the plant (Libby Environmental Audit, 9/30/91; Plant Asbestos Survey; Pacific Rim Limited Asbestos Survey 1994 and Power House Complex; Libby Mill Champion International Corp, Bison Environmental Resources July 9, 1991; Champion Employee Asbestos Certification Cards 4/1/91). ACM was present in cement asbestos board, pipe insulation and fitting insulation, mastic, roofing materials, putty, plaster, floor tile, floor tile mastic, gasketing material, and

electrical wire insulation. According to the Pacific Rim Limited Asbestos Survey, 1994, "Pipe insulation in numerous locations tested positive for asbestos within the survey area. All areas except the Shipping Building have some quantity of pipe insulation. All pipe insulation in the survey area was in poor to extremely poor condition. The majority of this pipe insulation is in poor condition and PRE recommends that this material be removed as soon as possible due to its high friability and poor condition. Debris in four locations in the survey was discovered to contain asbestos. This debris is generally extremely friable and PRE recommends it be cleaned up as soon as possible. This material will need to be cleaned up prior to any activity in these areas that could potentially disturb the debris." (Pacific Rim Limited Asbestos Survey, 1994, pages 11 and 12).

17. In addition to ACM within the Libby Lumbermill, Libby vermiculite which contained amphibole asbestos was used by the Mill as an insulating material, was present in piles on the Mill property, and was brought into the Mill in railroad cars and in logs to be processed by the Mill (Asbestos TEM Laboratories March 20, 2000; 5/15/2000; 7/20/2001; Lambert Group, Inc. letter May 3, 2001; MCS Environmental, Inc. September 11, 2001; Ward et.al. 2006).

    According to Contract No. DTRS57-99D-00017, November 2001, prepared for the EPA, "the property occupied by the current Stimson Lumbermill in Libby, Montana has been a recipient of vermiculite product for further processing, nursery amendments, and construction materials. Portions of the Stimson Lumber Company facilities are located on land formerly used in the production of ore into vermiculite insulation. Additionally, vermiculite insulation was installed in structures currently occupied by Stimson Lumber Company employees" (Contract No. DTRS57-99D-00017, November 2001, page 2-1, 2-2; Contract No. 68-W5-0022, December 23, 2002, page 1-1, 1-2).

    > "The unpaved parking area used by Mill workers was once used as an aboveground storage area for uncontainerized vermiculite insulation. Vermiculite insulation was stockpiled directly on the native surface and may have contaminated the area with measurable amounts of asbestos mineral fibers. The area was converted to a parking lot in 1990" (Contract No. DTRS57-99D-00017, November 2001, page 2-2; Contract No. 68-W5-0022, December 23, 2002, page 1-2).
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    > "A railroad spur exists near the former popping plant location. The siding was used for shipping raw and processed vermiculite material to and from the site. It is suspected that this section of railroad is contaminated with tremolite asbestos from loading/unloading operations" (Contract No. DTRS57-99D-00017, November 2001, page 2-2).
    >
    > "A landscaping nursery was previously located along the southern boundary of the lumber mill. It is believed that un-exfoliated, or raw vermiculite product, was introduced to the site for use as a growth media and fill material. The lot is currently used to stockpile woodchips (collected from 1991 through 1997). ....soil collected at the nursery area had concentrations of tremolite asbestos as high as 5%" (Contract No. DTRS57-99D-00017, November 2001, page 2-2; Contract No. 68-W5-0022, December 23, 2002, page 1-2).
    >
    > "The Central Maintenance building is currently insulated with vermiculite insulation. This structure is equipped with a large gantry crane that traverses the length of the building. Movement of this crane causes vibration within the structure and release of small amounts

of vermiculite insulation from around seams and joints of the clapboard walls. Employees routinely inspect and seal leaking seams and joints with an expanding spray foam caulking compound" (Contract No. DTRS57-99D-00017, November 2001, page 2-3; Contract No. 68-W5-0022, December 23, 2002, page 1-6).

"The former lunch/break area of the finger-joint facility has been abated. PCM clearance samples after the completion of the abatement indicated the area was safe for human occupancy. However, it appears that trace amounts of vermiculite insulation have been released from seams and joints in the clapboard siding as the building has expanded and contracted. Therefore, the cleanliness of the area is considered to be questionable at this time. Currently the area is used as equipment storage" (Contract No. 68-W5-0022, December 23, 2002, page 1-6, 1-7; MCS Environmental Inc. June 13, 2001, page 1). 5-10% Actinolite asbestos was found in this material (Asbestos TEM Laboratories Inc. March 20, 2000).

18. The EPA recently issued their Final Remedial Investigation Report for OU5 (EPA 2013). The Report provides that investigations at OU5 began in May of 2002 and continued through 2012. EPA performed several ABS studies in 2007 and 2008 to investigate levels of LA in air associated with a variety of activities under current conditions. ABS from most occupied buildings contained detectable levels of LA. For buildings where LA was detected, the mean concentration varied by a factor of 1,000. LA was detected in seven of the eight outdoor worker ABS areas. Dust samples were also taken at that time and of the 87 indoor dust field samples collected, 28 samples had detectable levels of LA. Soil samples were examined both visually for vermiculite and by polarized light microscopy (PLM), demonstrating the presence of LA and visible vermiculite in soils throughout OU5. See Attachement #3, EPA Map titled Visible Vermiculite in Surface Soils at OU5, dated May 2013. Waste bark samples were also taken at the Lumbermill. Of the 19 waste bark samples analyzed, LA was detected in 13 samples analyzed by transmission electron microscopy.

"During Site interviews conducted in 2001, three specific outdoor subareas of interest were identified (CDM, 2007a) due to potential vermiculite (and associated LA) contamination concerns:

- The former Popping Plant was once used as an aboveground storage area for uncontained vermiculite ore. Ore was stockpiled directly on the native soil surface in this area.

- The Railroad Spur was used for shipping raw and unprocessed vermiculite material to and from OU5.

- The former Tree Nursery may have introduced raw vermiculite product into this area as a growth medium and fill material.

Additionally, waste bark piles remain from historical lumber processing activities at OU5." The former Popping Plant and the Railroad Spur were located directly adjacent to the Plywood Plant. Additionally, much of the waste bark generated at the Lumbermill came from the unloading and debarking processes at the Lumbermill, including the Plywood Plant debarker.

"The following is a brief chronological summary of major regulatory actions taken at the Site.

- 1999 – Local concern alerts EPA to investigate asbestos in and around Libby, Montana
- 2002 – Libby Asbestos Site proposed for the NPL
- 2002 – Libby Asbestos Site formally added to the NPL
- 1999 through 2013 – Response actions taken to remove asbestos and vermiculite containing material throughout OU5 (Table 1-1)

EPA has not entered into any enforcement agreements or issued any orders for investigation, removal, or remedial work at any part of OU5. The Stimson Lumber Company removed some loose and accessible vermiculite insulation in 2002 and 2003. EPA contractors have taken samples at OU5 many times beginning in 2002. EPA removed vermiculite insulation from a portion of the roof and walls at the Central Maintenance Building in 2005 and contamination from surface soils several times since 2009. None of these actions was pursuant to any enforcement agreement or order. EPA entered into a site wide settlement with the only Potentially Responsible Party (PRP) for OU5, W. R. Grace, in 2008. That agreement provided for a cash settlement of past and future response costs for the entire Libby NPL Site except OU3, the mine site."

"A number of response actions have been completed to date and are summarized in Table 1-1 below.

TABLE 1-1
Response Actions Taken at OU5

Location (reference)	Date	Lead Agency/Company	Description
Plywood Plant and Truck Shop (CDM 2007)	November 1999	MCS Environmental through Stimson Lumber Company	Asbestos abatement
Finger Jointer (CDM 2007)	May 2000	MCS Environmental through Stimson Lumber Company	Removal of vermiculite insulation from lunch room and bathroom
Dry Kiln Tunnel (CDM 2007)	December 2002	IRS Environmental through Stimson Lumber Company	Removal of pipe insulation and asbestos containing debris
Central Maintenance Building (CDM 2007)	May/June 2003	IRS Environmental through Stimson Lumber Company	Removal of vermiculite insulation and asbestos containing materials on ground surface
Plywood Dryers (CDM 2007)	August 2003	IRS Environmental through Stimson Lumber Company	Removal of vermiculite insulation from walls, floors, and ceilings
Plywood Plant (CDM 2007)	August 2003	IRS Environmental through Stimson Lumber Company	Removal of pipe insulation of northwest corner
Screening Building (CDM 2007)	August 2003	IRS Environmental through Stimson Lumber Company	Removal of cement asbestos siding and roofing
Central Maintenance Building (CDM 2007)	December 2003	IRS Environmental through Stimson Lumber Company	Removal and repair of asbestos containing roofing material and asbestos containing materials on ground surface
Former Nursery (CDM 2007)	Fall 2004	EPA	Installation of fence to isolate area
Finger Jointer Lunch Room (CDM 2007)	February 2005	IRS Environmental through Stimson Lumber Company	Removal of vermiculite insulation

Central Maintenance Building (CDM 2007)	Summer 2005	EPA	Removal of vermiculite insulation
Soils northwest of Pipe Shop to support redevelopment (CDM 2007)	Spring and Summer 2009	EPA	Removal of LA-impacted soils to depths of 6"-18" to support Site redevelopment.
Libby Creek (OU4 action w/possible encroachment on OU5) (CDM 2007)	August 2009	EPA	Removal and replacement of rip-rap on east bank of Libby Creek
Former Plywood Plant (EPA, 2010c)	Summer 2010	EPA	Soil removal north of former veneer dryer and removal of vermiculite-containing bricks.
Valve House at Finger Joiner Building (EPA, 2010d)	Summer 2010	EPA	Removal of soil and vermiculite-containing building materials.
Central Maintenance Building (EPA, 2010e)	January 2010	EPA	Removal of vermiculite-containing insulation and interior cleaning.
Former Popping Plant (EPA, 2013a)	Summer 2011	EPA	Soil removal
Central Maintenance Building (CDM Smith, 2011)	Fall 2011	EPA	Interior cleaning of areas impacted by land owner removal of asbestos-containing roof materials
Port Authority Building (CDM Offices; EPA 2012a)	Spring 2012	EPA	Soil removal associated with revegetation demonstration plot/
Former Nursery Area (EPA, 2012b)	Summer 2012	EPA	Soil removal
Central Maintenance Building (EPA, 2012c)	Fall 2012	EPA	Removal of vermiculite-containing insulation and interior cleaning.
Former Tree Nursery (EPA, 2013b)	Spring 2013	EPA	Soil Removal

Source: CDM (2007) OU5, Final Data Summary Report – October 16, 200; CDM (2012) Summary Report Memorandum and various Removal and Restoration Completion Forms (EPA or CDM, 2010-2013).

See EPA 2013, Table 1-1 Response Actions Taken at OU5. The EPA has performed a multitude of sampling events at OU5, *See*, EPA 2013, Table 3-1 Sampling Events at OU5.

