Health Consultation

W.R. GRACE NEWARK PLANT
NEWARK, CALIFORNIA

EPA FACILITY ID: CAD981389653

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
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Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

HEALTH CONSULTATION

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Prepared by:

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

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Foreword

ATSDR National Asbestos Exposure Review

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

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

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

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

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

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

- or -

- The site was an exfoliation facility that processed more than 100,000 tons of vermiculite ore from the Libby mine according to EPA's database of W.R. Grace Libby invoices. ATSDR expects that exfoliation, a processing method in which ore is heated and "popped," releases more asbestos than other processing methods.

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

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

Site Background

From 1966 until 1993, the W. R. Grace & Company plant in Newark, California, located at 6851 Smith Avenue, processed approximately 300,000 tons of vermiculite from the Zonolite mine in Libby, Montana [1]. At one time the plant employed about 18 to 24 persons, including 10 local residents (unpublished information from EPA's database of W.R. Grace documents)[a]. Over time, it became known that the vermiculite from the Libby mine was contaminated with naturally occurring asbestos fibers. Vermiculite from Libby was found to contain several types of asbestos fibers including the amphibole asbestos varieties tremolite and actinolite and the related fibrous asbestiform minerals winchite, richterite, and ferro-edenite [1]. In this report we will use the term **Libby asbestos** to refer to the characteristic composition of asbestos contaminating the Libby vermiculite. The Newark plant produced typical vermiculite-based products such as vermiculite concentrate, gypsum, perlite, and peat moss (unpublished information from EPA's database of W.R. Grace documents)[b].

The plant is now owned by a building supply company, and vermiculite is no longer processed at the site. The facility is on the southeast edge of San Francisco Bay, approximately 30 miles south of San Francisco. The site is in an area of mixed commercial, industrial, and residential use. Residential housing is on the west side of Smith Avenue. Industrial properties are across Smith Avenue, east of the site. A railroad spur on the west of the site connects to the Union Pacific Railroad, which is approximately ⅛-mile south of the site [1]. Exfoliation operations at the plant ceased in 1993, and the plant was sold to the present owners in 1997 [1].

Site Demographic Information

1990 US census data indicate that approximately 10,000 people lived within one mile of the site. Demographic information is included in a map of the site (see Appendix A, Figure 1). 1990 US census data also indicate that the majority of homes in the surrounding census tracts were built either before or during the time that the plant was processing vermiculite (see Appendix A, Figure 2).

Site Environmental Data

On February 21, 2001, EPA representatives conducted a facility tour, interviewed current employees, and collected samples of soil, dust, and air at the site [1]. They observed vermiculite in the soil along the rail spur, particularly near the place where the conveyor system was located and along the west wall of the production building. They also noted a sprayed-on fireproofing material which was suspected to contain asbestos in the attic above the sales office and in the ceilings of the building used as a sales office.

EPA representatives selected 13 soil sample locations on the site, and 10 composite and 4 grab samples were collected from these locations. Soil samples were processed in accordance with

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a Unpublished data from an EPA database of W.R. Grace invoices for shipments of vermiculite from the Libby mine from 1964 to 1990.

b Unpublished data from a database of W.R. Grace documents that EPA Region 8 obtained through legal means during the Libby mine investigation. This document database contains confidential business information as well as private information that is not available to the public.

soil sample procedure ISSI-Libby-01 [1]. Samples were analyzed by polarized light microscopy (PLM) according to method 9002 of the National Institute for Occupational Safety and Health (NIOSH). Sample results reported as tremolite-actinolite indicate the presence of Libby asbestos. Results of the analysis of the samples are shown in Table 1, Appendix B. Eight of the soil samples contained detectible levels of tremolite-actinolite and/or chrysotile asbestos. Samples of vermiculite products found on the site were also sampled and analyzed using NIOSH method 9002. Results of this analysis are shown in Table 2 of Appendix B. Three soil samples and three vermiculite product samples contained between 2% to 4% tremolite-actinolite. Material from the attic of the sales office contained 15% chrysotile.

EPA contractors sampled dust from four horizontal areas inside buildings that had formerly been used for processing or storing vermiculite. Approximately 100 square centimeters per area were sampled by microvacuum dust sampling, a technique that samples settled dust and fibers by drawing air through a 0.45-micrometer pore-size, mixed cellulose esterase filter at a flow rate of 2.0 liter per minute. Sampling was performed for 2 minutes at each location. Air was pulled through the cassettes by battery-powered sampling pumps. Locations sampled included dusty areas such as window sills and the tops of equipment cabinets. Samples were analyzed using method 10312 of the International Standards Organization (ISO). This method uses transmission electron microscopy (TEM) to determine the type of asbestos fibers present, as well as the lengths, widths, and aspect ratios of asbestos structures. Results of the analysis of the dust samples are shown in Table 3, Appendix B. Tremolite-actinolite indicates the presence of Libby asbestos. All four of the microvacuum samples were found to contain asbestos structures. The largest amount of asbestos in dust found at the site came from the machine shop. Sixty-nine tremolite-actinolite structures (1,761,143 asbestos structures per square centimeter (s/cm^2) and 2 chrysotile structures (51,408 s/cm^2) were detected in the machine shop dust sample.[c]

Indoor air samples were collected by drawing air through a mixed cellulose esterase filter (0.45 micrometer pore size) over a 7- to 8-hour period. Samples were collected at a height of 5 feet above the floor. Air was pulled through the cassettes by electric sampling pumps. Five air samples were collected in the building in which vermiculite had been processed. Samples were analyzed by ISO method 10312. Results of air sampling are shown in Appendix B, Table 4. Sample results reported as tremolite-actinolite indicate the presence of Libby asbestos. Tremolite-actinolite asbestos fibers were detected in air samples from the warehouse and from the office area in the warehouse at concentration of 0.0019 asbestos structures per cubic centimeter (s/cc), and 0.0046 s/cc, respectively. Airborne chrysotile fibers were detected in the sales office building and in the office area of the warehouse at concentrations of 0.0018 s/cc and 0.0104 s/cc, respectively.

EPA representatives had noted materials that appeared to contain vermiculite in the ceilings of the sales office building and inside the west wall of the production building. This material could also be a source of the chrysotile fibers detected in the air samples. The operations manager at the site told EPA that when the property was purchased by the present owner (Steeler, Incorporated, Drywall Construction Supply), the only W.R. Grace equipment that was left on the site were two air compressors, a couple of air conditioning units, a couple of fork lifts, a sweeper machine, and some hand scales. The manager also said that the company fabricates and

[c] See Appendix B for conversions of TEM results to s/cm.[2]

distributes steel products for the construction industry and does not use vermiculite. Other employees reported that a brick dumpster with asbestos warning signs was on the site and said that when the yard dust got really bad in the summer, many of them complained often about sore throats, coughing, and difficulty breathing.

ATSDR Site Visit

On August 12, 2003, staff members from ATSDR and the California Department of Health Services Environmental Health Investigations Branch (EHIB) visited the Newark site. ATSDR and EHIB staff reported observations similar to those noted by EPA's contractors. There are two permanent structures are on the site, a sales office building at the southeast corner and a large production building on the southwestern edge of the site. Both buildings are steel-framed structures with roofs and siding of corrugated sheet metal. The entrance and the southeastern portion of the site (up to the production building) are paved. Unpaved areas are located along the northern portion of the site and along a railroad spur that runs north-to-south along the western portion of the site. Although the spur is not used now, employees mentioned that it might be used in the future. The railroad spur originates from the Union Pacific railroad tracks approximately ⅛ mile south of the site.

Remnants of a former conveyor system are located on the rail spur near the production building. The current owner's representatives stated that the conveyor system was removed after acquisition of the site. Footprints of 4 silos were evident on a concrete pad near the main building. Near the concrete pad was a sign reading "Vermiculite Concentrate." There was no evidence of any other vermiculite processing equipment at the site.

No evidence of vermiculite, exfoliated vermiculite, or vermiculite waste materials in bulk quantities was observed at the site. Vermiculite flakes were observed in the soil along the railroad spur. According to the site owner's representative, Union Pacific sprayed an encapsulant over the soil in this area to temporarily control the potential release of asbestos fibers until the ownership of the spur could be determined and the required soil removal completed.

An inspection of the area surrounding the facility confirmed the census data that indicated that residential housing existed in an area northeast of the site during the time vermiculite was processed on the site. The houses appeared to have been built in the 1950s or 1960s.

Discussion

The vermiculite processed at this site originated from the mine in Libby, Montana, now known to be contaminated with asbestos. Studies conducted in the Libby community indicate health impacts that are associated with exposure to asbestos [2,3]. The findings at Libby provided the impetus for investigating this site, as well as other sites across the nation that received asbestos-contaminated vermiculite from the Libby mine. It is important to recognize, however, that the asbestos exposures documented in the Libby community are in many ways unique and will not collectively be present at other sites that processed or handled Libby vermiculite. The site investigation at the Newark plant is part of a national effort to identify and evaluate potential exposure to asbestos at these other sites.

Exposure Assessment and Toxicologic Evaluation

Evaluating the health effects of exposure to Libby asbestos requires extensive knowledge of both exposure pathways and toxicity data. The toxicologic information about asbestos that is currently available is limited, and the exact level of health concern for exposure to different sizes and types of asbestos remains controversial. In addition, information is limited or unavailable on some specific exposure pathways at this site for the following reasons.

- Information is limited concerning past concentrations of Libby asbestos in air in and around the plant. In addition, significant uncertainties and conflicts exist concerning the methods used to analyze asbestos. This makes it hard to estimate the levels of Libby asbestos to which people may have been exposed.
- Most exposure occurred long ago. Little information is available about how people who did not work at the plant came into contact with Libby asbestos and how long they were exposed. This information is necessary to estimate quantitative exposure doses.
- We do not know how some vermiculite materials, such as waste rock, were handled or disposed of. Not knowing whether this material was made available for people in the community to use makes it difficult to identify and assess both past and present potential exposures.

Given these difficulties, the public health implications of past operations at this site are evaluated qualitatively. Current health implications are likewise evaluated qualitatively. The following sections describe the various types of evidence we used to evaluate exposure pathways and reach conclusions about the site. Definitions for the hazard category terminology used to characterize the pathways is presented in Appendix C. Appendix D provides a review of tremolite asbestos toxicity and standards.

Exposure Pathway Analysis

An exposure pathway describes how a person comes into contact with chemicals originating from a source of contamination. Every exposure pathway consists of the following five elements: (1) a *source* of contamination; (2) an environmental *medium* (such as air or soil) through which the contaminant is transported; (3) a *point of exposure*, the place where a person can come into contact with the contaminant; (4) a *route of exposure*, the way the contaminant enters or comes into contact with the body; and (5) a *receptor population*. A pathway is considered **complete** if all five elements are present and connected. **Potential** exposure pathways indicate that exposure to a contaminant *could* have occurred in the past, *could* be occurring currently, or *could* occur in the future. A potential exposure exists when information about one or more of the five elements of an exposure pathway is missing or uncertain. An **incomplete** pathway is missing one or more of the pathway elements; it is likely that the elements were never present, and that they are not likely to be present at a later point in time. An **eliminated** pathway was a potential or completed pathway in the past, but to prevent present and future exposures has had one or more of the pathway elements removed.

After reviewing information from Libby, Montana, and from facilities that processed vermiculite from Libby, the National Asbestos Exposure Review team identified likely exposure pathways for vermiculite processing facilities. All pathways have a common source—vermiculite from Libby contaminated with Libby asbestos—and a common route of exposure—inhalation. Although asbestos ingestion and dermal exposure pathways could exist, health risks from these pathways are minor in comparison to those resulting from inhalation exposure to asbestos, and therefore will not be evaluated.

The exposure pathways considered for each site are listed in the following table. Not every pathway identified will be a significant source of exposure for a particular site. An evaluation of the pathways for this site is presented in the following text.

Table 1. Summary of Pathways Considered for the Newark Plant

Pathway Name	Exposure Scenario	Past Pathway Status	Present Pathway Status	Future Pathway Status
Occupational	Workers exposed to airborne Libby asbestos during handling and processing of contaminated vermiculite	Complete	Not applicable	Not applicable
	Workers exposed to airborne Libby asbestos from residual contamination inside former processing buildings	Complete	Potential (confirmation sampling needed)	Potential (confirmation sampling needed)
Household Contact	Household contacts exposed to airborne Libby asbestos brought home on workers' clothing	Complete	Potential (confirmation sampling needed)	Potential (confirmation sampling needed)
Waste Piles	People disturbing piles of contaminated vermiculite or waste rock on the site (for example, children playing on contaminated rock piles)	Potential	Eliminated	Eliminated
On-Site Soil	Current on-site workers or contractors disturbing contaminated on-site soil (residual contamination, buried waste)	Potential	Eliminated	Eliminated
Ambient Air	Community members or nearby workers exposed to airborne fibers from plant emissions during handling and processing of contaminated vermiculite	Potential	Eliminated	Eliminated
Residential Outdoor	Community members using contaminated vermiculite or waste material at home (for example, for gardening, paving, fill material)	Potential	Potential	Potential
Residential Indoor	Community members disturbing household dust containing Libby asbestos from plant emissions or waste rock brought home for personal use	Potential	Potential	Potential
Consumer Products	Community members, contractors, and repairmen disturbing consumer products containing contaminated vermiculite	Potential	Potential	Potential

Occupational (former W.R. Grace employees) — The occupational exposure pathway for people who worked at the Newark plant prior to 1994 is considered complete. Former W.R. Grace workers were exposed to airborne levels of asbestos that posed a public health hazard. W.R. Grace records indicate that workers were exposed to high indoor levels of Libby asbestos in the air. Employee air sample results for the years 1975 to 1987 (unpublished information from EPA's database of W.R. Grace documents) are shown in Appendix A, Figure 3. For the personal air monitor samples for which sampling times were provided, the duration of the sampling period ranged from 12 to 120 minutes. Three 8-hour time-weighted-averages were reported in a 1987 industrial hygiene audit of the plant. However, these results were below the analytic limit of detection.