"In addition to addressing vermiculite (and associated LA) in buildings, EPA performed other response actions involving OU5 soils (Figure 1-4):

1. OU5 Redevelopment Area – Soil characterization and limited soil removal in an area west of the Pipe Shop. A summary of investigative and soil removal work is provided as Appendix A1.

2. Central Maintenance Building – Multiple actions to remove vermiculite-containing building and other materials by vacuum methods, from the edge of the walls and outward approximately 45 ft. A summary of investigative and soil removal work as well as asbestos containing building materials mitigation is provided as Appendix A2.

3. Libby Creek Remediation Area – Removal and replacement of rip-rap on the east bank of Libby Creek. Libby Creek is a part of OU4 as it traverses OU5. However, a portion of the response action may have encroached onto OU5 on the east bank of the creek. A summary of investigative and soil removal work is provided as Appendix A3.

4. Former Plywood Plant – Soil removal north of the former veneer dryer and removal of vermiculite-containing bricks. A Completion Form is provided as Appendix A4. See Attachment #13, Removal and Restoration Completion Form For Quick Response Action at Former Plywood Plant.

5. Valve House at Finger Joiner Building – Soil removal from the area surrounding the Valve House and from the floor of the Valve House. A Completion Form is provided as Appendix A5.

6. Former Popping Plant location – Soil removal as part of an OU4 action that extended onto OU5. A Completion Form is provided as Appendix A6.

7. Port Authority Building (CDM Offices) – Soil removal as part of a re-vegetation pilot study. Documentation is provided in Appendix A7.

8. Former Tree Nursery Area – Soil removal in preparation for construction of a proposed fishing pond in the area. A Completion Form is provided as Appendix A8.

In addition, EPA installed a chain-link fence to isolate the former Tree Nursery area (CDM, 2007a).” (EPA 2013). Some of the remediation actions taken at OU5 are summarized in the EPA Map titled Building and Soil Abatement Response Actions.

19. Like other buildings and processes at the mill, there were asbestos-containing materials (ACM) in the plywood plant. Bulk sampling performed as late as 1996 found ACM consisting of amosite and chrysotile asbestos in thermal insulation and roofing materials. The plywood plant was found to have asbestos-containing insulation on the condensate tank and steam pipes. In fact, asbestos-containing materials were being installed in the plywood plant as late as 1989 and in the powerhouse as late as 1993. (Plant Asbestos Survey, Caplin letter 3/9/87, 4/9/87, Gring letter 3/16-19/89, Champion memo 10/25/89, EJ Bartels purchase order 8/21/92, P.O. # Q3510W 5/4/93), BMMI Bids 1/22/96, Day Appropriation request 2/2/96, NESHAP Demolition Notification 3/1/96, BMMI Survey 4/2, 4/96). According to Plywood plant workers, the dryers in the plywood plant were heated with steam which fed through the steam pipes running over the top of and into the dryers.

Several asbestos surveys in the plywood plant found asbestos. Asbestos was removed. Later, asbestos was found, removed, and later found again. The following summarizes Lumbermill documentation of asbestos containing materials in the plywood plant that were found and remediated and then found again:

ASBESTOS FOUND, REMOVED AND FOUND AGAIN

Date	Location	Event	Notes
2/19/87	condensate tanks	found	it was "sealed"
4/9/87	plywood	found	on pipe insulation
5/16/89	condensate tanks	asbestos added	asbestos sealer was applied; labeled "asbestos"
11/12/91	condensate tanks	not found	Bulk PLM
4/28/92	plywood	removed	project to remove all asbestos insulation from asbestos pipe
8/21/92	plywood	removed	from 3" piping

3/1/96	plywood	removed	from 900' of piping and 200 sq. ft of surface area
4/2/96	big dryer	found	Map: found in 25 of 43 samples in plant, Exh. 83-27; found in 4 of 5 in steam piping near big dryer (map Exh. 83-3)1 Bulk PLM
4/15/96	plywood	removed	from 1,400' of pipe and 200 sq. ft of surface area
4/30/96	big dryer	found	air sample in front of big dryer 14/100 fields had fibers
5/3/96	plywood	removed	from 580' of pipe
5/21/96	plywood	removed	from 180' of pipe
7/12/99	big dryer	not found	on insulation gasket. Bulk PLM
10/22/99	big dryer	removed	from 90' of pipe between big and small dryers
12/8/99	dryers	found	air sample 0.008 f/cc north side of dryers
2/5/01	big dryer	not found	"top of big dryer #7 door insulation material." Bulk PLM
3/22/02	big dryer	not found	Bulk PLM
9/14/02	dryer tender	found	Air sample. "of the 11 samples collected on the dryer tender, asbestos structures were detected by TEM AHERA analysis on one sample, SL-00159. The TWA calculation based on the PCM analysis results for the remaining dates showed one exposure above the PEL."
12/02	big dryer	found	"vermiculite insulation is believed to be associated with the big dryer No. 1." EPA
6/10/03	big dryer	found	"vermiculite . . . sandwiched between the top of the dryer and the concrete layer"
6/12/03	plywood	found	"The plywood building appears to be contaminated with secondary dust."

After 2/5/01, several samples were non-detect for asbestos in the plywood Plant. Bulk samples for asbestos are reported as non-detect when asbestos is present at less than 1% in the bulk material. It must be noted that asbestos in bulk material, particularly vermiculite, is still hazardous at levels less than 1% if the asbestos fibers are allowed to become airborne. Although it was well known that asbestos contaminated vermiculate was present on top of the big dryer and in the flooring for the big dryer, no samples were taken from this location until 2001. Even in the major sampling effort done in 1996, no sample was taken from the top of the big dryer. It is also rather surprising that after the major effort in 1996, in 1999 another 90' of asbestos pipe insulation was removed from between the big and small dryers. There is no scientific basis for a conclusion that the asbestos removal effort was ever 100% complete, since apparently no extensive or random sampling was accomplished after 1999.

In the early 1990's Ray Johnson, a plywood plant worker, observed contractors removing insulation containing asbestos from the steam lines in the plywood plant (Johnson Depo., page 57, lines 15-17). He said the contractors attempted to seal off the area but that the enclosure was not an air tight enclosure. Plywood plant workers were kept away from the removal area by ribbons. He also noticed complete pipe wrap, which he believes was asbestos wrap, falling from the pipes all the time he was in the plywood plant, including the 1990's (Johnson Depo., page 59, lines 19-22). Another Plywood dryer worker, Steve Peterson, reports that vermiculite insulation would fall out of the cracks in the walls of the Plywood plant in the areas of the dryers and workers would sweep this material up on cleaning days.

20. In addition to ACM, vermiculite insulation contaminated with asbestos was used as an insulator for the plywood dryers.

"According to historical records, vermiculite insulation was used as an insulator for the plywood dryers. The Big Dryer #1 is the dryer of concern. According to Stimson employees, the Big Dryer was modified in 1986-87 and it is believed that vermiculite material was added to the concrete as well as sandwiched between the top of the dryer and the concrete layer" (Contract No. DTRS57-99D-00017, November 2001, page 2-3; Contract No. 68-W5-0022, December 23, 2002, page 1-6).

Much of this material on Dryer #1 was still present when the mill was dismantled. EPA sampled dust and air in all of the buildings at the Libby mill. Contamination was found in two of them; the central maintenance building and the plywood building (Libby Community Advisory Group Meeting Summary, June 12, 2003), (Response Action Contract for Remedial, Enforcement Oversight, and Non-Time Critical Removal Activities at Sites of Release or Threatened Release of Hazardous Substances in EPA Region 8, Contract No. 68-W5-0022, Document Control No. 3282-116-RT-OTHR-16171, pages 1-6, 3-9; Contract No. DTRS57-99D-00017, November 2001).

According to former Lumbermill employee Ray Johnson (Johnson Deposition, page 64, line 3) and other workers from the Plywood plant, in 1983 the mill owners insulated the top of the large dryer in the plywood plant with Zonolite (expanded vermiculite) insulation from WR Grace. Mr. Johnson said he complained to plywood management about the vermiculite insulation (*Id.* at page 67, lines 10-13). Mr, Johnson could see dust in the air, and "There was a lot of times, though, the sunlight would glisten in through the vents in the wall above the dryers, and you'd get a crosswind coming through there, and it would just glisten" (*Id.* at page 62, lines 14-18).

The large dryer (14' x 140' x 16') was insulated on top of the dryer with 6 inches of Zonolite (Ray Johnson deposition pages 65, line 3; page 69, lines 1-9). Mr. Johnson and other workers testified that they were required to climb to the top of the dryers and walk in the 6 inches of Zonolite to change fan belts, clean sprinkler heads, clean the ceiling, and extinguish fires (Ernest Anderson deposition page 8, lines 7-21). Mr. Johnson testified "it made a mess to walk in because I was up there a lot on top of the dryer" (page 109, lines 23-24). Ernest Anderson testified that there was a dust in it from walking on it and you'd get a powder coming up (page 10, lines 5-7). Mr. Johnson stated he could be on top the dryer 2-3 times per week for times ranging from 3 to 30 minutes.

The concrete Zonolite mixture that has been confirmed on the top, floor and inside of the big dryer has been reported by workers as becoming cracked and crumbly and requiring frequent repair and patching. The friable condition of this material was confirmed by photographs taken of the dryers.

21. Attached to the Plywood plant was the debarker, which stripped the bark from the trees that were to be used to produce the plywood veneer. Lumbermill workers report that the bigger "Peeler" logs were used in the plywood process. Workers report that beginning in approximately 1990, the "peeler" logs were debarked dry and would produce a lot of dust during that process. Due to the heat produced by the dryers and the exhaust fans on the roof, the Plywood plant would typically have a negative pressure. See 2/12/91- McAfee Report referencing installation of roof exhaust fans and negative pressure in the Plywood Plant. This resulted in air coming in at the ground level and going out the top of the plant. Steve

Peterson, who worked where the logs came in from the debarker reported that there was a constant breeze coming in from the debarker. This negative pressure had the tendency to trap dust coming in from outside and produced inside the plant from leaving the Plywood Plant.

The grounds of the Lumbermill have been shown to be extensively contaminated with asbestos fibers. Lumbermill operation involved a constant and intense soil disturbance through the operation of heavy equipment, trucks and activities of workers. This soil disturbance liberated asbestos fibers into the air column where they could be inhaled by workers. In addition, heavy equipment and workers were constantly moving in and out of the plywood plant. During this process they would be tracking significant amounts of contaminated soil and dust into the Plywood Plant. This soil dust would then be disturbed through work and cleaning activities in the Plywood Plant. Due to the negative pressure experienced in the Plywood Plant, the soil and dust particles would have a tendency to remain in the Plywood Plant where they could be continuously re-entrained into the air column when disturbed.