Because total sampled duration for most of the samples was below the total work shift, these samples do not directly represent 8-hour time-weighted-averages. However, based on field observations of two active vermiculite exfoliation facilities, employee job tasks are similar throughout the workday. Therefore, for purposes of evaluating potential exposure concentrations from these data, ATSDR took an overall average for employee exposure data per sampling event.

Individual sample results ranged from non-detect to 11.50 fibers per cubic centimeter (f/cc). Average fiber sample results from personal sampling ranged from a high of 4.34 f/cc in 1977 to 0.03 f/cc in 1987. According to information obtained from W.R. Grace records, efforts were underway to control fiber levels inside the plant through local exhaust ventilation systems in 1976. Accordingly, fiber levels appear to have decreased after 1976. According to these sampling data, by 1987 indoor fiber levels inside the plant were probably compliant with the present OSHA permissible exposure limit of 0.1 f/cc. Area samples collected by W.R. Grace show that concentrations of fibers up to 23 f/cc were generated by plant operations. These levels declined through 1987, as shown in Appendix A, Figure 4.

While no specific health data are available for this particular plant, two studies indicate that Libby vermiculite exfoliation workers are at risk for developing lung disease related to asbestos exposure. The first is a report of a person developing fatal asbestosis as a result of working two summers in a vermiculite exfoliation facility [4]. The second report is a study that was conducted in response to a report of 12 cases of pleural effusion within a 12-year period in an Ohio fertilizer plant that expanded and used Libby vermiculite [5]. The study of this cohort demonstrated cumulative tremolite-actinolite fiber exposure was correlated with dyspenea and pleuritic chest pain, and on chest radiographs pleural changes (thickening and/or plaques with and without calcification) [5]. Inhalation of airborne asbestos above the OSHA PEL would increase the risk for asbestos-related disease and therefore would have posed a public health hazard to former employees. Employee interviews conducted at other W.R. Grace sites by EPA and internal W.R. Grace documents indicate that a respiratory protection program was in place at least by 1986. Depending on the date the program started, the areas where respiratory protection was required, and the effectiveness of this program, the hazard to the employees could have been reduced significantly.

Occupational (past, current, and future employees) — From 1997 until 2002, workers at the plant were exposed to residual asbestos which may have come from vermiculite. Internal documents indicate that W.R. Grace conducted air sampling in 1994 (after plant operations had ceased) to determine whether airborne fibers remained in the building. Although the W.R. Grace 1994 samples did not find airborne asbestos inside the building, residual sources of asbestos remained in the building, as shown by the EPA air and surface sampling. EIHB wrote a health consultation concerning the air levels of asbestos reported by EPA in the remedial assessment and determined that the highest level of asbestos detected might pose an increased cancer incidence risk, but did not pose an "immediate" threat to public health. Because only a limited amount of air sampling results was available, EIHB concluded that the asbestos exposure at the site was an indeterminate public health hazard. EIHB recommended further air monitoring or evaluation and elimination of the sources of the asbestos exposure [6]. EPA ordered a removal action that included remediation of the horizontal surfaces inside the warehouse area and any exposed contaminated soil on the site; this was completed in 2002 [7]. However, confirmatory clearance sampling, necessary to verify successful removal of the asbestos fibers, has not been performed [8]. We therefore believe there is a potential for present and future exposures until such confirmatory sampling is completed.

Household contacts — The pathway for exposure of household members to airborne Libby asbestos brought home inadvertently by former workers (persons who worked at the plant before 1993) is considered complete. If workers did not shower and change clothes before leaving work, members of the workers' families or other household contacts could have been exposed to asbestos fibers brought home on workers' bodies or clothing. Family or other household contacts could have come into contact with Libby asbestos by direct contact with the worker, by laundering the worker's clothing, or by the resuspension of dust during cleaning activities. Exposures to household contacts cannot be estimated without information concerning Libby asbestos levels on worker clothing and behavior-specific factors (for example, worker practices, household laundering practices). ATSDR does not know whether procedures to reduce the amount of fibers that workers took home were implemented at this plant. However, exposure to asbestos resulting in asbestos-related disease in family members of persons who worked in the asbestos industry has been well-documented [9]. Inhalation of Libby asbestos fibers by household contacts because of worker take-home contamination is therefore considered a past public health hazard.

The exposure pathway is considered complete for household contacts of persons who worked at the site after vermiculite production stopped but before EPA's removal action in 2002. However, the overall low levels of airborne asbestos detected by EPA indicate that exposure from contaminants brought home by workers would be minimal. Therefore, ATSDR considers this exposure of household contacts of these workers to present no apparent public health hazard.

Waste piles — Persons who disturbed vermiculite waste piles could have been exposed to airborne asbestos. Stoner rock (the waste rock created in the exfoliation process) contains up to 10% asbestos by weight (personal communication with James Kelly and Jean Small-Johnson of the Minnesota Department of Health). At other exfoliation sites, waste rock was a significant exposure pathway to the community. For instance, at the Western Minerals plant in Minneapolis, children played in the waste piles and waste rock was given to the surrounding community for fill material and other uses [10].

An internal W.R. Grace document indicates that the Durham Road Landfill, Freemont, California, may have received waste from the Newark plant that contained asbestos. Waste manifests for the asbestos waste from the plant were supplied to ATSDR for the years 1985 and 1990. Steeler employees told EPA that when they took possession of the property, a dumpster with an asbestos warning label on it was on the site [1].

Because information about waste handling procedures at the plant is available for only a period of the plant's operations, exposure to waste piles at the site before 1985 was determined to be an indeterminate public health hazard. After 1985, community exposure to on-site waste piles appears to have been eliminated.

The facility no longer processes vermiculite, and EPA and ATSDR representatives did not find evidence of waste piles on the site during their site visits. Current and future exposure to waste rock at the site has been eliminated.

On-Site Soil — The exposure pathway concerning current workers or contractors disturbing contaminated soil on the site—including residual contamination or buried waste—is considered an eliminated pathway for both the present and future. EPA sampling showed residual vermiculite contaminated with Libby asbestos in the soil around the plant. Soil with the highest levels of contamination was covered with grass or railroad ballast [1]. EPA required encapsulation and eventual removal of the soil containing Libby asbestos from the spur and the back lot of the plant. Some areas of the site have trace amounts of asbestos. Disturbing soil containing trace amounts of Libby asbestos can result in airborne levels of Libby asbestos fibers [11]. However, the trace amounts of asbestos were located in areas that were not accessible (for example, under asphalt), and EPA was negotiating institutional controls to prevent disturbance of the soil in a manner that would generate airborne asbestos. Because the EPA removal action required either encapsulation or removal of the asbestos-contaminated soil, ATSDR considers the future and current exposure pathways to be eliminated. ATSDR considers past exposure from on-site soil to be no apparent public health hazard assuming no significant disturbances of the soil occurred.

Ambient air — Past exposure to airborne fibers from plant emissions is considered a potential exposure pathway for the community surrounding the site as well as for nearby workers. This exposure was categorized as an indeterminate public health hazard because the asbestos fiber concentration that was present is unknown. Specific information concerning historical emissions from the exfoliation processes at the plant is not available; therefore, an estimate of the health effects from this exposure cannot be made. It is likely that emissions occurred from ore handling activities, exfoliation units, and local exhaust ventilation. Figure 5 in Appendix A shows the wind rose from a meteorological station located 21 miles from the site. An analysis of this wind rose indicates that predominant wind direction is toward the east. However, an individual's exposure will be driven by factors other than wind direction, factors such as the plant's operational cycles and the times and locations where people would have been exposed. Community members and area workers could have been exposed to Libby asbestos fibers released into the ambient air from fugitive dusts or the furnace stack while the plant was running. Exposure of the public to airborne emissions downwind of the site would have been at much lower concentrations than that experienced by the W.R. Grace workers. Some contamination of nearby businesses may have occurred from the airborne dispersal of asbestos fibers.

Residential outdoor — Some vermiculite processing facilities in the United States allowed or encouraged workers and nearby community members to take stoner rock, vermiculite, or other process materials for personal use [10]. Some vermiculite sites have disposed of waste rock by burying it on site as fill material [12]. Available documentation dating back to 1985 indicated waste from the facility was shipped to various landfills for disposal. Actual quantities of waste generated and disposed of could not be verified from this information. Because the facility processed a high tonnage of Libby vermiculite in the past and insufficient information is available concerning historical waste disposal, the past, present, and future community exposures to waste rock brought home for personal use are considered to present an indeterminate public health hazard.

Residential indoor — Insufficient information is available concerning past air emissions and community use of waste rock. Therefore, residential indoor exposure to Libby asbestos fibers presents an indeterminate past public health hazard.

The facility does not currently process Libby vermiculite, therefore facility emissions are not currently a source for Libby asbestos contamination in nearby homes. Residual Libby asbestos (from potential past sources) is possible, though housekeeping (particularly wet cleaning methods) over the past 10 years would probably have removed most residual fibers. As discussed in the *residential outdoor* pathway section, not enough information is available to know whether waste rock was used at homes in the community. Exposure to Libby asbestos from waste rock in the community would primarily be an outdoor exposure concern; the waste rock alone would not be expected to significantly contribute to residential indoor exposures. Therefore the residential indoor exposure pathway is considered no apparent public health hazard for community members now or in the future.

Consumer Products — People who purchased and used company products that contain Libby asbestos may be exposed to asbestos fibers by using those products in and around their homes. At this time, determining the public health implication of commercial or consumer use of company products (such as home insulation or vermiculite gardening products) that contain Libby vermiculite is beyond the scope of this evaluation. Additional information for consumers of vermiculite products has been developed by EPA, ATSDR, and NIOSH and provided to the public (see www.epa.gov/asbestos/insulation.html).

Contaminated vermiculite insulation in homes and in soil could pose an inhalation hazard if it were disturbed. Therefore, exposure to asbestos in vermiculite insulation in an uninhabited attic or behind walls should be negligible provided the materials are not disturbed. Exposure to asbestos in soil is less likely if the soil is covered by asphalt, concrete, or vegetation. Asbestos fibers do not break down in the environment, and asbestos in soil may remain for decades [13].

Health Outcome Data

As a separate project, ATSDR's Division of Health Studies has funded states to perform health statistics reviews around sites that have received vermiculite from Libby. The California Department of Health Services' Environmental Health Investigation Branch has performed a review of cancer incidence data for the Newark site. The results of the health statistics review are presented and discussed in Appendix E.

Summary of Removal and Remedial Actions Completed and Proposed

EPA has overseen a removal action at this site that included

- Remediation of the horizontal surfaces inside buildings (April 8–12, 2002)
- Remediation of highly contaminated soil (>1% asbestos content) on the site and along the railroad spur (October 21–November 11, 2002)
- Institutional controls to prevent disturbance of soil contaminated with asbestos (proposed

and being negotiated by EPA).

Child Health Considerations

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

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

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

Because of the limited amount of information regarding the exposure pathways at this site, the health implications for children are difficult to determine. During the time the facility exfoliated Libby vermiculite, the most at-risk children were those who were household contacts of former workers while the plant was expanding vermiculite. Other exposure pathways (ambient air, residential outdoor, waste piles) may also have affected children, but ATSDR does not have information at this time to determine whether these pathways were completed or not. We do not know if the facility gave vermiculite waste materials to the community for use. If this practice occurred, it could represent an ongoing exposure to children in the community.

Conclusions

Occupational Exposure Pathways

- People who worked at the Newark plant from 1966 to 1993 were exposed to airborne levels of Libby asbestos above current occupational standards. Repeated exposure to airborne Libby asbestos at these elevated levels increased a worker's risk for asbestos-related disease and therefore posed a *public health hazard* to former employees.

- Workplace exposures at the site from 1997 until the present[d] are an indeterminate public health hazard due to incomplete data.

Household Contacts

- Persons who lived in a household with someone who worked at the plant before 1994 may have been exposed to asbestos fibers brought into the home on workers' bodies or

[d] Site was apparently unoccupied from 1994 until 1997.

clothing. This past exposure represents a public health hazard to household contacts of former workers.

- No apparent public health hazard exists for household contacts of person who worked at this site between 1997 and the completion of the remedial action in 2002.

Waste Piles

- Community exposure to waste piles at the site in the past posed an indeterminate public health hazard. Available information regarding the waste practices at this site is inadequate to determine whether the public had access to the waste piles.

- Currently, the facility does not process vermiculite from Libby, and no waste piles were observed at the site. Therefore, no exposure pathway exists for community members to be exposed to contaminated waste piles at the site now or in the future and therefore no public health hazard exists for present and future exposure.

On-Site Soil

- Under current conditions, and even assuming occasional contact with areas that may contain Libby asbestos, on-site exposure of workers and contractors to Libby asbestos-contaminated soils poses no apparent public health hazard. If asbestos-contaminated soil is disturbed as a result of changes in site conditions or use of the property, a public health hazard could be created.

Ambient Air

- Insufficient data exist to evaluate past asbestos exposure to the community from air emissions of asbestos from the plant. Therefore, past exposure to ambient air presents an indeterminate public health hazard.

- Present and future community exposure to Libby asbestos in air has been eliminated because the facility no longer processes vermiculite from Libby.

Residential Outdoor

- Because the facility processed a high tonnage of Libby vermiculite in the past and insufficient information is available concerning historical waste disposal practices, exposure to persons in the community from waste rock brought home for personal use has been categorized as an indeterminate public health hazard for past, present, and future exposures.

Residential Indoor

- Insufficient information is available to evaluate past indoor residential exposures, therefore this pathway poses an indeterminate public health hazard to the community.

- Because this site stopped processing vermiculite in 1993, current indoor residential exposures pose no apparent public health hazard to the community.

Recommendations

Occupational and Household Contacts Exposure

- Promote awareness of past asbestos exposure among former workers and members of their households.
- Encourage former workers and their household contacts to inform their regular physician about their exposure to asbestos. If former workers or their household contacts are concerned or symptomatic, they should be encouraged to see a physician who specializes in asbestos-related lung diseases.
- Conduct air and dust confirmation sampling inside the former processing building to verify the effectiveness of the EPA removal action.

Waste Piles and Residential Outdoor Exposure

- Promote awareness of potential past asbestos exposure among community members who lived near the facility from1966 to 1993. Provide these people with easily accessible materials that will assist them in identifying their own potential for exposure.
- Encourage persons who lived in the community in the past and feel they were exposed to inform their regular physician about their potential asbestos exposure.

On-Site Soil Exposure

- Develop plans to ensure that adequate controls are in place to protect workers from asbestos exposure during excavation or disturbance of on-site soil, including soil beneath the asphalt parking areas.

Public Health Action Plan

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

Actions Completed

- EPA conducted a site visit in February 2001.
- EPA completed a removal action in 2002.

- ATSDR visited the site in August 2002.

Actions Ongoing

- ATSDR is developing a site-specific communication and education plan for the former W.R. Grace & Company site in Newark; the primary goal of the plan is to promote knowledge and awareness of the health effects of asbestos among exposed individuals and concerned community members.

- ATSDR is available to provide consultative services regarding confirmation sampling inside the buildings.

Actions Planned

- ATSDR, in cooperation with state partners, is researching and determining the feasibility of conducting additional worker and household contact follow-up activities.

- ATSDR will notify the current site owner that we recommend confirmation sampling inside the building to verify the effectiveness of clean-up activities. ATSDR is available to provide consultative services to the owner regarding confirmation sampling.

- ATSDR will notify the current site owner, as well as local permitting authorities, that management plans should be developed to protect workers from asbestos exposure during excavation or disturbance of on-site soil, including soil beneath the asphalt parking areas.

- ATSDR will combine the findings from this health consultation with findings from other sites nationwide that received Libby vermiculite to create a comprehensive report outlining overall conclusions and strategies for addressing public health implications.

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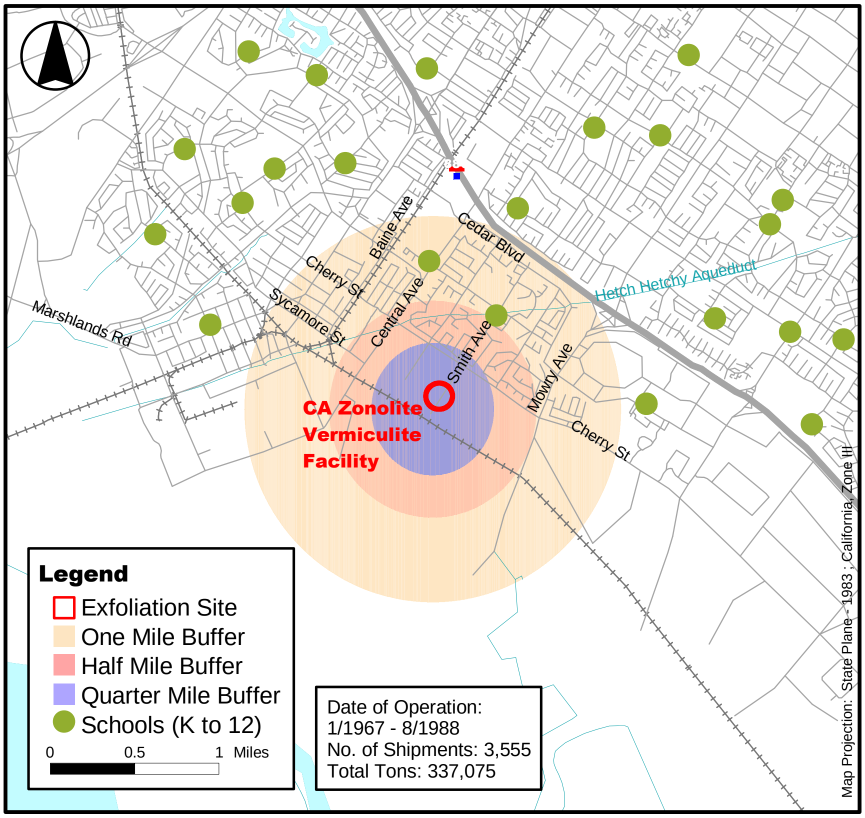
Appendix A. Figures

CA Zonolite/Diversified Insulation

INTRO MAP

6851 Smith Avenue
Newark, California



Base Map Source: 1995 TIGER/Line Files

Region 9

Alameda County, California

Demographic Statistics Within Specified Distance*	.25 mi	.5 mi	1 mi
Total Population	181	2067	10183
White	144	1589	6862
Black	7	89	430
American Indian, Eskimo, Aleut	0	8	49
Asian or Pacific Islander	19	233	1697
Other Race	13	148	1138
Hispanic Origin	32	393	2563
Children Aged 6 and Younger	22	224	1327
Adults Aged 65 and Older	10	103	461
Females Aged 15 - 44	47	496	2631
Total Housing Units	54	633	3141

Demographics Statistics Source: 1990 US Census
*Calculated using an area-proportion spatial analysis technique

Population Density

Source: 1990 U.S. Census

Children 6 Years and Younger

Source: 1990 U.S. Census

Adults 65 Years and Older

Source: 1990 U.S. Census

Females Aged 15 - 44

Source: 1990 U.S. Census

LMR 041202

ATSDR GIS SAIDS

Figure 2. Census Data on Age of Houses

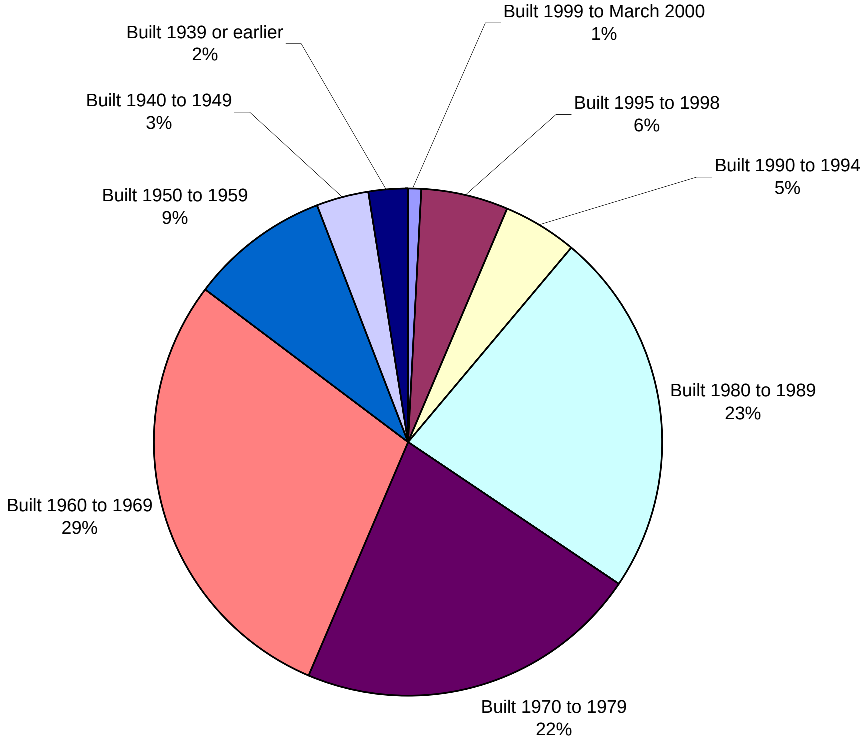


Figure 3. Asbestos Levels Detected in Air Samples From Personal Air Monitors of Workers at the W. R. Grace Plant in Newark. Collected by W. R. Grace.

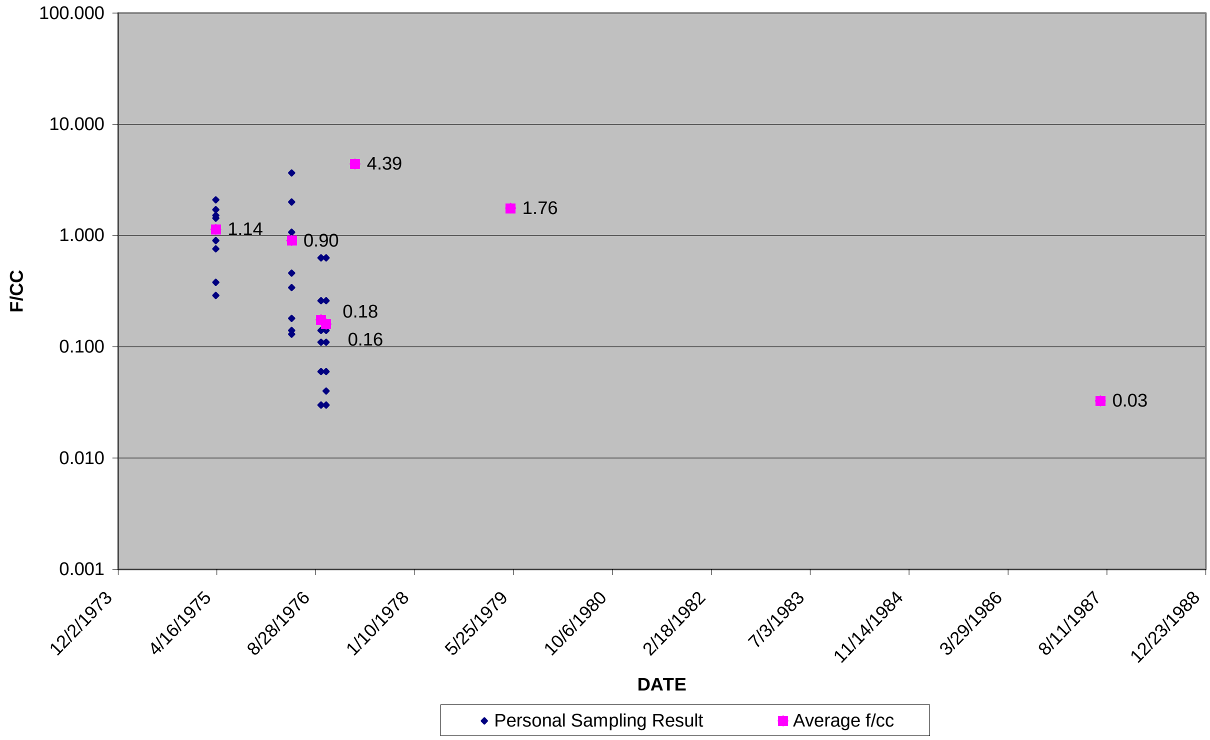


Figure 4. Asbestos Levels Detected in Air Samples From the Newark Plant. Collected by W. R. Grace.