22. ACM was present in all Mill buildings and in the forests of Rainey Creek and other drainages in the vicinity of Vermiculite Mountain where much of the lumber processed at the Mill came from.

23. Much of the timber processed at the Mill came from the forested areas surrounding the W.R. Grace mine. On 9/19/2012, Dr. Spear interviewed six woods workers by phone:

James McNulty drove a logging truck for forty years in the area. He kept a log book documenting who he pulled for and where the logs ended up. He says that between 1993 and 2002 the logs he pulled in the Libby area were delivered to various mills in the northwest. He hauled peelers from logging operations in the WR Grace Mine area to the Libby Mill in 1993.

John Martineau worked for the Kootenai and Flathead National Forest from 1974 until 1980. He was not involved in timber sales but he was aware of lumber mills in Libby, Eureka, and Trout Creek. He believes that a lot of the logs harvested from the WR Grace Mine area were hauled to the Libby Mill.

John Sauer worked as the Mill Logging Superintendent for a long time until retiring in 1992. He handled all the timber sales and timber contractors and oversaw the Mill's logging department including some 300 logging employees. He was aware of logging operations around the WR Grace mine. In the mid-1980's he was involved with a logging contract with WR Grace in the vicinity of the mine and a U.S. timber sale also in the mine vicinity. Logs from both of these contracts went to the Libby Mill. He stated that practically all the logs harvested in the Libby area, except for some small logs which went to lumber mills Eureka and Idaho, came into the Libby Mill for processing.

David McMillan logged in the Libby area. In 1997 he logged for Mark Owens right across the river from Rainy Creek road (within contaminated area) where he said the big logs went to Libby while the small (8 footers) went to Eureka. He also said that until around 02 or 03 all the logs pretty much went to Libby.

Michael Parker hauled logs from 1983 to 2008. He hauled quite a few loads of logs out of the WR Grace Mine area off and on in the decades of the 80's, 90's and 2000's. He stated that when Stimson took over the Libby Mill, Plum Creek bought Champion's timber land, and Stimson got a 10 year contract on all the peelers harvested to make plywood. The majority of the stud wood went to Plum Creek in Columbia Falls. Peelers were the non-pine (fir and larch). He said that Stimson also purchased peelers from other jobs.

Ray Hammons worked for the Kootenai National Forest from 1956-1991. He was the Road Manager for the Kootenai National Forest in the 1980s. As Road Manager he knew the timber that had to be hauled and he was aware of logging operations around the WR Grace mine. He stated that the whole area around the mine was clear cut over the years and that a lot of timber came out of there. He stated that J. Neils and St Regis bought most of the timber sales and that they had big road building crews. They would get timber credits for the road building in the forests. He stated that from 1956 when he began working for the Kootenai National Forest, until he retired in 1991, about 80% of the logs from the WR Grace Mine area went to the Libby Mill.

Other logging workers have stated that they were involved in logging operations in the vicinity of the Vermiculite Mountain, including Rainey creek, Jackson and Little Jackson creeks, and Carney Creek. From 1975-89 Louie O'Brien, a former woods worker for the Mill, ran a line skidder on logging operations. Mr. O'Brien also worked doing line skidding in the Rainey Creek area in the 1970s. He worked close to where Zonolite was being loaded, and there was a lot of dust from that. He remembers seeing dust blowing off the trucks hauling ore from the mine. O'Brien described the areas along rainy creek road as having heavy dust on the branches of the trees. Harry Moe, another woods worker or the mill, also operated a loader and drove logging trucks in Rainey Creek and other drainages in the vicinity of Vermiculite Mountain. Mr. Moe also stated that dust would fall out of the trees and that dust would fly from the haulage trucks on Rainey Creek road. Mr. Moe remembers that Zonolite was spread on the Rainey Creek road for traction. Mr. Moe said that the logging trucks they operated in those days had no air conditioning and they often worked with the windows open. Bert Cole and Larry Urdahl, other Champion employees, stated that they too hauled logs to the Mill from Rainey Creek and other drainages in the vicinity of Vermiculite Mountain.

24. An EPA 2008 map shows the detection of asbestos in tree bark of a least 10,000 structures/square centimeter was used in delineating the area included in the summary. USFS data indicates that 9,200 acres of timber has been harvested within this delineated area since 1950. During the years of 1985-2002, there were 272 stands of USFS timber harvested in the designated area encompassing 4,563 timbered acres. It is important to note that these figures report only those timber sales occurring on USFS land within the designated area and does not reflect the timber sales or harvesting that occurred on the surrounding State or privately owned lands also located within OU3. More recent bark studies taken outside of the area delineated by the EPA have indicated that the contamination of tree bark at levels above 10,000 structures/square centimeter (s/cc) extends much farther than previously projected by EPA maps. Recent studies in the Flower Creek Area, approximately ten miles upwind (prevailing wind pattern) from the W.R. Grace Mine, have demonstrated bark concentrations up to 283,000 s/cc in trees at that location, indicating that the contamination of tree bark in the Libby area is likely much more widespread than previously projected. (MDEQ 2012).

25. On October 10th and 12th, 2007, EPA collected 20 bulk samples from the top, middle, and bottom sections of wood chip piles on the former Stimson lumber property. Using the PLM method, one of the samples contained a measurable concentration of Libby asbestos, and using the TEM method, 20% of the samples contained a measurable concentration of Libby asbestos. See EPA Memorandum from Rebecca Thomas to Paul Rumelhart, August 27, 2009 and EPA 2013.

On October 15, 2007, during the same study, EPA (2008a) collected waste bark samples from piles located on the Mill property. These piles contain material including bark, soil, logs, and rocks that were scraped from the surface of the log storage yard over a period of two years. LA was detected in 13 of 19 or 68% of waste bark samples when analyzed by transmission electron microscopy.

In the same study, EPA (2008a) collected personal air samples from seven occupied buildings at the Mill to evaluate risks to workers at OU5. These air samples were obtained using a personal air monitor worn by an individual engaged in normal or "high end" activities. There are two types of activities or behaviors that are expected. The first is a passive behavior that was simulated by walking between rooms and/or floors and working at a desk or computer. The second is active behavior that was simulated by walking between rooms and/or floors, dusting a desk or computer, and sweeping or vacuuming a floor. Of the 7 occupied buildings, the Log Yard Truck Scale House had the highest LA concentrations observed, with airborne Libby asbestos results up to 0.1217 s/cc and airborne chrysotile asbestos results up to 0.7648 s/cc. During the same study, nine out of 13 vacant buildings tested using stationary air monitors revealed the presence of airborne asbestos fibers.

26. In addition to the previously mentioned documents and studies, Dr. Spear has personally reviewed thousands of Lumbermill documents produced by International Paper, Champion and Stimson in litigation before the Worker's Compensation Court. These documents demonstrate the presence of vermiculite and/or various asbestos containing materials throughout all areas of the Lumbermill including the Powerhouse, the Studmill, the Plywood Plant, the Planer buildings, the Log Yard Scale House, the Finger Jointer Building, the Saw Mill, the Central Maintenance Building, the Nursery, the Greenhouse, the Truck Barn, the Tire Shop, the Fire Hall, the Parking Lots and throughout the Mill in general. Testing ordered by Stimson in the Plywood Plant demonstrated the presence of airborne asbestos as late as September, 2002. In addition, the presence of vermiculite and asbestos containing materials has been well documented by EPA studies and reports throughout the Lumbermill complex (EPA 2002, EPA 2008a, EPA 2010, EPA 2013).

27. Airborne asbestos contamination in buildings is a significant environmental problem and the extensive use of asbestos products in buildings has raised concerns about exposure to asbestos in nonindustrial settings. When building maintenance, repair, renovation or other activities disturb ACM, or if it is damaged, asbestos fibers are released creating a potential hazard to building occupants (EPA, 1985). According to EPA (1985), the steps that a building owner should take to control asbestos in buildings include, but are not limited to, the following:

- Survey to see if asbestos is present.
- Inspect the building for friable materials on walls or ceilings.

- Collect samples of friable ceiling and wall materials following EPA procedures.
- Establish an Operations and Maintenance (O&M) Program.
- Obtain cooperation of building maintenance and custodial managers.
- Educate building occupants and employees about ACM.
- Train custodial and maintenance workers in special cleaning techniques and maintenance precautions.
- Clean the building thoroughly using wet cleaning and HEPA-vacuum techniques.
- Take special precautions before starting maintenance and construction work.

Health concerns remain today, particularly for the building's custodial and maintenance workers. Their jobs are likely to bring them into close proximity to ACM, and may sometimes require them to disturb the ACM in the performance of maintenance activities. For these workers in particular, a complete and effective O&M program can greatly reduce asbestos exposure (EPA, 2003).

EPA (1988) found that "friable" (easily crumbled) ACM can be found in an estimated 700,000 public and commercial buildings. About 500,000 of those buildings are believed to contain at least some damaged asbestos, and some areas of significantly damaged ACM can be found in over half of them. According to the EPA (1988) study, significantly damaged ACM is found primarily in building areas not generally accessible to the public, such as boiler and machinery rooms, where asbestos exposures generally would be limited to service and maintenance workers. Friable ACM, if present in air plenums, can lead to distribution of the material throughout the building, thereby possibly exposing building occupants. ACM can also be found in other building locations. Asbestos materials can become hazardous when, due to damage, disturbance, or deterioration over time, they release fibers into building air. Under these conditions, when ACM *is* damaged or disturbed – for example, by maintenance repairs conducted without proper controls — elevated airborne asbestos concentrations can create a potential hazard for workers and other building occupants.

28. Almost 660 custodians employed by the New York City Board of Education were examined between 1985 and 1987 for asbestos-related disease and 39% of those with 35 years of employment had abnormal films (Levin and Selikoff, 1991). Eighty-four percent reported removing asbestos and 89% reported working in areas where asbestos was present and abated. In a study of male employees at one California school district, 13.3% of custodians were found to have asbestos-related disease, and because these were related to parenchymal and pleural fibrosis, it would indicate rather high exposure of asbestos to these custodial workers (Balmes et al., 1991). Oliver et al. (1991) found pleural plaques above background and restrictive lung disease among 120 white male public school custodians in the Boston school district.

29. As noted by Doll and Peto (1985), it is important to look at combined exposures, to chrysotile and amphiboles, because exposure to a small amount of amphibole added to chrysotile causes a disproportionate mesothelioma risk.

30. Vermiculite Mountain is about six miles northeast of Libby, Montana. Rainy Creek, adjacent to Vermiculite Mountain, originates between Blue Mountain and the North Fork of Jackson Creek at an elevation of about 5,000 feet and descends to an elevation of 2,080 feet at the confluence with the Kootenai River. (Zinner, 1982). The mineral vermiculite was first discovered at Vermiculite Mountain in the 1920s when Edward Alley, a hotel owner and

part-time miner, discovered a unique mineral that when heated by flame it expanded to a large lightweight puffy cluster that did not burn.