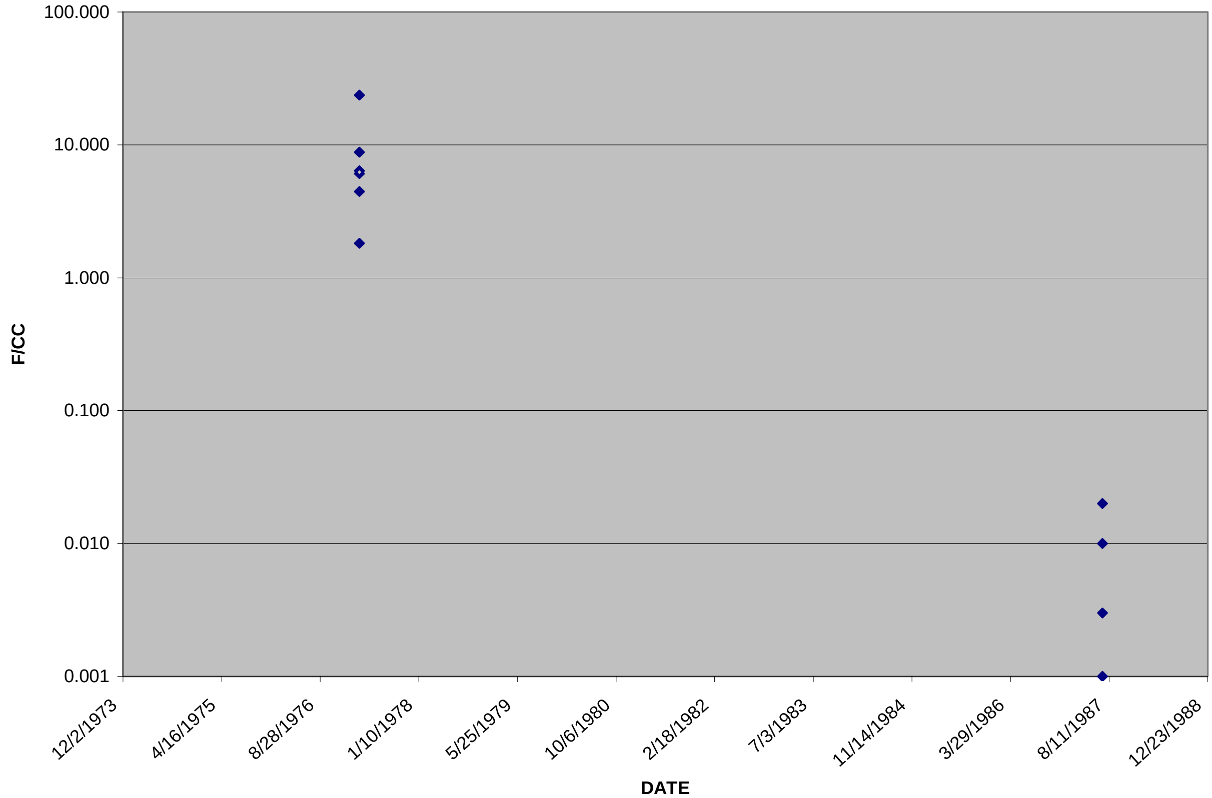
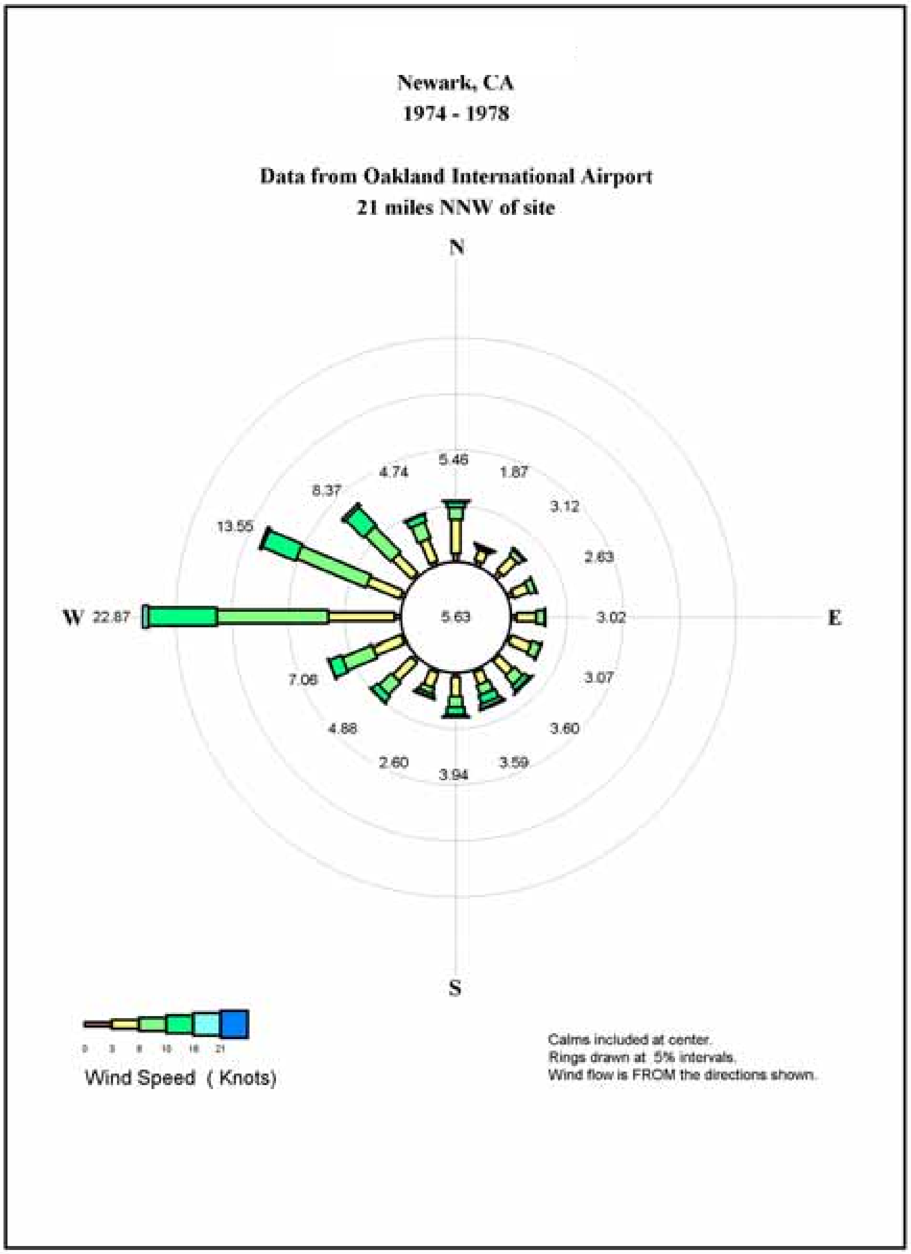


Figure 5. Wind Rose From Oakland International Airport



Appendix B. EPA Sampling Results

Table 1. Results of Analysis of Surface Soil Samples*

Sample Type	Sample Location	Asbestos Concentration (Percent by Volume)	Type of Asbestos
Grab	Soil stockpile	Trace†	Chysotile, tremolite-Actinolite
Grab	Soil stockpile	Not detected	
Composite	Soil stockpile	Trace	Chrysotile
Grab	Soil stockpile	Trace	Chysotile, tremolite-Actinolite
Grab	Soil stockpile	Trace	Chysotile, tremolite-Actinolite
Composite	Soil stockpile	Trace	Tremolite-actinolite
Composite	Yard area east of stockpile	Trace	Chrysotile
Composite	Eastern portion of yard	Not detected	
Composite	Along north fence	Not detected	
Composite	Planter east of sales office	Not detected	
Composite	Fence, northeast corner	Not detected	
Composite	Along rail spur	Trace	Chrysotile
		4%	Tremolite-actinolite
Composite	Along rail spur (duplicate of previous sample)	Trace	Chrysotile
		4%	Tremolite-actinolite
Composite	Along rail spur	Trace	Chrysotile
		2%	Tremolite-actinolite

Source: US Environmental Protection Agency. Focused removal assessment report for W.R. Grace & Co. Newark: CDM for EPA; 2001.
* All soil samples were analyzed by polarized light microscopy.
† Asbestos fibers were detected but concentration not quantifiable by analyst.

Table 2. Results of Analysis of Product Samples*

Sample Type	Sample Location	Asbestos Concentration (Percent by Volume)	Type of Asbestos
Grab	Product pile near former conveyor at rail spur	3%	Tremolite-actinolite
Grab	Product pile outside west wall of production building	3%	Tremolite-actinolite
Grab	Bulk sample; overspray on ceiling in attic in sales office	15%	Chrysotile
Grab	Bulk vermiculite product in wall space in machine shop	2%	Tremolite-actinolite

* All soil samples were analyzed by polarized light microscopy.

Table 3. Results of Analysis of Microvacuum Surface Dust Samples*

Sample Type	Sample Location	Area Sampled	Number of Asbestos Structures Detected (on the filter sample)	Grid Openings (grid opening area = 0.0105 mm^2)	Effective Filter Area	Dilution Factor	Total Asbestos Concentration (s/cm^2) (estimated for the surface area sampled)
Composite	Two wood shelves and perimeter wall I-beam in machine shop	300 cm^2	69 tremolite-actinolite	2	201 mm^2	0.00125	1,761,143
			2 chrysotile	2	201 mm^2	0.00125	51,048
Composite	South, east, and west perimeter wall I beams in warehouse	300 cm^2	1 tremolite-actinolite	10	201 mm^2	0.00125	5,105
			1 chrysotile	10	201 mm^2	0.00125	5,105
Composite	Three areas on roof of the office in the warehouse	300 cm^2	3 tremolite-actinolite	10	201 mm^2	0.00125	66,362
			13 chrysotile	10	201 mm^2	0.00125	15,314
Blank	Blank	N/A	Not detected	10			
Blank	Blank	N/A	Not detected	10			

* All microvacuum dust samples were analyzed by ISO method 10312 (TEM). Results reported as "Number of Asbestos Structures Detected" correspond to the actual number of structures observed during analysis of a portion of the microvacuum filter. The "Total Asbestos Concentration" values are estimated for the surface area sampled.

$$Total\ Asbestos\ Concentration\,(s/cm^2) = \frac{\left(\dfrac{number\ of\ asbestos\ fibers \times effective\ filter\ area}{dilution\ factor \times number\ of\ grid\ openings \times grid\ opening\ area}\right)}{Area\ Sampled}$$

Table 4. Results of Analysis of Indoor Air Samples*

Sample Type	Sample Location	Asbestos Result	Concentration
Air	Machine shop	Not detected†	
Air	Production area	Not detected	
Air	Warehouse area	2 structures, tremolite-actinolite	0.0019 s/cc
Air	Sales office building	Chrysotile	0.0018 s/cc
Air	Warehouse office area	4 structures, tremolite-actinolite	0.0046 s/cc
		9 structures, chrysotile	0.0104 s/cc
Blank	Blank	Not detected	
Blank	Blank	Not detected	

* All air samples were analyzed by ISO method 10312 (TEM).
† The limit of detection was 0.0009 s/cc.

Appendix C. Health Hazard Category Definitions

Health Hazard Category Definitions

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

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

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

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

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

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

Appendix D. Tremolite Asbestos Toxicology

Asbestos Overview

Asbestos is a general name applied to a group of silicate minerals consisting of thin, separable fibers in a parallel arrangement. Asbestos minerals fall into two classes, serpentine and amphibole. Serpentine asbestos has relatively long and flexible crystalline fibers; this class includes chrysotile, the predominant type of asbestos used commercially. Amphibole asbestos minerals are brittle and have a rod- or needle-like shape. Amphibole minerals regulated as asbestos by OSHA include five classes: crocidolite, amosite, and the fibrous forms of tremolite, actinolite, and anthophyllite. Other unregulated amphibole minerals, including winchite, richterite, and others, can also exhibit fibrous asbestiform properties [1].

Asbestos fibers do not have any detectable odor or taste. They do not dissolve in water or evaporate into the air, although individual asbestos fibers can easily be suspended in the air. Asbestos fibers do not move through soil. They are resistant to heat, fire, and chemical and biological degradation. As such, they can remain virtually unchanged in the environment over long periods of time.

Vermiculite that was mined in Libby, Montana, contains amphibole asbestos, with a characteristic composition including tremolite, actinolite, richterite, and winchite; this material will be referred to as Libby asbestos. The raw vermiculite ore was estimated to contain up to 26% Libby asbestos as it was mined [2]. For most of the mine's operation, Libby asbestos was considered a by-product of little value and was not used commercially. The mined vermiculite ore was processed to remove unwanted materials and then sorted into various grades or sizes of vermiculite that were then shipped to sites across the nation for expansion (exfoliation) or use as a raw material in manufactured products. Samples of the various grades of unexpanded vermiculite shipped from the Libby mine contained 0.3%–7% fibrous tremolite-actinolite (by mass) [2].

The following sections provide an overview of several concepts relevant to the evaluation of asbestos exposure, including analytical techniques, toxicity and health effects, and the current regulations concerning asbestos in the environment.

Methods for Measuring Asbestos Content

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

Asbestos content in soil and bulk material samples is commonly determined using polarized light microscopy (PLM), a method which uses polarized light to compare refractive indices of minerals and can distinguish between asbestos and nonasbestos fibers and between different types of asbestos. The PLM method can detect fibers with lengths greater than approximately

1 µm (~1 µm), widths greater than ~0.25 µm, and aspect ratios (length-to-width ratios) greater than 3. Detection limits for PLM methods are typically 0.25%–1% asbestos.

Scanning electron microscopy (SEM) and, more commonly, transmission electron microscopy (TEM) are more sensitive methods that can detect smaller fibers than light microscopic techniques. TEM allows the use of electron diffraction and energy-dispersive x-ray methods, which give information on crystal structure and elemental composition, respectively. This information can be used to determine the elemental composition of the visualized fibers. SEM does not allow measurement of electron diffraction patterns. One disadvantage of electron microscopic methods is that determining asbestos concentration in soil and other bulk material is difficult [1].