Mining operations began soon after, and Alley named the substance Zonolite and his company the Zonolite Company. By 1924, Alley was producing 4 tons of Zonolite per day, and by 1926, the Zonolite plant was producing 100 tons per day. The vermiculite mine was operated as a strip mine by the Zonolite Company from 1923 to 1963 when it was purchased by W.R. Grace. The operation continued to run until 1990. In a typical year, about 5 million tons of rock were mined to generate 220,000 tons of vermiculite product. During active operation from the 1920s to 1990 the mine produced up to 80% of the world's supply of vermiculite. (EPA 2009b). Primary waste materials were waste rock (3.5 million tons per year) and tailings (1.1 million tons per year), with the lesser amounts of oversize rock and screening plant concentrate wastes (EPA 2008b, ATSDR 2003a). The vermiculite mineral had a naturally occurring asbestos impurity that was known as early as the 1920s. There were attempts to market the asbestos in the 1920s and about 1962.

The mine area is heavily disturbed by past mining activity and some areas remain largely devoid of vegetation. There are a number of areas where mine wastes have been disposed, including waste rock dumps (mainly on the south side of the mine), coarse tailings (mainly to the north of the mine), and fine tailings (placed in the tailings impoundment on the west side of the site.

Strip mining, transportation and processing of vermiculite ore containing asbestiform minerals was conducted from 1923 to 1990 and was processed for export in and around the town of Libby. The dry mill was constructed part way down the mountain from the mining operations in about 1937 to process the raw ore. This open cut mining and milling operation on Vermiculite Mountain contained a number of steps, including: the removal of the raw material from the ore body by blasting, the removal of the material leaving open cut benches, dumping waste, hauling ore to conveyors, sorting of the raw material, processing of the raw material into concentrate, disposal of the slag, transportation of the concentrate off of the mountain, and transportation of the concentrate to an expanding facility.

31. The main sources of asbestos contamination from the mine site are the mine wastes generated by historic vermiculite mining and milling activities. This includes piles of waste rock and waste ore at onsite locations, as well as the coarse tailings pile and the fine tailings impoundment.

Asbestos occurs naturally in the environment and may be released to water and air from erosion and the weathering of natural deposits of asbestos-bearing rocks. However, asbestos is more likely to be released to the environment when these natural deposits are disturbed during processes such as mining operations.

The mine produced about 4,800 tons of ore per day. Every 8 tons of ore results in 1 ton of concentrate resulting in the production of 600 tons of vermiculite concentrate per day. Estimates of asbestos content of the ore ranged from 3-22%. Using a conservative 3% number, there were approximately 300,000 pounds of asbestos per day going through the dry mill. During the milling process, the concentrate produced significant dust. The dust in the air where the workers were present was measured by State and Federal investigators at 20-60% asbestos content. In 1967, Grace's Chief Engineer performed a test on the large "600 fan" at the dry mill. It was estimated that 24,000 pounds of dust was emitted by the large stack per day. (See, Letter from Kujawa to Lovick, 2/6/1969). At 40% asbestos content in the dust, a generally recognized average by the State, this was about 10,000 pounds of asbestos dispersed into the air column per day from the large stack alone. Considering the blasting, hauling and other processing activities, the estimate of 10,000 pounds of asbestos dust per day was likely a small fraction of the total asbestos emitted into the air by the mine and mill operations.

LA is highly friable and produced clouds of dust whenever it was moved. The entire mining and milling operation involved moving ore from point to point, and processing it in various ways. The mining and milling operation produced enormous amounts of dust. LA became suspended in the air and transported from sources via release mechanisms such as wind, mechanical disturbances and/or erosion. Once airborne, contaminants move with the air and then settle and become deposited onto surface soils and trees. Thus, the impacted area also includes surrounding forest lands that were impacted by airborne releases of asbestos (EPA 2008b).

Asbestos is released to the environment from the crushing, screening, milling and transport of ore, the processing of asbestos products, the use of asbestos-containing materials, and the transport and disposal of asbestos-containing wastes (ATSDR, 2001). Virtually every time the ore or the vermiculite concentrate was moved clouds of dust were created, except in wet weather. LA may become suspended in air and transported from sources via release mechanisms such as wind, mechanical disturbances and/or erosion. Once airborne, contaminants may move with the air and then settle and become deposited onto surface soils and trees. The impacted area also includes surrounding forest lands that were impacted by airborne releases of asbestos (EPA 2008b).

There was no area in the mining operation which was not dusty. Workers recounted that all flat surfaces were dusty. There was often visible dust in the air, as can be seen from photos of the dry mill and blasting operations. Additionally, the community of Libby lies in a mountain valley. The valley air shed functions somewhat like a bowl. Pollutants, when disturbed by wind or human activity, tend to be recycled into the bowl.

Asbestos release to air was likely concentrated by Libby's unique topographical and meteorological situation. Libby is in a narrow valley surrounded by mountains that are 4,000 feet higher than the town, which in winter leads to persistent temperature inversions that have the effect of concentrating atmospheric contaminants, including asbestos in the valley. (EPA 2009a.)

32. Once asbestos fibers enter the environment from either a natural or artificial source, they tend to settle out of the air or water and deposit in soil and sediment (USEPA, 1977; USEPA, 1979). Asbestos fibers can be re-suspended into the air or water following soil and sediment disturbances. The rate at which asbestos particles settle out of the air or water depends on their size (ATSDR, 2001; USEPA, 1979). Jaenicke (1979) reported that the residence time for a particle to remain airborne is greatest for particles ranging from 0.1-1 μm in diameter. Fibers in this size range can be transported long distances in air. Asbestos fibers are nonvolatile and insoluble; they are transported and distributed by air and water and tend to persist under typical environmental conditions (ATSDR, 2001).

33. In 2005, it was discovered that trees in areas surrounding the vermiculite mine and throughout Libby serve as reservoirs for LA (Ward et.al. 2006), when tree bark samples were collected in support of a proposed firewood harvesting / commercial logging exposure study in the Libby area. Bark samples were collected to simulate a probable amphibole fiber concentration gradient emanating from the mine from forests around the W.R. Grace mine. Bark samples were collected from three separate, heavily forested locations within the Superfund site, within the town of Libby and on the railroad line seven miles west of town, and two miles northeast of the mine on United States Forest Service (USFS) road 4872 in an area that had been recently clear cut. Asbestos concentrations on bark near the mine were greater than one hundred million fibers per square centimeter of tree bark surface area. Asbestos concentrations on bark within the town of Libby showed a quarter of a million fibers per square centimeter, and the tree bark sample collected from a ponderosa pine tree located on the railroad line seven miles west of town (note that the vermiculite mine is east of town) showed 5.8 million fibers of asbestos per square centimeter of tree bark surface area. Tree bark samples collected two miles northeast of the mine on United States Forest Service (USFS) road 4872 showed asbestos concentrations ranging from non-detect to 2 million fibers per square centimeter of tree bark surface area (Ward et.al. 2006).

It is more probable than not that a significant quantity of the logs obtained from forests surrounding the mine site and Libby in general and brought into the Lumbermill and LPSM were contaminated with amphibole asbestos (Ward et al. 2006), leading to contamination of the Lumbermill and the LPSM.

34. From the original samples that were collected near the abandoned W.R. Grace Mine in November 2004 (Ward, 2006), concentrations ranged from 14 million asbestos structures/cm2 bark surface area (s/cm2) to 110 million s/cm2. These original results were confirmed by our team in follow-up bark sampling programs throughout the mine site, and through a more comprehensive bark sampling program conducted by Region 8 EPA (EPA 2008c).

35. EPA (2008c) collected samples of bark from trees at least 30 years old were collected at a number of stations located on transects that radiate away from the mine, with special emphasis on the predominant downwind direction (northeast). The EPA bark sampling map is shown in Appendix 1. All tree bark samples were collected from the side of the tree facing toward the mine site, from a height of about 4-5 feet above ground. The tree bark samples were ashed and analyzed for LA by TEM. Results are expressed as LA fibers per cm^2 of tree bark. Although there is moderate spatial variability, there is a general tendency for the highest levels (> 2.5 million fibers per cm^2) to occur within about 2 to 3 miles of the mined area, with a tendency for values to diminish as a function of distance from the mine. Elevated values are noted not only in the downwind direction (north-northeast from the mine), but also along nearly all transects. It is suspected that the majority of the LA in tree bark is attributable to historic releases to air during the time the mine was active, although current and on-going releases may also be contributing (EPA 2008c). The EPA program measured significant amphibole contamination in tree bark near the mine (2.5 to 20 million structures/cm^2), with contamination extending out miles from the mine in all directions (Ward et al., 2012).

36. In 2012, EPA conducted a study to evaluate the extent of LA contained in the duff and trees in the forest surrounding Libby. The results of the study was summarized by EPA

contractors CDM Smith. EPA 2013a. The study concluded that "LA was detected in 23 of 51 tree bark samples with surface loading values of LA ranging from less than .01 to about 3 Ms/cm^2… LA was detected in tree bark as far as 13.8 miles from the mine and there were no apparent spatial trends (i.e., locations in the downwind direction of the mine did not have concentrations that were different from locations in the upwind or cross wind direction)." LA contamination was detected in duff as far as 16.9 miles from the mine. Similar to tree bark, there were no apparent spatial trends in the data (EPA 2013).

The study also evaluated duff on the forest floor and concluded "LA was detected in 20 of 51 duff samples. Duff total LA concentrations ranged from .03 to 25 Ms/g… Similar to tree bark, there were no apparent spatial trends in the data; however, it is notable that three of the four duff samples with the highest concentrations of LA were in the downwind direction from the mine" (EPA 2013a). LA contamination was detected in duff as far as 16.9 miles from the mine. Similar to tree bark, there were no apparent spatial trends in the data" (EPA 2013).

37. CDM Smith produced a draft Site Wide Human Health Risk Assessment for the Libby Superfund site. The report notes, "extensive data on LA levels on the bark surface of trees have been collected in the forested areas near the mine and the forested area near the current NPL boundary for the Site. These data show that LA fibers are present on the outer bark surface of trees at the site. Tree bark surface loading values of LA tend to be highest on trees closest to the mine (within 3-4 miles), but LA was also detected on trees located even 13 miles from the mine. LA has also been detected in other wood related materials, including wood waste piles at Lincoln County landfills and in woodchip/waste bark piles located in OU5. If LA containing trees or wood related materials are disturbed, such as during wood harvesting activities… people may become exposed to LA that is released into the air from the wood." EPA 2014b

38. As described above, historic mining, milling, and processing of vermiculite at the Libby mine site, Operable Unit 3 (OU3), are known to have caused releases of vermiculite and LA to the environment. A range of different human receptors may be exposed to LA in OU3, including:

- Commercial loggers in the forested area – This receptor population includes adult workers who are employed in commercial logging operations in OU3. Exposures of potential concern for asbestos include inhalation of ambient air, inhalation of airborne emissions of LA from roadways and inhalation of air that contains LA released from soil or duff as well as LA fibers released to air by cutting and stacking timber that has LA in the tree bark. Commercial loggers harvesting wood in OU3 may be exposed as a result of release of fibers from soil, duff or tree bark into breathing zone air. EPA has evaluated the hazard to outdoor wood workers as of 2014 and found LA concentrations in the air during bark disturbance activities such as falling trees, hooking, skidding, and processing. The EPA found that LA exposure was an order of magnitude higher with activities that disturbed both bark as well as soil and duff materials than during felling activities. (EPA 2013) The movement of the vehicle along the road may disturb contaminated soil in or along the roadway, potentially leading to inhalation exposure of the vehicle occupants (EPA 2011b).

- Forest service workers in the forested area – This population includes employees of the USFS who may engage in a range of forest management activities, including maintenance of roads and trails, cutting fire breaks, thinning and trimming trees, measuring trees, etc (EPA 2011b) (Hart, 2009).

- Recreational visitors in the forested area – This receptor population includes older children (assumed to be age 7 or older) and adults who engage in activities such as camping, hiking, dirt bike riding, all terrain vehicle (ATV) riding, hunting, etc. Exposures of primary concern for asbestos include inhalation of ambient air, inhalation of air in the vicinity of contaminated soil, duff, or roadways/trails disturbed by recreational activity, and inhalation of LA released from contaminated tree bark while gathering wood for a campfire and while burning the wood in a campfire (EPA 2011b).

- Residential wood harvester in the forested area – This receptor population includes adult area residents who engage in sawing, hauling, and stacking wood for personal use. Exposures of potential concern for asbestos in OU3 include inhalation of ambient air, inhalation of airborne emissions of LA from roadways and inhalation of air that contains LA released from soil or duff as well as LA fibers released to air by cutting and hauling timber that has LA in the tree bark (EPA 2011b) (Hart, 2007).

39. Following the initial discovery of LA contamination in tree bark (Ward et al., 2006), multiple independent studies that have been conducted in an effort to understand the impact of these findings on the Libby community. These studies include assessing the potential for inhalation exposures to the general public that disturb LA-contaminated trees through residential home heating activities (i.e. firewood harvesting and wood stove use) (Hart et al., 2007; Ward et al., 2009), as well as studies designed to evaluate wild land firefighting and other routine occupational tasks conducted by the United States Department of Agriculture Forest Service (Forest Service) in Libby (Hart et al., 2009; Ward, 2012).

40. Hart et.al (2007) demonstrated that amphibole fibers are released from tree reservoirs during firewood harvesting activities in asbestos-contaminated areas and that the potential for asbestos exposure exists during such activities. The firewood harvesting study consisted of three independent simulation trials conducted on Forest Service property in an area of the Kootenai Forest inside the EPA restricted zone with potential exposures primarily assessed via personal breathing zone (PBZ) sampling and surface wipe sampling of the outer layer of Tyvek™ clothing. The majority of the personal breathing zone (PBZ) samples collected during the EPA-restricted zone harvest simulations showed concentrations above analytical sensitivities for transmission electron microscopy (TEM) (21 of 24 samples).

    The mean time weighted average concentration for fibers <5 μm long was 0.15 s/ml, while the mean concentration for fibers >5 μm long was 0.07 s/ml. Even though the PBZ sample from the chainsaw operator's assistant revealed the highest mean total LA concentration (0.40 ± 0.51 s/ml), overall no significant differences were observed in PBZ concentrations between tasks.

    In addition to the airborne exposure potential associated with harvesting amphibole-contaminated trees, there is also a strong potential for clothing contamination and substantial LA concentrations were also revealed on Tyvek clothing wipe samples from each of the investigators. Wipe samples collected from the investigators' chest and thigh revealed asbestos fiber contamination above the AS in 23 of 24 samples. The mean LA concentration (n = 14) was 30,000 s/cm2, with 91% (27,000 s/cm2) composed of fibers <5 μm long.

41. A United States Department of Agriculture (USDA) Forest Service occupational exposure study was conducted during the summer of 2008 to assess the potential for Forest Service employee exposures while working near the abandoned vermiculite mine, but outside of the EPA restricted zone (Hart et al., 2009). Investigators simulated the following four routine

activities: 1) walking through forested areas, 2) conducting tree measurement, 3) constructing a fire line, and 4) performing trail maintenance. In addition to PBZ and Tyvek clothing surface wipe sampling, pre and post vehicle wipes were collected on the rear bumper of the vehicle used to transport investigators and equipment to the research site. Wipe samples were also collected from the chainsaw used in several of the trials post activity.

For individual PBZ samples with LA >5 µm detected, 10 of 24 samples (42%) exceeded the Occupational Safety and Health Administration (OSHA) exposure limit of 0.1 f/ml (assuming an eight hour exposure duration) when analyzed by PCM. These 10 PBZ samples were all collected during the fireline construction simulation activity. When analyzed by TEM (and therefore excluding cellulose fibers from the analyses), 25% of the PBZ samples revealed concentrations greater than the analytical sensitivity (AS). These samples were collected during the fireline construction and tree measurement simulation activities. The mean (n = 4) PBZ sample weighted average concentration for fireline construction activity samples was 0.08 s/ml, while the mean PBZ sample weighted average concentration for tree measurement activity was 0.01 s/ml.

LA was detected on Tyvek clothing wipe samples collected from all of the activities evaluated. Fifty two percent of post activity wipe samples revealed concentrations greater than the detection limit, with mean concentrations (n = 10) of 941 s/cm2. The most elevated wipe concentrations were associated with the fireline construction activity, with a mean (n = 4) of 1,456 s/cm2. Similar to the PBZ samples, the tasks that generated wipe sample concentrations greater than the AS for the fireline construction activity were brush clearing, comby tool operating, and Pulaski tool operating. Other activities that generated LA (as detected by the wipes) were tree measurement activities, trail maintenance (brush clearer and chainsaw operator), and hiking activities.

In addition, the wipe samples collected from the chainsaw bar after each trial (n = 3) revealed amphibole contamination ranging from 896 to 11,825 s/cm2, with 12 of 15 fibers <5 µm long. Clothing and equipment contamination may serve as a secondary source of exposure to forest service personnel. Cross contamination of vehicle cabs, vehicle boxes, equipment storage areas, equipment maintenance areas, and offices may occur as a result of clothing and equipment contamination.

The vehicle wipes collected for one of the roads evaluated near the mine revealed concentrations below the AS, while results from another roadway (Jackson Creek) evaluated measured LA concentrations of 17,917 s/cm2.

42. While the Forest Service occupational exposure assessment provided some guidance into the exposure potential associated with common occupational activities, firefighting or controlled burn activities were not included in this assessment. To address this activity, a small-scale controlled burn was conducted in a (3.7 m X 3.7 m) plot in July 2009 (Ward et al., 2012). The plot location was within the same geographical area where several of the simulated Forest Service tasks were conducted in the occupational assessments described above.

The controlled burn consisted of three activities, including fire line construction, combustion, and mop-up. Sampling was performed independently for each controlled burn activity. In addition to PBZ and Tyvek clothing surface wipe sampling, high volume ambient air sampling was performed during the controlled burn activities. This sampling consisted of four sampling stations positioned 1.2 m from the perimeter of the burn, one station positioned

3.7 m above the burn plot, and one station positioned within the prevailing wind direction. Following the controlled burn, three ash samples were collected from the burn plot.

Nine of 12 (75%) of the PBZ samples revealed concentrations greater than the analytical sensitivity when analyzed by AHERA TEM, with the majority (64%) of structures detected >5 µm. Tyvek clothing wipe samples collected from each investigator showed TEM total LA structure concentrations ranging from ND to 2,500 s/cm2, with the majority (62%) of LA <5 µm.

Sixty-two percent of the high volume ambient air samples revealed LA concentrations greater than the analytical sensitivity when analyzed by AHERA TEM, with LA identified in samples collected during all three activities (fireline construction, combustion, and mop-up). The mean high volume TEM air concentrations for LA <5 µm and > 5µm were 0.01 and 0.01 s/ml, respectively. In terms of fiber counts, 70% of the LA fibers identified in high volume air samples were >5 µm long. Bulk ash LA concentrations collected above mineral soil ranged from 8,294,575 to 18,736,220 s/g, with 61% of LA <5 µm.

43. Results from the above studies suggest that there is an acute airborne exposure potential to LA associated with disturbing contaminated trees and undergrowth such as brush – both through common public and occupational activities. When analyzed by TEM, 100% of the firewood harvesting samples, 25% of the Forest Service occupational assessment samples, and 75% of the controlled burn samples revealed detectable concentrations of LA. PBZ results showed that the majority of the fibers detected were <5 µm in length, which is consistent with the size fractions seen in our bark sample results measured in the areas surrounding the abandoned vermiculite mine. LA concentrations as measured by PBZ sampling were consistently higher in the firewood harvesting simulation samples compared to samples collected during the Forest Service occupational assessment and controlled burn trials. It is unclear whether the firewood harvesting activity is more likely to contribute to inhalation and clothing contamination or whether the higher concentrations observed were due to elevated concentrations of LA in tree bark. Since two of the Forest Service occupational activities evaluated also employed the use of a chainsaw (fireline construction and trail maintenance), this supports the hypothesis that the higher PBZ and wipe concentrations are most likely associated with elevated tree bark (source) concentrations (Ward et al., 2012).

44. EPA (2011a) Warning Re: Gathering of Wood in the Libby Valley.
In 2011, notices by EPA (Victor Ketellapper, 5/5/2011) and the USDA Forest Service [Informed Choices Regarding Libby Amphibole (Asbestos On the Forest)] stated the following:

"Gathering Of Wood In The Libby Valley

To understand the effects of vermiculite mining activity on the surrounding forest area, EPA sampled tree bark and forest ground covering around the Vermiculite Mountain mine. Asbestos fibers were detected in both the tree bark and forest ground covering as far as 8 miles away from the mine. Based on these findings, EPA suggests residents only cut and gather firewood from outside of the Libby valley. Be aware the bark from trees in the Libby valley may contain asbestos fibers." (EPA 2011a).

45. As part of the Phase 2 study, EPA (2001) collected data from personal and stationary air monitors in the immediate vicinity of people actively engaged in disturbing vermiculite insulation. This scenario (referred to as Scenario 3) was intended to assess exposures that

might be experienced either by homeowners who engaged in activities in unfinished attic areas, or for contractors who might come into contact with vermiculite during repair or remodeling activities. The results of personal air samples [transmission electron microscopy TEM (PCME-asb)] showed a mean concentration of 0.309 f/cc with a range of 0.042 – 1.057 f/cc. The results of stationary air samples (TEM (PCME-asb) showed a mean concentration of 0.309 f/cc with a range of 0.023 – 0.789 f/cc.