For risk assessment purposes, TEM measurements are sometimes multiplied by conversion factors to give PCM equivalent fiber concentrations. The correlation between PCM fiber counts and TEM mass measurements is very poor. A conversion between TEM mass and PCM fiber count of 30 micrograms per cubic meter per fiber per cubic centimeter (µg/m^3)/(f/cc) was adopted as a conversion factor, but this value is highly uncertain because it represents an average of conversions ranging from 5 to 150 (µg/m$^{3)}$/(f/cc) [3]. The correlation between PCM fiber counts and TEM fiber counts is also very uncertain, and no generally applicable conversion factor exists for these two measurements [3]. Generally, a combination of PCM and TEM is used to describe the fiber population in a particular air sample.

Asbestos Health Effects and Toxicity

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

> *Malignant mesothelioma*—cancer of the membrane (pleura) that encases the lungs and lines the chest cavity. This cancer can spread to tissues surrounding the lungs or other organs. The great majority of mesothelioma cases are attributable to asbestos exposure [1].
>
> *Lung cancer*—cancer of the lung tissue, also known as bronchogenic carcinoma. The exact mechanism relating asbestos exposure with lung cancer is not completely understood. The combination of tobacco smoking and asbestos exposure greatly increases the risk of developing lung cancer [1].
>
> *Noncancer health effects*—these include asbestosis, scarring, and reduced lung function caused by asbestos fibers lodged in the lung; pleural plaques, localized or diffuse areas of thickening of the pleura; pleural thickening, extensive thickening of the pleura which may restrict breathing; pleural calcification, calcium deposition on pleural areas thickened from chronic inflammation and scarring; and pleural effusions, fluid buildup in the pleural space between the lungs and the chest cavity [1].

Not enough evidence is available to determine whether inhalation of asbestos increases the risk of cancer at sites other than the lungs, pleura, and abdominal cavity [1].

Ingestion of asbestos causes little or no risk of noncancer effects. However, some evidence indicates that acute oral exposure might induce precursor lesions of colon cancer and that chronic oral exposure might lead to an increased risk of gastrointestinal tumors [1].

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

The scientific community generally accepts the correlations of asbestos toxicity with fiber length as well as fiber mineralogy. Fiber length may play an important role in clearing the materials from the body, and mineralogy may affect both biopersistence and surface chemistry.

ATSDR, responding to concerns about asbestos fiber toxicity from the World Trade Center disaster, held an expert panel meeting to review fiber size and its role in fiber toxicity in December 2002 [4]. The panel concluded that fiber length plays an important role in toxicity. Fibers with lengths <5 µm are essentially nontoxic in terms of association with mesothelioma or lung cancer promotion. However, fibers with lengths <5 µm may play a role in asbestosis when exposure duration is long and fiber concentrations are high. More information is needed to definitively reach this conclusion.

In accordance with these concepts, it has been suggested that amphibole asbestos is more toxic than chrysotile asbestos, mainly because physical differences allow chrysotile to break down and to be cleared from the lung, whereas amphibole is not removed and builds up to high levels in lung tissue [5]. Some researchers believe the resulting increased duration of exposure to amphibole asbestos significantly increases the risk of mesothelioma and, to a lesser extent, asbestosis and lung cancer [5]. However, OSHA continues to regulate chrysotile and amphibole asbestos as one substance, as both types increase the risk of disease [6]. EPA’s Integrated Risk Information System (IRIS) assessment of asbestos also currently treats mineralogy (and fiber length) as equipotent.

Evidence suggesting that the different types of asbestos fibers vary in carcinogenic potency and site specificity is limited by the lack of information on fiber exposure by mineral type. Other data indicate that differences in fiber size distribution and other process differences can contribute at least as much as fiber type to the observed variation in risk [7].

Counting fibers using the regulatory definitions (see below) does not adequately describe risk of health effects. Fiber size, shape, and composition contribute collectively to risk in ways that are still being elucidated. For example, shorter fibers appear to deposit preferentially in the deep lung, but longer fibers may disproportionately increase the risk of mesothelioma [1,7]. Some of the unregulated amphibole minerals, such as the winchite present in Libby asbestos, can exhibit asbestiform characteristics and contribute to risk. Fiber diameters greater than 2 µm–5 µm are considered above the upper limit of respirability (that is, too large to inhale), and thus do not contribute significantly to risk. Methods to assess the risk posed by varying types of asbestos are being developed and are currently awaiting peer review [7].

Current Standards, Regulations, and Recommendations for Asbestos

In industrial applications, asbestos-containing materials are defined as any material with >1% bulk concentration of asbestos [8]. It is important to note that 1% is not a health-based level, but instead represents the practical detection limit in the 1970s when OSHA regulations were created. Studies have shown that disturbing soil containing <1% amphibole asbestos, however, can suspend fibers at levels of health concern [9].

Friable asbestos (asbestos which is crumbly and can be broken down to suspendible fibers) is listed as a hazardous air pollutant on EPA's Toxic Release Inventory [10]. This classification requires companies that release friable asbestos at concentrations >0.1% to report the release under Section 313 of the Emergency Planning and Community Right-to-Know Act.

OSHA's permissible exposure limit (PEL) is 0.1 f/cc for asbestos fibers with lengths >5 µm and with an aspect ratio (length:width) >3:1, as determined by PCM [6]. This value represents a time-weighted average (TWA) exposure level based on 8 hours per day for a 40-hour work week. In addition, OSHA has defined an "excursion limit," which stipulates that no worker should be exposed in excess of 1 f/cc as averaged over a sampling period of 30 minutes [6]. Historically, the OSHA PEL has steadily decreased from an initial standard of 12 f/cc established in 1971. The PEL levels prior to 1983 were determined on the basis of empirical worker health observations, while the levels set from 1983 forward employed some form of quantitative risk assessment. ATSDR has used the current OSHA PEL of 0.1 f/cc as a reference point for evaluating asbestos inhalation exposure for past workers. ATSDR does not, however, support using the PEL for evaluating exposure for community members, because the PEL was developed as an occupational exposure for adult workers.

In response to the World Trade Center disaster in 2001 and an immediate concern about asbestos levels in buildings in the area, the Department of Health and Human Services, EPA, and the Department of Labor formed the Environmental Assessment Working Group. This work group was made up of ATSDR, EPA, CDC's National Center for Environmental Health, the National Institute for Occupational Safety and Health (NIOSH), the New York City Department of Health and Mental Hygiene, the New York State Department of Health, OSHA, and other state, local, and private entities. The work group set a re-occupation level of 0.01 f/cc after cleanup. Continued monitoring was also recommended to limit long-term exposure at this level [11]. In 2002, a multiagency task force headed by EPA was formed specifically to evaluate indoor environments for the presence of contaminants that might pose long-term health risks to residents in Lower Manhattan. The task force, which included staff from ATSDR, developed a health-based benchmark of 0.0009 f/cc for indoor air. This benchmark was developed to be protective under long-term exposure scenarios, and it is based on risk-based criteria that include conservative exposure assumptions and the current EPA cancer slope factor. The 0.0009 f/cc benchmark for indoor air was formulated on the basis of chrysotile fibers and is therefore most appropriately applied to airborne chrysotile fibers [12].

NIOSH set a recommended exposure limit of 0.1 f/cc for asbestos fibers longer than 5 µm. This limit is a TWA for up to a 10-hour workday in a 40-hour work week [13]. The American Conference of Government Industrial Hygienists has also adopted a TWA of 0.1 f/cc as its threshold limit value [14].

EPA has set a maximum contaminant level (MCL) for asbestos fibers in water of 7,000,000 fibers longer than 10 µm per liter, on the basis of an increased risk of developing benign intestinal polyps [15]. Many states use the same value as a human health water quality standard for surface water and groundwater.

Asbestos is a known human carcinogen. Historically, EPA's IRIS model calculated an inhalation unit risk for cancer (cancer slope factor) of 0.23 per f/cc of asbestos [3]. This value estimates additive risk of lung cancer and mesothelioma using a relative risk model for lung cancer and an absolute risk model for mesothelioma.

This quantitative risk model has significant limitations. First, the unit risks were based on measurements with phase contrast microscopy and therefore cannot be applied directly to measurements made with other analytical techniques. Second, the unit risk should not be used if the air concentration exceeds 0.04 f/cc because the slope factor above this concentration might differ from that stated [3]. Perhaps the most significant limitation is that the model does not consider mineralogy, fiber-size distribution, or other physical aspects of asbestos toxicity. EPA is in the process of updating their asbestos quantitative risk methodology given the limitations of the IRIS model currently used and the knowledge gained since this model was implemented in 1986.

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Appendix E. Health Statistics Review

Health Statistics Review for Populations in Close Proximity to the W.R. Grace & Company Facility in Newark, California

Background

In 1999 a series of articles in the *Seattle Post-Intelligencer* about high rates of asbestos-related disease brought national attention to the W.R. Grace & Company vermiculite mine in Libby, Montana. The Agency for Toxic Substances and Disease Registry (ATSDR), in cooperation with the Montana Department of Public Health and Human Services, analyzed mortality statistics (information on causes of death obtained from death certificates) for the Libby community for a 20-year period (1979–1998). This review found that death due to asbestosis was 40 times more common in the Libby population than in the rest of the state of Montana, and 80 times more common than in the rest of the U.S. population. Death due to lung cancer was 20% to 30% (1.2 to 1.3 times) higher than expected. Although rates of mesothelioma were elevated, it was not possible to quantify by how much. Still, these elevations were high enough that they were considered unlikely to have been due to natural fluctuations in the occurrence of these diseases [1]. Findings from the review of mortality statistics led to several follow-up activities to address the health impacts to those who lived and worked in Libby [2, 3].

Libby vermiculite was distributed to and processed by facilities located throughout the United States. Because human exposure to asbestos has possibly occurred in communities near these facilities, ATSDR's Division of Health Studies initiated a nationwide follow-up effort. This project is designed to screen for similar impacts on the health of populations living near facilities that received shipments of Libby vermiculite. As part of that effort, the Environmental Health Investigation Branch of the California Department of Health Services (CDHS) received funding to conduct health statistics reviews on communities located near facilities that processed or packaged Libby vermiculite.

Health statistics reviews are statistical analyses of information from **cancer registry** and **death certificate** records that investigate whether people in a particular community have developed cancer or have died from a particular disease more often than another comparison population. The health statistics reviews are being conducted in communities located near facilities that received Libby vermiculite, regardless of whether that community was in fact exposed to hazardous levels of asbestos from the vermiculite. (Usually, reviews of health information are conducted only when exposure to a harmful chemical is known to have occurred.) Communities are being investigated because, given the experience in the Libby community, it is not

> A **cancer registry** collects, organizes, and analyzes information on cancer cases that have been diagnosed or treated in a specific geographic area (for example, the state of California).
>
> A **death certificate** is an official, legal record of an individual's death. Death certificates provide information on the cause of death (as determined by a physician) and demographic information related to the person who died.

unrealistic to think that exposure to levels of asbestos high enough to have caused disease might have occurred in these communities.

Finding an excess of asbestos-related cancers or disease in a community would alert ATSDR and CDHS to the possibility that workers or community members might have been exposed to hazardous levels of asbestos as a result of the facility's handling or processing of Libby vermiculite. If, however, the health statistics review does not find an excess of asbestos-related disease, this does not prove that the community was not exposed to Libby asbestos.

This appendix presents the results of the health statistics review for the population living near the W.R. Grace & Company plant in Newark, California.

Methods

CDHS followed a health statistics review protocol developed by ATSDR's Division of Health Studies [4]. The objectives of this protocol are

1. to identify the residential area at highest risk of exposure to hazardous levels of asbestos from the exfoliation and processing of Libby vermiculite at the Newark plant
2. to determine whether the population living in this area had higher incidence rates of asbestos-related cancers than the U.S. population as a whole, and
3. to determine whether the population residing in this area had higher mortality rates from asbestos-related disease than the U.S. population as a whole.

The analysis of incidence rates of asbestos-related cancers will be referred to as the "cancer statistics review" and the analysis of mortality rates of asbestos-related disease will be referred to as the "mortality statistics review."

Incidence rate is a measure of the occurrence of disease in a population. It is the number of people in a population who get a disease in a specific time period, divided by the number of people in that population during the time period. For example, the incidence rate of lung cancer in California for the year 1997 was 60.1 new cases per 100,000 people living in California during that year [5].

Mortality rate is a measure of the occurrence of death from a disease in a population. It is the number of people in a population who die from a disease in a specific time period, divided by the number of people in that population during the time period. For example, the mortality rate for lung cancer in California for the year 1997 was 41.8 per 100,000 people residing in California during that year [6].

Diseases Evaluated in the Health Statistics Review

The ATSDR Division of Health Studies selected a variety of diseases for evaluation (1) to assess the full burden of disease and death that exposure to asbestos could have had on a population and (2) to confirm that the information obtained from cancer registries and vital statistics records for this review was consistent and therefore comparable.

Exposure to asbestos is known to cause lung cancer, mesothelioma, and asbestosis. Some studies suggest that exposure to asbestos might also increase the risk of certain digestive organ cancers. It is also possible that exposure to asbestos might worsen and cause premature death from certain diseases of the pulmonary and circulatory system.

One factor complicating the study of asbestos-related diseases is that physicians often misdiagnose these diseases, particularly when establishing a cause of death. This review also evaluated the number of people getting or dying from a certain disease because these people might have actually had an asbestos-related disease that was misdiagnosed.