46. EPA collected data from personal and stationary air monitors in the immediate vicinity of people actively engaged in disturbing vermiculite insulation. This scenario was intended to assess exposures that might be experienced either by homeowners who engaged in activities in unfinished attic areas, or for contractors who might come into contact with vermiculite during repair or remodeling activities. These data demonstrated that active disturbance of vermiculite results in very high concentrations of fibers as measured by both phase-contrast microscopy (PCM) and transmission electron microscopy (TEM) phase-contrast microscopy equivalents (PCME). The highest airborne concentration of 3.3 total asbestos fibers per cubic centimeter (f/cc) by TEM occurred during the simulation with Zonolite Vermiculite. In Phase 2, levels of airborne asbestos fibers were detected during seven simulations conducted in an artificial containment system. Bulk analysis of the Zonolite product indicated that it contained trace amounts of asbestos fibers (PLM: <1% tremolite; TEM: <0.1% tremolite/actinolite). Airborne asbestos fibers were detected in approximately half of the total air samples collected (total from all personal and stationary air samples combined). The maximum airborne concentration of 4.3 total actinolite f/cc by TEM occurred during the first simulation with dry vermiculite (EPA 2003a).

    These findings are consistent with previous studies conducted by W.R. Grace. These "drop tests" demonstrated that fiber concentrations in air resulting from pouring vermiculite insulation onto the floor under controlled conditions can be extremely high even when bulk concentrations in the vermiculite are less than 1% (Grace 1976).

47. 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. It is currently believed that in Libby the most important of these exposure pathways is the inhalation of air in the immediate vicinity of an active soil disturbance that causes a release of LA fibers from soil into the air (ATSDR 2003a).

48. A variety of factors can influence the extent of airborne exposures associated with asbestos fibers in soil, the most important of which appears to be a disturbance of contaminated soil or material by human activity. Even today, after twelve years of soil remediation in Libby "outdoor activities that disturb soil appear to be the greatest source of Libby amphibole exposure." (McKean 2011).

    Other factors which may affect the suspension of asbestos fibers into the air, and thus airborne asbestos exposures, include the environmental conditions, moisture content of the soil, concentration of asbestos in the soil, the type of the soil, and the characteristics of the asbestos present. Nearly all exposure comes from near-surface soils. These soils generate dust and are often actively disturbed. In most circumstances, contamination is also limited to near surface soils. The EPA Action Plan for Libby established a maximum depth of excavation at 12-18 inches based on the depth that typical residential activities may intrude into the soil (EPA 2003c).

49. Workers may be exposed to asbestos in outdoor soil during a variety of different activities that disturb the soil and cause release of fibers from soil into the breathing zone of the person engaged in the soil disturbance activity as well as the breathing zone of workers in the vicinity. When outdoor soil that contains LA is disturbed (e.g., by raking, mowing or digging), fibers are released into the breathing zone of the person who is causing the soil disturbance. The concentration of fibers that are released into the air is highly variable, based on differing types of disturbance activities, but there is a clear trend for levels in air to increase as the levels in soil (as measured by a polarized light microscopy method referred to as PLM-VE) increase. That is, the lowest average levels of LA in air are observed while disturbing soil that is non-detect (ND)(Bin A) by PLM-VE, with increasing average levels for soil that is < 0.2% (Bin B1), between 0.2% and 1% (Bin B2), or > 1% (Bin C) (EPA 2007a). However, from studies of outdoor soil disturbance, it is evident that soils that are ND can release LA fibers into the air (Addison et al 1988).

    The EPA uses PLM-VE to estimate levels of LA in soil in Libby. This is a semi-quantitative method that reports a sample as non detect when the microscopist cannot observe any LA in the sample. However, from the studies of outdoor soil disturbance, it is evident that soils that are non detect can release LA fibers to air. For this reason, the EPA used more powerful electron microscopy methods to estimate the average level of LA in soils that were reported as non detect by PLM-VE. The results were variable between samples, but the average LA concentration was approximately 0.05% by mass.

50. According to the Colorado Department of Public Health And Environment, Hazardous Materials and Waste Management Division (http://www.cdphe.state.co.us/hm/asbestos/111021riskppt.pdf), several studies using a variety of approaches, including the state of the science, for the release of asbestos fibers from significantly <1% asbestos in soil/debris demonstrated that all types of asbestos fibers can be released into the air or breathing zone during soil disturbing activities resulting in unacceptable risk that is significantly above acceptable cancer risk level of 1 in a million at 0.000004 (4X10-6) f/cc (EPA IRIS), and even above the OSHA limit of 0.1 f/cc, in some cases.

51. EPA Region 10 (EPA 2004b) conducted a three phase study at the Spokane vermiculite exfoliation plant to determine if asbestos fibers in the soil at the site could become airborne when the soil was disturbed. Soil samples were taken from several locations within the site boundary and analyzed using polarized light microscopy and X-ray diffraction. Analysis revealed that most of the asbestos in the soil was similar to the amphibole asbestos that occurs in vermiculite from Libby, Montana. In phase two of this study, twelve soil specimens were collected from the site and eleven were agitated inside a laboratory enclosure equipped with air monitoring equipment. Ten of the eleven soil specimens contained asbestos that became airborne when the soil was agitated. Filters used for collection of air samples were analyzed with a transmission electron microscope (TEM) and were found to contain asbestos, with concentrations of asbestos in the air ranging from 0.051 fibers per cubic centimeter (f/cc) to 10.713 f/cc.

During phase three, air samples were collected while performing property maintenance and excavation tasks at two locations on-site. Samples analyzed using TEM showed concentrations of asbestos ranging from 0.010 f/cc to 0.045 f/cc of air. Several asbestos fibers were also detected in filters from stationary air monitors. According to EPA (2004b), this study clearly shows that asbestos in the soil at the former vermiculite exfoliation plant in Spokane can be released into the air when the soil is actively disturbed. Because there is a clear pathway for asbestos to move from contaminated soil to the air, individuals working on the site can be exposed to potentially hazardous levels of airborne asbestos fibers.

52. The best information about the levels of asbestos content in soils likely to cause a health risk comes from the Addison et al (1988) experiments where it was recommended "that soils containing more than 0.001% asbestos are regarded as being capable of generating airborne fibre concentrations in excess of 0.1 f ml-1 (the OSHA workplace standard) and that precautions to protect the workforce by wetting the soil, providing respiratory protection etc., are taken". Addison (1995) stated:

> It would be necessary therefore to take action specifically to control for the asbestos emissions if soils containing higher levels than 0.001% asbestos were to be handled without significant health risks. Asbestos, if present in vermiculite, is likely to behave in a similar fashion; with the asbestos loosely dispersed and readily available for release into the air. Even relatively gentle handling of the vermiculite would abrade the friable asbestos, splitting fiber bundles, and adding to the released fibers. Thus, even though the carcinogens legislation may impose only a 0.1% limit for packaging and labeling, the vermiculite industries would be advised to establish their own target limit of 0.001% for amphibole asbestos. Most current supplies of vermiculite could still meet this standard (Addison, 1995).

53. Addison et al. (1988) conducted experiments to evaluate the release of dispersed asbestos fibers from soils. Addison et al. (1988) showed that the most important factor controlling airborne fiber concentrations in the experiments with dry loose aggregate mixtures was the bulk asbestos content and that, irrespective of fiber type or soil type, high airborne fiber concentrations over 200 times the current OSHA Permissible Exposure Limit (PEL) for asbestos can be generated from soil containing just 1% asbestos. Addison also showed that soil with concentrations of 0.1%, or 1/10 the EPA action level, were capable of producing airborne asbestos levels in excess of 8 times the current OSHA PEL for asbestos.

54. Addison (1988) also reported,

> There was a progressive reduction in airborne fibre concentrations at a given dust concentration with reducing amounts of asbestos in the mixtures, but this reduction was not proportionate to the reduction in asbestos content below 0.1%. With 0.1%, and often 0.01%, of asbestos in soils, the 0.5 f/ml-1 Control Limit for chrysotile and the 0.2 f/ml-1 Control Limit for crocidolite and amosite could be exceeded while respirable dust concentrations were below 5 mg/m-3, the nuisance dust OEL. Similarly, it is apparent that the clearance limit of 0.01 f/ml-1 could be exceeded with any of the 0.01% and 0.001% asbestos mixtures if respirable dust concentrations approached the nuisance dust OEL.

See tables of results from Addison (1988).

55. A 1982 EPA study reported that approximately 21 to 26% of the unprocessed ore and 0.3 to 7% (by weight) of the concentrated vermiculite was asbestos, while a 1984 WR Grace study reported 3.5 to 6.4% of the unprocessed ore and 0.4 to 1% (by weight) of the concentrated vermiculite was asbestos (ATSDR 2001).

56. For chrysotile asbestos, it is thought by some authors that 25 fiber per cubic centimeter years (f/cc years) of exposure is necessary to cause asbestosis. For amphiboles in general and Libby amphiboles in particular, the threshold exposure may be 2 f/cc years or less (Rohs et. al. 2007). *See also* Sluis-Cremer et al. (1990), page 440, "Table 5 showing that even when exposed to an average fiber concentration of 2 f ml^{-1} or less, very significant proportions of the men have developed asbestosis." McDonald et al. (2004) reported overall proportional mortality from mesothelioma in a cohort of vermiculite miners exposed to fibrous amphibole in Libby, Montana, similar to that for crocidolite miners in South Africa and in Australia, and over 10 times higher than that in Quebec chrysotile miners.

57. In December 2014, the EPA released the toxicity assessment for Libby amphibole asbestos, setting forth a reference concentration for LA of 0.00009 fibers per cubic centimeter (fiber/cc). *IRIS Summary*, I.B.1 The reference concentration sets forth what the EPA determines to be an estimate of a daily exposure over a lifetime that is likely to not cause appreciable risk of adverse health effects. *Id.* at I.B. The assessment recognizes the abnormally toxic nature of the Libby amphibole by noting that workers exposed to LA had a 10-fold increase risk of parenchymal disease and up to a 3-fold increase of any other nonmalignant respiratory disease over the general population. *Id.* at I.B.2. Additionally, the reference concentration is considerably lower than OSHA permissible exposure limit of 1 fiber per cubic centimeter for 30 minutes or less per day and 0.1 fibers per cubic centimeter over an eight hour period per day. (29 C.F.R. 1910.1001(c))

The reference concentration and inhalation unit risk from the toxicity assessment are unique in the sense that for the first time the risk for asbestos has been evaluated for a 24 hour period. Typically, regulatory standards have been based on occupational exposure over the course of a work day. Because of the consistent and various exposure pathways in Lincoln County, the EPA necessitated a number that reflected the unique situation. The number derived from the EPA for Libby exposure is 1,000 times lower than the OSHA standard for a 8 hour work day, or 333 times lower for a 24 hour day by converting the OSHA standard. This demonstrates the increased risk of multiple exposure pathways and chronic exposure. (EPA 2014)

58. Another important issue pertaining to the toxicity of asbestos is fiber morphology. For the purposes of counting asbestos fibers in air samples, regulatory agencies commonly count particles that have lengths ≥5 micrometers (μm) and length to width ratios ≥3:1 as fibers. For detecting asbestos fibers in air samples, particles with length to width ratios ≥5:1 are counted by EPA as fibers. The current occupational exposure limit for asbestos is 0.1 f/cc (8-hour time weighted average) for fibers ≥ 5 μm in length, with an aspect ratio (length:width) ≥ 3:1 (OSHA 1994; ACGIH 2001).

The current standard method for determining airborne asbestos particles in the U.S. workplace is the National Institute for Occupational Safety and Health (NIOSH) Method 7400 which uses phase contrast light microscopy (PCM) (NIOSH 1994a, 1994b). Fibers are collected on a filter and counted with 400-450x magnification. The method does not accurately distinguish between asbestos and non-asbestos fibers, and cannot detect fibers thinner than about 0.25 μm.

Polarized light microscopy is frequently used for determining the asbestos content of bulk samples of insulation or other building materials (*see e.g.* NIOSH Method 9002 (NIOSH 1989) and OSHA method ID-191 (OSHA, 1994)). This method enables qualitative identification of asbestos types using morphology, color, and refractive index.

Transmission electron microscopy (TEM) and scanning electron microscopy (SEM) methods can detect smaller fibers than PCM and can be used to determine mineral habit in bulk materials that may become airborne. NIOSH Method 7402, Asbestos by TEM, is used to determine asbestos fibers in the optically visible range and is intended to complement PCM (NIOSH Method 7400). However, NIOSH Method 7402 still counts fibers ≥ 5 μm in length.

In addition to the occupational exposure limits specifying mineral species, counting rules for asbestos apply when comparing air concentrations to occupational exposure limits. Fibers equal to or longer than 5 μm with a length-to-width ratio (aspect ratio) (AR) of 3:1 or greater are counted (ACGIH, 2001; CDC, 2010; OSHA, 1994b). This counting rule has been questioned by epidemiologists and others in the environmental health community (Dodson et al., 2003; Stayner et al., 2008).

Stayner et al. (2008) emphasized that the counting rule was based largely on accuracy and reproducibility limitations associated with phase contrast microscopy (PCM) counting versus a toxicological basis. Libby amphibole studies which revealed similar inflammatory potencies in respirable size fractioned and non-size fractioned LA strengthen this discussion (Duncan et al., 2010).

A common toxicological justification for the counting rule is that short fibers are cleared more readily from the lungs (Dodson et al., 2003) and that longer fibers impair the phagocytic process (Stanton et al., 1981). Longer fibers have a greater potential than short fibers to generate an inflammatory response and stimulate a release of Il-1B from macrophages (Kane, 1992; Donaldson et al., 2010, Palomaki et al., 2011). However, as in any toxicological assessment, the dose and dosing frequency are critical factors to consider in the long versus short fiber toxicity discussion (Kane et al., 1992; Castranova et al., 2000; and Dodson et al., 2003).

In the Dodson et al. (2003) review of fiber length and pathogenicity, the conclusions drawn from Castranova et al. (2000), of "constant infusions of short fibers and a resultant eventual dust overload, can greatly compromise clearance" was cited as the main reason to underscore the short fiber clearance reasoning. A similar hypothesis regarding particle overload and the potential for short crocidolite asbestos fibers to generate substantial inflammatory responses was discussed by Kane (1992). Dodson et al. (2003) further emphasized that when appropriate techniques are used to analyze asbestos fiber tissue burden, in most tissues, a substantial majority of asbestos fibers are less than 5 μm in length. These observations may be due to increased deposition of shorter fibers and/or breaking of longer fibers over time.

Additional counting rules other than those specified by OSHA are used for ambient and indoor asbestos monitoring to provide more detailed quantification of asbestos structures. Two that have been used in studies assessing exposure to LA are the Asbestos Hazard

Emergency Response Act (AHERA) and International Standards Organization 10312 methods (AHERA, 1987; ISO, 1995). The AHERA method was derived for clearance sampling in school buildings following asbestos abatement. Under the AHERA method, an asbestos fiber is defined as a structure greater than or equivalent to 0.5 µm in length and a diameter > 0.002 µm with an AR of 5:1 or greater. Fibers are classified as 0.5 – 5 µm and > 5 µm in length (AHERA, 1987). The ISO 10312 method applies the same minimum length and diameter criteria as AHERA, however, 3:1 or 5:1 AR may be used. From an ISO 10312 analysis, several different airborne asbestos structure concentration values based on a number of fiber size classifications may be obtained (ISO, 1995).

Analytical techniques that count only fibers greater than 5 µm may substantially under-report inhalation exposures. Fiber lengths reported for LA range from less than 1 µm to greater than 20 µm with thicknesses ranging from 0.1 to 1 µm. If PCM counting rules are applied to LA, only one third of the fibers observed would be counted (EPA 2001a). Because the health effects associated with asbestos are not confined to fibers in the regulatory size fraction of greater than 5 µm, it is important to thoroughly characterize the fiber concentration and morphology and not limit this characterization to a counting rule that exists primarily because of an analytical method limitation.

59. Hart et. al. (2007) reported that 69% of asbestos fibers collected in the Libby area were < 5 µm in length. This is consistent with ambient air sampling trends reported for Libby, using AHERA TEM analysis, of 65% of the airborne fibers collected at Libby being < 5 µm in length (ATSDR, 2003b). In addition, fiber dimension analysis of bark samples reported by Ward et al. (2006) showed the majority of the asbestos fibers detected were < 5 µm in length.

60. Consequently, the current regulatory methods of counting fibers based on fiber length and aspect ratio may not adequately describe the risk of asbestos-related health effects in that the concentration of fibers < 5 µm may contribute to health risks. Fiber size, shape and composition contribute collectively to health risks in ways that are currently being evaluated (ATSDR, 2003b). The likelihood that Libby amphibole fiber toxicity is confined strictly to fibers in this regulatory size fraction is neither toxicologically sound nor supported by the available health data from Libby (EPA, 2001). A study by Suzuki (2005) concluded that "contrary to the Stanton hypothesis, short, thin asbestos fibers appear to contribute to the causation of human malignant mesothelioma. Such fibers were the predominant fiber type detected in lung and mesothelial tissues from human mesothelioma patients. These findings suggest that it is not prudent to take the position that short asbestos fibers convey little risk of disease." Animal and *in vitro* studies also suggest that fibers < 5 µm may also play a role in fibrosis, particularly under conditions of overload. Intense exposures may result in overload, limiting clearance of small fibers (Sullivan, 2007; ATSDR, 2003b). Data presented by Dodson et. al. (2003) argue that asbestos fibers of all lengths induce pathological responses and that caution should be exerted when an attempt is made to exclude any population of inhaled fibers, based on their length, from being contributors to the potential for development of asbestos-related diseases.

61. The amphibole minerals within the Rainy Creek Complex (RCC) near Libby, MT, have been referred to under a variety of names. They were initially classified as tremolite, tremolite/actinolite, or soda-rich tremolite by early geologists (Pardee and Larsen, 1929; Bassette, 1959; Boettcher, 1963), with Larsen (1942) and Deer et al., (1963), further characterizing the amphibole mineral as richterite. Langer et al. (1991) and Nolan et al.

(1991) classified the RCC amphibole as tremolite and richterite, while Wylie and Verkouteren (2000) and Gunter et al. (2003) identified the RCC amphiboles as primarily winchite (once considered a subset of richterite). Wylie and Verkouteren (2000) further postulated that the amphibole composition may range from winchite to richterite.

An extensive systemic evaluation of the RCC amphibole minerals was conducted by Meeker et al. (2003) which included 30 sample locations from the former mine area. Analytical techniques to characterize the composition, mineralogy, and morphology of both fibrous and non-fibrous components of RCC amphiboles included X-ray diffraction (XRD), electron probe microanalysis (EPMA) using wavelength dispersive spectroscopy (WDS), and scanning electron microscopy combined with energy dispersive X-ray analysis (SEM/EDS), respectively. Amphiboles were classified based on the Leake et al. (1997) system which is based on site assignments for each cation in the structure, including the oxidation state of iron. Meeker et al. (2003) approximated the respirable fraction of RCC amphiboles as winchite (84%), richterite (11%) and tremolite (6%), with possible magnesioriebecktite, edenite, and magnesio-arfvedsonite components. Meeker et al. (2003) further reported that the Vermiculite Mountain amphibole minerals displayed a range of morphologies from prismatic to asbestiform, with fibril diameters ranging from 0.1 to 1 μm.

The discrepancy in the RCC amphibole mineral classification may be due to several factors. These include: (1) amphiboles were viewed as a secondary mineral by early geologists and received little attention (Bandli and Gunter, 2006); (2) there have been modifications in the International Mineralogical Association (IMA) classification systems (Wylie and Verkouteren, 2000); (3) naming of amphibole species is complex because of the variations in chemistry and the substitutions that occur in this mineral group (Gunter et al. 2003); (4) the optical properties of winchite from the RCC are very similar to tremolite (Bandli and Gunter, 2006); and (5) many techniques and methods available for analysis and classification of asbestos are not capable of adequately identifying or distinguishing these minerals according to current IMA guidelines (Meeker et al., 2003).

Environmental data for Libby collected prior to 2007 and analyzed by TEM were limited in their ability to quantify winchite and richterite, which most likely resulted in under-reporting of LA concentrations. In his 2003 paper, Meeker stated "…none of the present regulatory analytical methods (with the possible exception of well-calibrated SEM/EDS analysis using calibrated standards similar to EPMA/WDS) can accurately differentiate the amphiboles present in the asbestiform material from Vermiculite Mountain" (Meeker et al. 2003). These analytical methods were presumably not used during site characterization of the Libby Asbestos Site.

An example of the failure to recognize and count the previously non-regulated components of LA, winchite and richterite is found in the sampling done at the Lumbermill at the request of Stimson and Liberty Northwest Insurance. *See* Prezant/Liberty Northwest bulk sample analysis of vermiculite containing materials found in the Stimson Plywood plant. This September 2004, sample analysis clearly demonstrates that laboratories were failing to recognize the non-regulated amphibole components of LA as asbestos. Two of these samples from the plywood plant, one of which was 85% richterite including fibrous richterite and another which was 60% winchite were reported as containing no asbestos. This problem appears to have been common with sampling of LA using TEM performed at and before the time of this analysis. Failing to identify and count the winchite and richterite components of

LA is a serious issue, considering that they make up approximately 94% of the respirable fraction of LA.

62. Once asbestos fibers enter the environment from either a natural or artificial source, they tend to settle out of the air or water and deposit in soil and sediment (EPA, 1977; EPA, 1979). Asbestos fibers can be re-suspended into the air or water following soil and sediment disturbances. The rate at which asbestos particles settle out of the air or water depends on their size (ATSDR, 2001; EPA, 1979). Jaenicke (1979) reported that the residence time for a particle to remain airborne is greatest for particles ranging from 0.1-1 μm in diameter. Fibers in this size range could be transported long distances in air.