Incidence rates of eight types of cancer or cancer groups were evaluated in the cancer statistics review (see list, at right). Lung and bronchus cancer, mesothelioma, and digestive organ cancers were studied because of their known or suspected association with asbestos exposure. Cancer of the peritoneum, retroperitoneum and pleura, and cancer of the respiratory system and intrathoracic organs were evaluated because people with these diagnoses might actually have had an asbestos-related cancer instead. Lastly, all types of cancer, female breast cancer, and prostate cancer were evaluated to determine whether cancer was underreported to the cancer registries that provided information for this review.

Mortality rates from 13 types of diseases or disease groups were evaluated as part of the mortality statistics review (see list, at right). Lung and bronchus cancer, cancer of the peritoneum, retroperitoneum, and pleura—including mesothelioma, asbestosis, and digestive organ cancers were evaluated because of their known or suspected association with asbestos exposure. Respiratory system and intrathoracic organ cancers, cancer with no specification of site, pneumoconioses, and chronic obstructive pulmonary disease were evaluated because these deaths might actually have resulted from misdiagnosed asbestos-related diseases. Chronic obstructive pulmonary disease, disease of the pulmonary circulation, and other diseases of the respiratory system were evaluated because asbestos-exposure might have worsened these conditions and led to premature death. Finally, all types of cancer, female breast cancer, and prostate cancer were evaluated to determine whether causes of death were underreported to the registries that provided information for the mortality statistics review.

The cancer statistics review evaluated the following types of cancer:

Lung and bronchus
Mesothelioma
Digestive organs
Peritoneum, retroperitoneum, and pleura
Respiratory system and intrathoracic organs
All types of cancer
Female breast
Prostate

The mortality statistics review evaluated death from the following diseases:

Lung and bronchus cancer
Cancer of the peritoneum, retroperitoneum and pleura – including mesothelioma
Asbestosis
Digestive organ cancers
Respiratory system and intrathoracic organ cancers
Cancer – no specification of site
Pneumoconioses
Chronic obstructive pulmonary disease
Diseases of pulmonary circulation
Other diseases of respiratory system
All types of cancer
Female breast cancer
Prostate cancer

Studying mesothelioma

During the years that were evaluated in this review, cancer and causes of death were coded in cancer registries and on death certificates according to two classification systems: the International Classification of Diseases—Oncology Codes, Revision 2 (ICD-O-2) (used by cancer registries), and the International Classification of Diseases, Injury, and Causes of Death Codes, Revision 9 (ICD-9) (used for death certificates).

The ICD-O-2 system has a specific code for mesothelioma, which makes it possible to evaluate the incidence rate of this cancer in the Newark community. In contrast, the ICD-9 system does not have a specific code for mesothelioma. Therefore, it is not possible to analyze mortality rates for mesothelioma alone; only a larger group of diseases (cancer of the peritoneum, retroperitoneum, and pleura—including mesothelioma) can be studied. Nearly all of the deaths in this cancer group are, in fact, deaths from mesothelioma (W. Kaye, ATSDR, personal communication, 2004). So, evaluating mortality from this group of cancers reflects, with relative accuracy, the occurrence of death from mesothelioma.

Study Populations

As discussed earlier in this health consultation, whether people who lived near the Newark plant between 1967 and 1992 were exposed to hazardous levels of asbestos from Libby vermiculite, and if so, which areas of Newark experienced such exposure, is currently unknown.

Therefore, the first step of the health statistics review was to determine which area near the Newark plant was most likely to have experienced an increased burden of asbestos-related disease (assuming that the Newark plant did pollute the surrounding air with hazardous levels of asbestos). CDHS concluded that the population living within ½-mile of the Newark plant site was the most likely population to have been exposed to levels of asbestos high enough to cause a detectable excess burden of asbestos-related disease. This distance was selected on the basis of information presented in this health consultation and information from health studies of lung cancer and mesothelioma rates in communities near asbestos industries [7-10].

Figure E–1 shows the location of the Newark plant and the area of Newark that is located within ½-mile of the facility. The health statistics review would ideally evaluate the incidence and mortality rates of asbestos-related disease in the population residing in this area. But the smallest geographic area on which cancer statistics are publicly available is the **census tract** (providing information on a smaller geographic area could make it possible to identify a cancer patient, and thus would violate their right to privacy). For similar reasons pertaining to privacy, the smallest geographic area on which mortality statistics are publicly available is the ZIP Code.

Census tracts are small geographic areas defined by the U.S. Census Bureau. Census tracts usually have 2,500 to 8,000 residents with similar population characteristics, economic status, and living conditions.

Therefore, for the cancer statistics review, CDHS studied the population living in census tract 4446. For the mortality statistics review, CDHS studied the population residing in ZIP Code 94560. Figure E–2 shows the location of the Newark plant, the area that CDHS determined was most likely to experience an excess of asbestos-related disease, and census tract 4446. Figure E–3 shows the location of the Newark plant, the area that CDHS determined was most likely to experience an excess of asbestos-related disease, and ZIP Code 94560.

Figure E–1. Area of Newark that is most likely to have been exposed to levels of asbestos high enough to cause a detectable excess burden of asbestos-related disease, assuming that the Newark plant polluted the outside air with hazardous levels of asbestos.

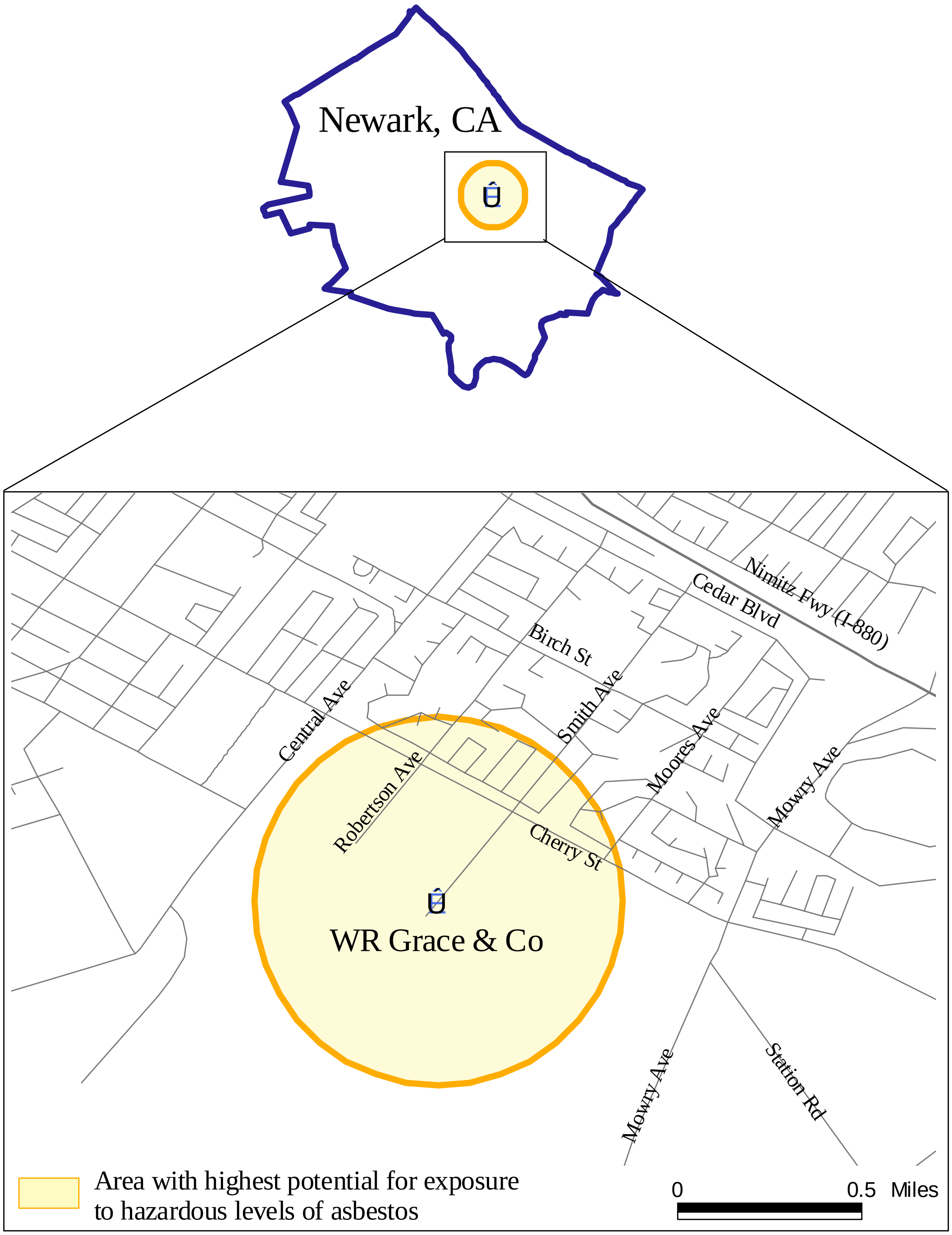


Figure E–2. Map of Census Tract 4446 in Relationship to the Area Located Within ½ Mile of the Newark Plant, Newark, California.

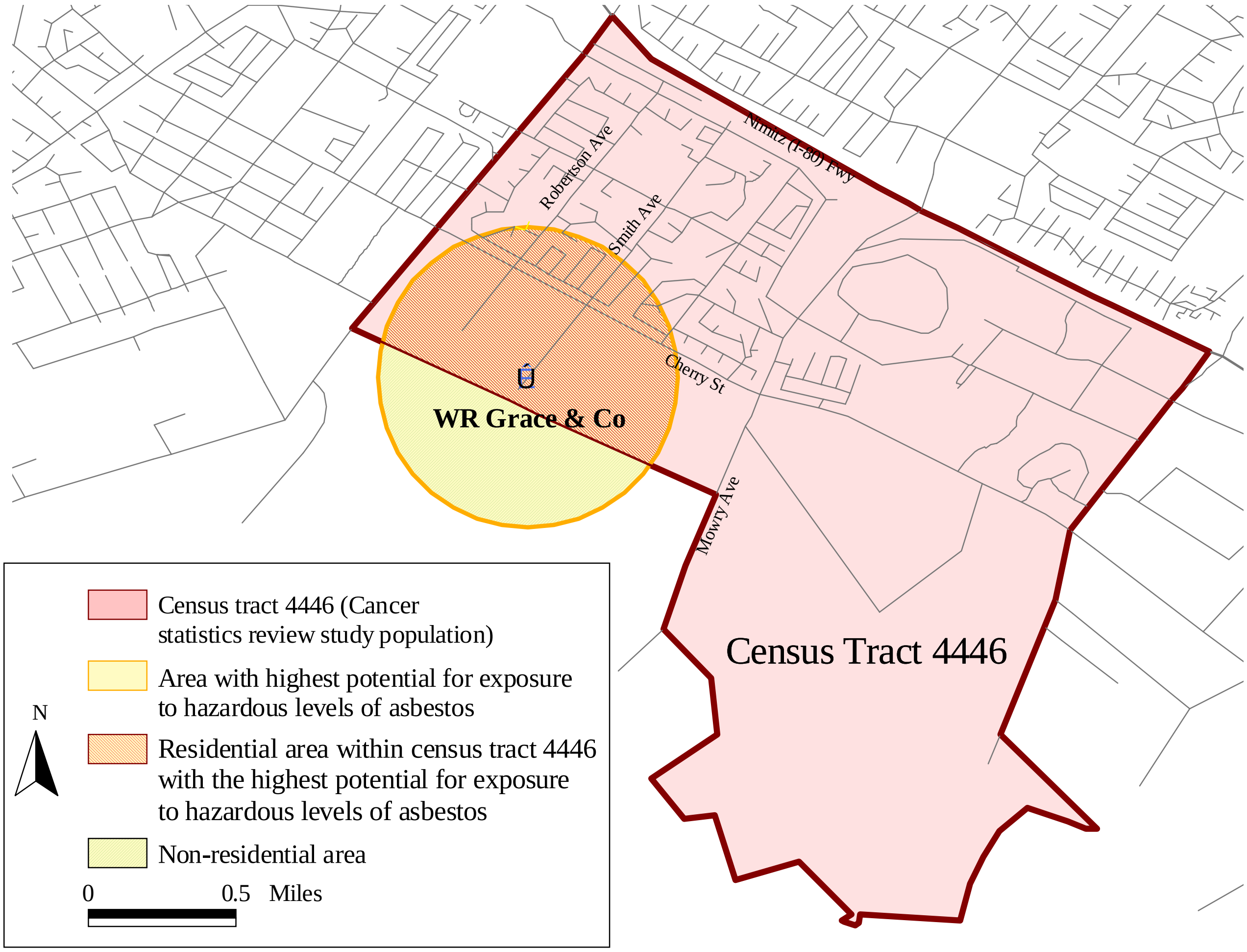
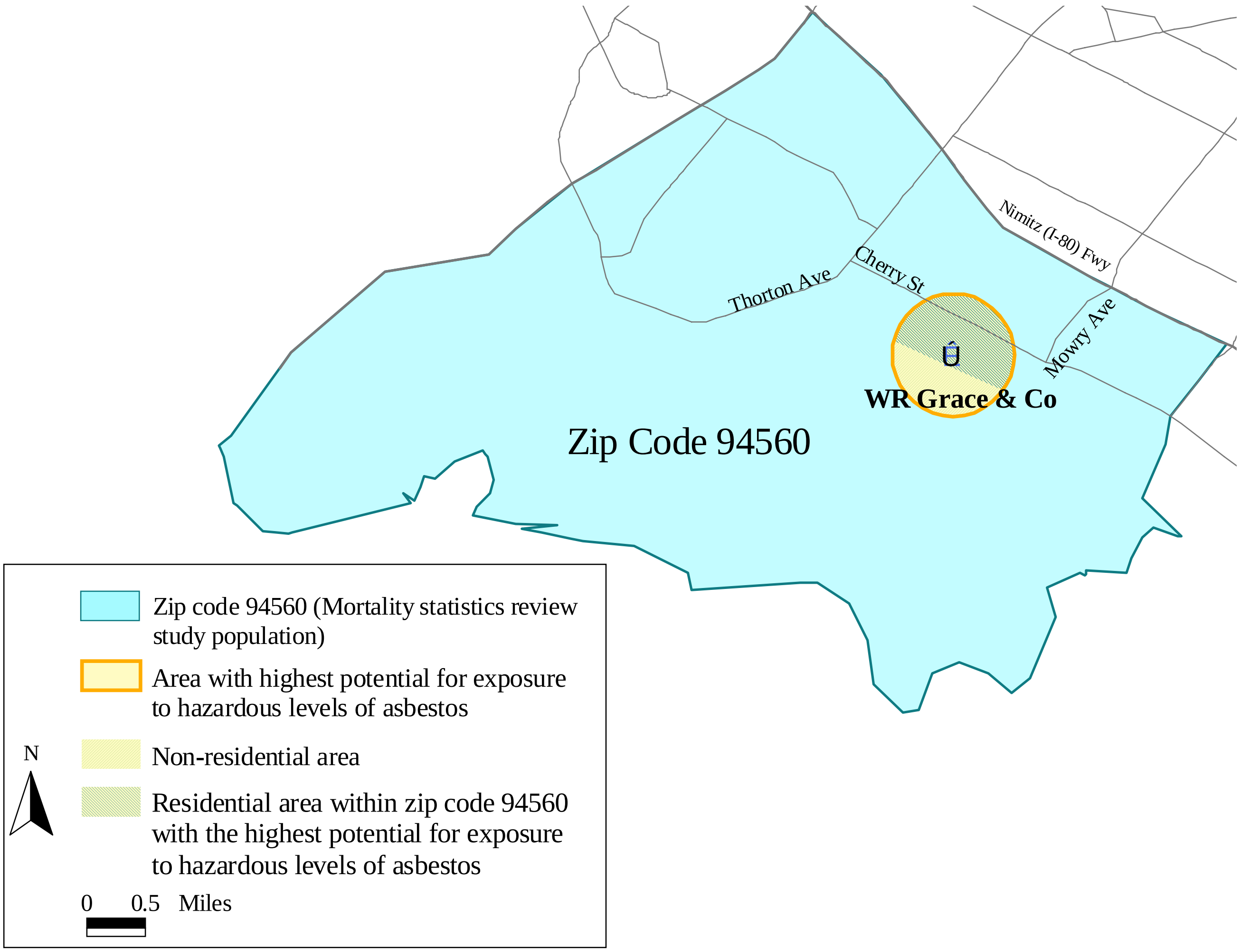