"The fate and transport of asbestos containing fibers is dependent on the type of host media (soil, water, air, etc.), land use, and site characteristics. Asbestos fibers (both serpentine and amphibole) are indefinitely persistent in the environment. According to the Agency for Toxic Substances and Disease Registry (ATSDR):

"Asbestos fibers are nonvolatile and insoluble, so their natural tendency is to settle out of air and water, and deposit in soil or sediment" (EPA 1977, 1979c). However, some fibers are sufficiently small that they can remain in suspension in both air and water and be transported long distances. For example, fibers with aerodynamic diameters of 0.1–1 μm can be carried thousands of kilometers in air (Jaenicke 1980), and transport of fibers over 75 miles has been reported in the water of Lake Superior (EPA 1979c)." In addition, "they are resistant to heat, fire, and chemical and biological degradation"(ATSDR, 2001).

The primary transport mechanisms for asbestos and asbestos containing material include:

- Suspension in air and transport via dispersion
- Suspension in water and transport downstream

Asbestos can become suspended in air when asbestos or asbestos containing material is disturbed. Wind, recreational activities, construction, and site work can disturb material outdoors.

Asbestos residence time in the air is determined primarily by particulate thickness; however it is influenced by other factors such as length and static charge. The average thickness of LA particles is 0.4 μm and ranges from approximately 0.1 to 1.0 μm. The suspension of LA in air is measured in "half times" which is the amount of time it will take 50% of LA particles to settle out of the air column. A particle with a thickness of 0.5 μm has a half time of approximately two hours, assuming the source of disturbance has been removed (CDM, 2009).

Larger particles will settle faster; a particle of 1 μm has a half time of about 30 minutes. Smaller LA particles may stay suspended for significantly longer. The typical half time for a 0.15 particle is close to 40 hours (CDM, 2009).

Activity-specific testing found that the half-time of LA suspended by dropping vermiculite on the ground was about 30 minutes. LA suspended from disturbing vermiculite insulation settled within approximately 24 hours (CDM, 2009). Once suspended, LA moves by dispersion through air. LA concentration will be highest near the source and will decrease with increasing distance. In outdoor air, wind speed will determine direction and velocity of LA particle transport. Wind can cause the rapid dispersal of LA from the source of release." (EPA 2008b)

Asbestos fibers in the air are known to travel long distances from their source or point of origin and the Environmental Protection Agency (EPA) states that, "During the time that the [asbestos] fiber remains airborne, it is able to move laterally with air currents and contaminate spaces distant from the point of release." Significant levels of contamination have been documented hundreds of meters from a point source of asbestos fibers, and fibers also move across contamination barrier systems with the passage of workers during removal of material.

The theoretical times needed for such [respirable] fibers to settle from a 3 meter (9 ft) ceiling are 4, 20 and 80 hours in still air. Turbulence will prolong the settling and also cause re-entrainment of fallen fibers" (EPA 1978b).

63. Because of their shape and small size, asbestos fibers, particularly those of respirable dimensions, remain airborne for hours once they are introduced into the air. Once they are airborne the asbestos fibers will drift long distances from their source. Movement and air turbulence causes fibers that have settled out of the air to be reintroduced (re-entrained) into the air and to drift long distances from their source. In addition, the human traffic on a worksite can also be expected to disburse asbestos throughout the entire work area. For this reason, asbestos fibers do not respect work areas or job classifications. It has been repeatedly demonstrated that a source of asbestos emission in the air puts everyone in the general vicinity (bystander exposure) at risk. Because of the microscopic size of asbestos fibers, and their aerodynamic properties, typical housekeeping activities such as sweeping tend not to remove that asbestos from the plant. Rather, such activities have the effect of stirring up and re-entraining the asbestos that is in the location, ensuring that it is available for inhalation by workers in the vicinity.

64. Environmental contamination from asbestos-containing materials can occur not only during construction and demolition, but also throughout the life of the structure (EPA 1978). It has been known since 1930 that bystanders are at risk of significant asbestos exposure. That is, people who do not themselves work directly with asbestos materials are at risk of significant exposure caused by others who are working with asbestos materials. For this reason, it was recommended in the 1930's that dusty processes involving asbestos be isolated from other work areas to avoid exposing people whose presence is not necessary in the dustier operations, or to perform the dustier operations with asbestos at times when there is a minimum number of other workers present. *See e.g.*, Hoffman, 1918; Oliver, 1927; Merewether, 1930; Merewether, 1933; Page, 1937; and Ellman, 1933 (dog kept in factory to catch rats dies of asbestosis);

48. The EPA generally considers soil containing Libby asbestos at levels equal to or greater than 1% to be a health hazard requiring remediation. Depending on site-specific exposure scenarios, remediation or other measures may also be appropriate to prevent exposure to soils containing less than 1% Libby asbestos (Anderson et.al. 2005, page 5). Federal standards regulate materials that contain more than 1% asbestos (EPA 1987 and EPA 2003c); therefore, the 1% level has been used as an action level for soil remediation activities at a number of

sites. It is important to note that this 1% standard is not derived from a risk assessment or any other type of health-based analysis; therefore, it does not ensure that airborne asbestos fibers re-suspended by disturbing these soils will be below levels protective of human health. In fact, recent activity-based studies have shown that disturbing soil containing less than 1% Libby asbestos can resuspend fibers and generate airborne concentrations at or near the Occupational Safety and health Administration (OSHA) permissible exposure limit (EPA 2001 and EPA 2004a). This 1% standard has been widely criticized and there is no scientific basis to infer that the 1% standard protects human health.

65. The Occupational Safety and health Administration (OSHA) has established an 8-hour time-weighted average (TWA) Permissible Exposure Limit for asbestos of 0.1 f/cc. OSHA's risk assessment also showed that reducing exposure to 0.1 f/ cc would further reduce, but not eliminate, significant risk. The excess cancer risk at that level would be reduced to a lifetime risk of 3.4 per 1,000 workers (OSHA, 1994c). EPA found a number of personal air samples collected from residential or commercial locations (mainly those associated with active disturbance of vermiculite) exceed one or both of these standards. In relation to these findings, EPA stated:

> It is important to recognize that occupational exposure standards for asbestos are not generally applicable or protective for residents or workers in non-asbestos environments because occupational standards are intended to protect individuals who (a) are fully aware of the hazards of the occupational environment; (b) have specific training and access to protective equipment such as respirators and/or protective clothing; and (c) participate in medical monitoring (USEPA 1995). None of these conditions apply to residents or to workers at typical commercial establishments. Thus, simple compliance with the OSHA standards is not evidence that exposure levels are acceptable in a home or a non-asbestos workplace. Indeed, risks to residents or workers occur at exposure levels substantially below the OSHA workplace standards. (EPA 2001).

66. The National Institute for Occupational Safety and Health (NIOSH) has stated that "any vermiculite that originated from the mine near Libby, Montana should be regarded as potentially contaminated with asbestos." As with any asbestos-containing or asbestos-contaminated material, the only way to know the amount of asbestos present is to have the material tested. Bulk sampling is reliable only when over 1% of the material is asbestos. Negative results from bulk samples can therefore be falsely reassuring when less than 1% of the sample is asbestos, as disturbing contaminated vermiculite with less than 1% asbestos can result in hazardous concentrations of airborne asbestos fibers.

NIOSH IH guidelines regarding vermiculite recommend workers consult Occupational Safety and Health Administration (OSHA) asbestos standards for general industry and construction (29 CFR 1910.1001 and 1926.1101) when work will involve vermiculite that is known or presumed to be contaminated with asbestos. If the vermiculite is known or presumed to be contaminated with asbestos, NIOSH recommends the following general industrial hygiene guidelines for limiting asbestos exposure:

- Avoid handling or disturbing loose vermiculite
- Isolate work areas with temporary barriers or enclosures to avoid spreading fibers
- Use wet methods, if feasible, to reduce exposure

- Never use compressed air for cleaning
- Avoid dry sweeping, shoveling, or other dry clean-up methods
- Use disposable protective clothing or clothing that is left in the workplace. Do not launder work clothing with family clothing
- Use proper respiratory protection.
- Dispose of waste and debris contaminated with asbestos in leak-tight containers in accordance with OSHA and EPA standards" (DHHS (NIOSH) Publication Number 2003-141, May 2003).

67. Asbestos may be released to indoor or outdoor air as a result of the disturbance of asbestos-containing/asbestos contaminated materials. An exposure pathway consists of five elements:

    i. a source of contamination,
    ii. a transport mechanism,
    iii. a point of exposure,
    iv. a route of exposure, and
    v. a receptor population (that is, the people who actually come into contact with the substance).

    All five of these elements must be present for an exposure to a contaminant such as asbestos to occur.

68. Any asbestos contamination on clothing or boots provided a secondary take home exposure pathway to asbestos. As early as 1949, reports of asbestos disease among housewives exposed to dust brought home on their husband's work clothes appeared in the medical literature (Wyers, 1949). The studies by Newhouse and Thompson, Wagner et al., and Dr. Selikoff in the 1960's further documented asbestos disease among family members exposed to asbestos dust carried home on clothing.

    Studies investigating secondary exposures from work clothing contaminated with asbestos (Hatfield and Longo, April 1999) concluded (1) the shaking of typical work clothes that are contaminated from the use of asbestos will cause amosite fibers to be released into the breathing zone of the individual who is performing this work resulting in a significant exposure to airborne amosite fibers, and (2) also caused the surfaces in the area to become contaminated with amosite fibers (as measured by the passive dust samplers) providing another potential source of exposure through re-entrainment from such activities as sweeping, vacuuming or other cleaning projects.

    In another study (Sawyer, 1977), a laundry operation was examined because of its relevance to household exposures in cases of malignancies in families of asbestos workers. Airborne asbestos concentrations during general laundry activities showed a mean of 0.4 f/cc and a maximum of 1.2 f/cc.

    Exposure to indoor dust that is contaminated with asbestos is a potentially important exposure pathway for residents. This is because most people spend a large fraction of time indoors, and a wide variety of routine and indoor activities may cause the asbestos in dust to become suspended in air where it can be inhaled into the lung. One potential source of asbestos contamination in indoor dust is asbestos in outdoor soil (EPA 2007a). EPA typically assumes that about 70% of indoor dust is derived by transport of outdoor soil inside the home, although this may vary from site to site. At Libby, the potential role of outdoor soil as a source of LA in indoor dust is supported by an analysis of available soil and dust data which suggests that the presence of detectable levels of LA in outdoor soil is correlated with an increased detection frequency and average level of LA in indoor dust (EPA 2007b).

69. Dr. Spear is expected to testify that Defendants owed the above duties of care and breached the duties of care owed specifically by Defendants in this case to the Plaintiffs.

70. Dr. Spear is expected to rely on the following documents for his opinions

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