Figure E–3. Map of ZIP Code 94560 in Relationship to the Area Located Within ½ Mile of the Newark Plant, Newark, California.



Study Periods

The cancer statistics review studied the period from January 1, 1986, through December 31, 1995, and the mortality statistics review studied the period January 1, 1989, through December 31, 1998. ATSDR selected these periods for two reasons: (1) they come closest to corresponding to the time of exposure and the latency period of asbestos-related disease, and (2) a 10-year period provides the minimum amount of data required for informative statistical analysis [4].

Demographic Information on the Study Populations

In 1990, there were 7,785 people residing in census tract 4446 and 37,861 people residing in ZIP Code 94560 (see Table E–1). Both study populations had equal number of males and females and were primarily white, with sizeable Asian/Pacific Islander and Hispanic-white populations. Compared with the U.S. population as a whole, the study populations had fewer people age 65 and older and had a higher socioeconomic status, as measured by educational attainment, the percentage of people in the labor force, employment status, and poverty status.

Table E–1. Demographic Characteristics of the Populations Living in Census Tract 4446, ZIP Code 94560, and in the United States [11]

	Census Tract 4446	ZIP Code 94560	United States
Total population	7,785	37,861	
Sex			
males	50%	50%	49%
females	50%	50%	51%
Race/Ethnicity			
non-Hispanic			
White	63%	58%	76%
Black	4%	4%	12%
Asian/Pacific Islander	18%	15%	3%
Hispanic			
White	8%	11%	5%
Asian/Pacific Islander	1%	1%	0%
Other race	5%	10%	4%
Age			
under 18	26%	28%	27%
18–64	71%	66%	60%
65 and over	4%	5%	13%
Education			
up to 9th grade	3%	7%	7%
some high school	8%	15%	11%
high school graduate	24%	26%	22%
some college or higher	64%	52%	34%
Employment			
in labor force	83%	77%	65%
not in labor force	17%	23%	35%
employed	95%	95%	94%
unemployed	5%	5%	6%
Poverty			
income below poverty level	2%	5%	13%

Statistical Analysis

The statistical analysis was designed to screen for an excess of asbestos-related disease in communities with facilities that received Libby vermiculite [4]. Specifically, the analysis explored the following questions.

1. Is the number of people who were diagnosed with an asbestos-related cancer while residing in census tract 4446 from 1986–1995 higher than what we would expect if the incidence rates of these cancers in census tract 4446 population were the same as the rates in the U.S. population as a whole?

2. Are the incidence rates of asbestos-related cancers in census tract 4446 population from 1986–1995 higher than the rates in the U.S. population as a whole?

3. Is the number of people who died from asbestos-related disease while residing in ZIP Code 94560 from 1989–1998 higher than what we would expect if the mortality rates in the ZIP Code 94560 population were the same as the mortality rates in the U.S. population?

4. Are the mortality rates for asbestos-related disease in the ZIP Code 94560 population from 1989–1998 higher than the mortality rates for the U.S. population as a whole from 1989–1998?

These four questions are similar in that they all compare the incidence and mortality rates in the Newark community with the incidence and mortality rates in the U.S. population as a whole. They differ, however, in how the comparison is made.

Statistical Measures of Comparison

The first question is explored by calculating a statistical measure called the **standardized incidence ratio (SIR)**. The SIR is a numerical expression. In this review the SIR compares how many people in the census tract 4446 population were diagnosed with cancer and how many diagnoses would be expected (hypothetically) if the incidence rate of cancer in the census tract 4446 population was the same as the incidence rate of cancer in the U.S. population. Details on how the SIR is calculated are provided in Addendum 1. If the number of people who were diagnosed with an asbestos-related cancer while residing in census tract 4446 is the same as the expected number, the SIR will equal 1. If the number of people in the census tract 4446 population who were diagnosed with an asbestos-related cancer is less than the expected number, the SIR will be less than 1. If the number of people in the census tract 4446 population who were diagnosed with an asbestos-related cancer is more than one would expect, the SIR will be greater than 1.

The second question is explored by calculating a statistical measure called the **standardized rate ratio (SRR)**. The SRR is a numerical expression, and in this review the SRR compares how many people in the United States were diagnosed with cancer and how many would be expected (hypothetically) if the U.S. population had the same incidence rates of cancer as the census tract 4446 population. Details on how the SRR is calculated are provided in Addendum 2. If the incidence rate of cancer in the U.S. population is the same as that in the census tract 4446 population, the SRR will equal 1. If the incidence rate of cancer in the U.S. population is lower than the incidence rate in the census tract 4446 population, the SRR will be less than 1. If the incidence rate of cancer in the U.S. population is higher than that in the census tract 4446 population, the SRR will be greater than 1.

The third question is explored by calculating a statistical measure called the **standardized mortality ratio (SMR)**. The SMR is essentially the same measure as the SIR except that it evaluates the number of people who died from a disease rather than the number of people who were diagnosed with a disease. Thus the SMR is a numerical expression that compares how many people in ZIP Code 94560 died of an asbestos-related disease and how many would be expected to die (hypothetically) if the mortality rates of asbestos-related disease in the ZIP Code 94560 population were the same as the mortality rates in the U.S. population. Details on how the SMR is calculated are provided in Addendum 3. If the number of people who died from an asbestos-related disease while residing in ZIP Code 94560 is the same as the expected number, the SMR will equal 1. If the number of ZIP Code 94560 residents who died from an asbestos-related disease is less than the expected number, the SMR will be less than 1. If the number of persons in ZIP Code 94560 who died from an asbestos-related disease is more than would be expected, the SMR will be greater than 1.

Finally, the fourth question is also answered by calculating a standardized rate ratio (SRR), but for mortality rates instead of cancer incidence rates. In this review the SRR is a numerical expression that compares the number of people in the United States who died from an asbestos-related disease and the number of people in the United States who would be expected (hypothetically) to die if the U.S. population had the same mortality rates as the ZIP Code 94560 population.

Interpreting the expected number of people to get a disease or die from a disease

The SIR, SMR, and SRR all compare the actual number of persons who get a disease or die from a disease with an expected number. This expected number of persons is a calculated and theoretical number that is often not a whole number. For example, the expected number might be 2.6 persons. Because it is not possible for a fraction of a person to get or die from a disease, the expected number can be thought of as an approximation. In this example, the expected number (2.6 persons) can be interpreted to mean that either 2 or 3 persons are expected to get a disease or die from a disease.

Accounting for differences between the study populations and the comparison population

In this review, the incidence and mortality rates of disease in the Newark and U.S. populations are compared because it is thought that the Newark population might have higher rates of disease due to past exposure to harmful levels of asbestos. But other characteristics can also increase the risk for developing many of the diseases linked to asbestos. If the study populations differ from the U.S. population in terms of how common these characteristics are, then these differences can bias (that is, create a faulty appearance in) the results of the comparison unless they are accounted for in the analysis. For example, smoking can increase the risk of developing lung cancer. If smoking rates in the Newark populations are lower than the smoking rates in the U.S. population, but the analysis does not adjust for this difference, then the study populations might appear to have lower rates of lung cancer in comparison with the U.S. population than they in fact do. This bias can hide a true excess of disease or create the appearance of an excess when none really exists.

This analysis did account for differences in age and sex, but did not account for other risk factors for asbestos-related disease (for example, smoking, race/ethnicity, or socioeconomic status).

Statistical Tests

The number of people who get or die from cancer or other diseases in a given geographic area changes from year to year; this fluctuating pattern is characteristic of the occurrence of disease and is expected. Because of this, the values of the SIR, the SMR, and the SRR will also change, depending on which time period is under study. If the number of cases occurring in one time period under study is higher than average, then the SIR, SMR, or SRR will be higher than 1 (for example, 1.2). If a different time period were under study and the number of cases were lower than average, the SIR, SMR, and SRR would be less than 1 (for example, 0.9). Some degree of fluctuation in the SIR, SMR, and SRR values from one time period to another is normal and expected.

An important question is when is an SIR, an SMR, or an SRR higher or lower than what would be expected, given that the number of people getting disease in a given geographic area normally varies over time? In other words, is the incidence rate or mortality rate in the Newark population the same as that in the U.S. population, or is disease or death occurring less or more frequently in the Newark population than in the U.S. population as a whole?

To answer this question, a statistical test measure called a **confidence interval (CI)** was calculated for the SIR, the SMR, and the SRR using Byar's approximation method [12]. A confidence interval is a range of possible values for the SIR, SMR, or SRR that are consistent with the normal variation in disease over time in a geographic area. If the CI range includes the value one, then there is no "statistically significant" difference between the incidence or mortality rates in the Newark and U.S. populations, as represented by the SIR, SMR, or SRR. In other words, the incidence or mortality rate in the Newark population is the same as the incidence or mortality rate in the U.S. population. If the CI range is less than one or greater than one, then there is a "statistically significant" difference between the incidence or mortality rates in the two populations, and the incidence rate or mortality rate in the Newark population is not the same as the incidence rate or mortality rate in the U.S. population.

Part of the process of calculating a confidence interval includes selecting a level of certainty for this statistical test. CDHS used a 95% level of certainty, which is the standard value selected for these types of analyses.

Sources of Information on Incidence and Mortality Rates

Information on the number of people who developed cancer while residing in census tract 4446 was obtained from the California Cancer Registry (CCR). Information on cancer rates in the U.S. population was obtained from the Surveillance, Epidemiology, and End Results program of the National Cancer Institute (SEER) [13].

Information on the number of people who died while residing in ZIP Code 94560 was obtained from CDHS, Center for Health Statistics, Office of Vital Records (CDHS-OVR). Information on mortality rates in the U.S. population was obtained from the National Center for Health Statistics (NCHS) [14].

Results of the Cancer Statistics Review

The standardized incidence ratios and standardized rate ratios for the census tract 4446 population are presented in Table E–2.

For each cancer group studied, Table E–2 shows the reason for studying that type of cancer.

For the SIR analysis, Table E–2 shows

- the number of persons who were diagnosed with the type of cancer while residing in census tract 4446
- the number of persons expected to be diagnosed (if the census tract 4446 population had the same incidence rate as the U.S. population), and
- the SIR and 95% CI for the SIR.

For the SRR analysis, Table E–2 shows

- the number of persons who were diagnosed with the type of cancer while residing in the United States
- the number of persons expected to be diagnosed (if the U.S. population had the same incidence rate as the census tract 4446 population), and
- the SRR and the 95% CI for the SRR.

Table E–2. Standardized Incidence Ratio (SIR), Standardized Rate Ratio (SRR), and 95% Confidence Interval (CI) of Selected Cancers in the Census Tract 4446 Population, 1986–1995

		Census Tract 4446			United States.		
Cancer Group (ICD-O-2 Code)	**Reason†**	**# of diagnoses**	**expected #**	**SIR (95% CI)**	**# of diagnoses**	**expected #**	**SRR (95% CI)**
Lung and bronchus (C340:C349*)	1	29	27.2	1.07 (0.71–1.53)	148,246	177,777.3	1.20 (0.79, 1.82)
Mesothelioma (M-9050:9053)	1	1	0.4	2.49 (0.03–13.87)	2,360	2,573.7	1.09 (0.15, 7.72)
Digestive organs (C150: C218, C260:C269*)	2	25	27.0	0.92 (0.60–1.36)	163,384	156,787.4	0.96 (0.62, 1.48)
Respiratory system and intrathoracic organs (C320:C399*)	3	32	30.1	1.06 (0.73–1.50)	162,067	192,230.4	1.19 (0.79, 1.77)
Peritoneum, retroperitoneum, and pleura (C480:C488, C384*)	3	3	0.7	4.06 (0.82–11.85)	3,814	14,463.5	3.79 (0.87, 16.61)
All cancers (C000:C809*)	4	197	205.2	0.96 (0.83–1.10)	1,045,968	1,057,077.3	1.01 (0.85–1.20)
Female breast (C500:C509*)	4	43	34.3	1.25 (0.91–1.69)	154,568	196,966.3	1.27 (0.91–1.78)
Prostate (C619*)	4	24	22.4	1.07 (0.69–1.59)	153,845	169,339.6	1.10 (0.70–1.73)

* excluding M-9590:9989

† Reason for studying:

1. Exposure to asbestos is known to cause a type of cancer in this cancer group.
2. There is some, but inconclusive, evidence that exposure to asbestos might be associated with some digestive organ cancers.
3. This cancer group might include people with an asbestos-related cancer that was misdiagnosed.
4. This cancer or cancer group was studied to confirm that information on cancer diagnoses is reported to CCR and SEER in a consistent manner.

Between 1986 and 1995, the incidence rates of asbestos-related cancers in the census tract 4446 population were not statistically significantly different from the incidence rates in the U.S. population. Twenty-nine persons were diagnosed with lung or bronchial cancer, when 27.2 diagnoses would be expected if the incidence rate in the census tract 4446 population was the same as the incidence rate in the U.S. population (SIR=1.07). The 95% CI (0.71–1.53) indicates that there is no statistically significant difference between the incidence rates of lung and bronchus cancer in the census tract 4446 population and the U.S. population, as measured by the SIR. Similarly, the SRR for lung and bronchus cancer was 1.20, with a 95% CI of (0.79–1.82). There is also no statistically significant difference between the incidence rates of lung and bronchus cancer in the census tract 4446 population and U.S. populations, as measured by the SRR. One person was diagnosed with mesothelioma, when 0.4 diagnoses would be expected if the census tract 4446 population had the same incidence rate as the U.S. population (SIR=2.49). However, the 95% CIs for the SIR (0.03–13.87) and the SRR (0.15–7.72) indicate that there is no statistically significant difference between the incidence rate of mesothelioma in the census tract 4446 population and that in the U.S. population during the years 1986–1995.

Between 1986 and 1995 the incidence rate of digestive organ cancers in the census tract 4446 population was not statistically significantly different from the incidence rate in the U.S. population, as measured by the SIR analysis (SIR=0.92; 95% CI, 0.60–1.36) and the SRR analysis (SRR=0.96; 95% CI, 0.62–1.48).

The incidence rate of cancer of the respiratory system and intrathoracic organs in the census tract 4446 population was not statistically significantly different from the incidence rate in the U.S. population, as evaluated by the SIR analysis (SIR=1.06; 95% CI, 0.73–1.50) and the SRR analysis (SRR=1.19; 95% CI, 0.79–1.77). Neither was the incidence rate of cancer of the peritoneum, retroperitoneum, and pleura in the census tract 4446 population statistically significantly different from that in the U.S. population (SIR=4.06; 95% CI 0.82–11.85) and (SRR=3.79; 95% CI, 0.87–16.61).

Finally, according to both the SIR and SRR analyses, the incidence rates of all types of cancer, female breast cancer and prostate cancer in the census tract 4446 population were not statistically significantly different from the incidence rates in the U.S. population. For all types of cancer, the SIR=0.96 and 95% CI, 0.83–1.10; and the SRR=1.01 and 95% CI, 0.85–1.20. For female breast cancer, the SIR=1.25 and 95% CI, 0.91–1.69; and the SRR=1.27 and 95% CI, 0.91–1.78. For prostate cancer, the SIR=1.25 and 95% CI, 0.91–1.69; and the SRR=1.27 and 95% CI, 0.91–1.78.

Results of the Mortality Statistics Review

Standardized mortality ratios and standardized rate ratios for the ZIP Code 94560 population are presented in Table E–3.

For each disease group studied, Table E–3 shows the reason for studying the disease.

For the SMR analysis, Table E–3 shows

- the number of persons who died from the disease while residing in ZIP Code 94560
- the number of persons expected to die (if this population had the same disease mortality rate as the U.S. population), and
- the SMR and 95% CI for the SMR.

For the SRR analysis, Table E–3 shows

- the number of persons who died from the disease while residing in the United States
- the number of persons expected to die (if the U.S. population had the same disease mortality rate as the ZIP Code 94560 population), and
- the SRR and 95% CI for the SRR.

Table E-3. Standardized Mortality Ratio (SMR), Standardized Rate Ratio (SRR), and 95% Confidence Interval (CI) of Selected Causes of Death Occurring in ZIP Code 94560, 1989–1998

Cause of Death (ICD-9 Code)	Reason *	ZIP Code 94560 # deaths	ZIP Code 94560 expected #	SMR (95% CI)	United States # deaths	United States expected #	SRR (95% CI)
Cancer of the lung and bronchus (162.2–162.9)	1	125	124.3	1.01 (0.84–1.2)	**1,476,326**	**1,720,846.9**	**1.17 (1.06–1.28)**
Cancer of the peritoneum, retroperitoneum, and pleura (including mesothelioma) (158, 163)	1	0	0.9	0 (0–4.10)†	10,615	0.0	0‡
Asbestosis (501)	1	1	0.2	4.59 (0.06–25.55)	**3,367**	**11,762.6**	**3.49 (1.29–9.45)**
Cancer of the digestive organs (150–154, 159)	2	74	63.4	1.17 (0.92–1.47)	**832,523**	**1,220,903.3**	**1.47 (1.31–1.64)**
Cancer of the respiratory system and intrathoracic organs (161–165)	3	126	128.7	0.98 (0.82–1.17)	1,524,872	1,727,613.3	1.13 (1.03–1.24)
Cancer - no site specified (199)	3	34	25.9	1.31 (0.91–1.84)	327,646	479,557.6	1.46 (1.24–1.73)
Pneumoconioses (500–505)	3	1	0.7	1.37 (0.02–7.64)	11,617	11,762.6	1.01 (0.37–2.74)
Chronic obstructive pulmonary disease (490–496)	3, 4	79	65.2	1.21 (0.96–1.51)	**986,772**	**1,295,895.0**	**1.31 (1.17–1.47)**
Other diseases of the respiratory system (510–519)	4	8	12.5	0.64 (0.28–1.26)	172,155	119,782.5	0.70 (0.46–1.05)
Diseases of pulmonary circulation (415–417)	4	3	9.9	0.30 (0.06–0.88)	119,554	32,643.9	0.27 (0.11–0.66)
All cancers (140–208)	5	381	429.9	0.89 (0.8–0.98)	5,259,810	5,444,169.4	1.04 (0.98–1.09)
Female breast cancer (174)	5	46	38.8	1.18 (0.87–1.58)	430,680	629,663.4	1.46 (1.21–1.77)
Prostate cancer (185)	5	17	20.4	0.83 (0.49–1.34)	334,151	303,150.5	0.91 (0.69–1.19)

*Reason for studying:

1. Exposure to asbestos is known to cause a type of cancer in this cancer group or this disease.
2. There is some, but inconclusive, evidence that exposure to asbestos might be associated with some digestive organ cancers.
3. This cancer group might include people with an asbestos-related cancer that was misdiagnosed.
4. Exposure to asbestos might have exacerbated the condition of people with these diseases and thereby led to premature or increased chance of death.
5. This cancer or cancer group was studied to confirm that information is reported to the CDHS-OVR and the NCHS in a consistent manner.

† Exact confidence interval based on Poisson distribution.

‡ Confidence interval not calculated since expected number of deaths was 0 (W. Kaye, ATSDR, personal communication, 2004). **Bold** typeface indicates a statistically significant result.

The mortality statistics review found inconsistent evidence that the ZIP Code 94560 population experienced statistically significantly higher rates of death from some asbestos-related disease than the U.S. population between the years 1989–1998. First, according to the SMR analysis, the mortality rate of cancer of the lung and bronchus in the ZIP Code 94560 population was not statistically significantly different from the rate in the U.S. population (SMR=1.01; 95% CI, 0.84–1.20). In contrast, the SRR analysis indicates that the mortality rate of cancer of the lung and bronchus in the ZIP Code 94560 population was statistically significantly different from the rate in the U.S. population (SRR=1.17; 95% CI, 1.06–1.28). Second, neither the SMR nor the SRR analysis indicated that the rate of death from cancer of the peritoneum, retroperitoneum, and pleura (including mesothelioma) in the ZIP Code 94560 population was different from the rate in the U.S. population (SMR=0, because no deaths from these cancers occurred; 95% CI, 0–4.10;and SRR=0). Finally, the ZIP Code 94560 population did not experience statistically significantly different rates of death from asbestosis than the U.S. population, as evaluated by the SMR analysis (SMR=4.59; 95% CI, 0.06–25.55). In contrast, the SRR analysis indicates that the ZIP Code 94560 population did have statistically significantly higher rates of death from asbestosis than the U.S. population (SRR=3.49; 95% CI, 1.29–9.45).

The mortality statistics review also found inconsistent evidence that the ZIP Code 94560 population experienced statistically significantly higher rates of death from digestive organ cancers, which have been inconclusively linked to asbestos exposure in previous epidemiologic studies. Between 1989 and 1999, the rate of death from digestive organ cancers in the ZIP Code 94560 population was not statistically significantly different from the rate in the U.S. population, as measured by the SMR analysis (SMR=1.17; 95% CI, 0.92–1.47). In contrast, the SRR analysis did indicate that the mortality rate for digestive organ cancers in the ZIP Code 94560 population was statistically significantly higher than the rate in the U.S. population (SRR=1.47; 95% CI, 1.31–1.64).

The mortality statistics review also found inconsistent evidence that the ZIP Code 94560 population experienced statistically significantly higher rates of death from cancer of the respiratory system and intrathoracic organs, cancer with no site specified, and chronic obstructive pulmonary disease than the U.S. population. According to the SMR analysis, the rates of death from these diseases in the ZIP Code 94560 population were not statistically significantly different from the mortality rates in the U.S. population: SMR=0.98, 95% CI 0.82–1.17 for cancer of the respiratory system and intrathoracic organs; SMR=1.31, 95% CI 0.91–1.84 for cancer with no site specified; and SMR=1.21, 95% CI 0.96–1.51 for chronic obstructive pulmonary disease. In contrast, the SRR analysis indicates that the mortality rates for these diseases in the ZIP Code 94560 population were statistically significantly higher than the rates in the U.S. population: SRR=1.13, 95% CI 1.03–1.24 for cancer of the respiratory system and intrathoracic organs; SRR=1.46, 95% CI 1.24–1.73 for cancer with no site specified; and SRR=1.31, 95% CI 1.17–1.47 for chronic obstructive pulmonary disease. Neither the SMR nor the SRR analysis indicated that the ZIP Code 94560 population experienced statistically significantly different rates of death from pneumoconioses (SMR=1.37, 95% CI 0.02–7.64; and SRR=1.01, 95% CI 0.37, 2.74).

The SMR analysis indicates that the rate of death from all types of cancer in the ZIP Code 94560 population was statistically significantly lower than the mortality rate in the U.S. population

(SMR=0.89; 95% CI, 0.80–0.98), but the SRR analysis does not (SRR=1.04; 95% CI 0.98–1.09). The SMR analysis does not indicate that the ZIP Code 94560 female population experienced statistically significantly higher rates of death from breast cancer than the U.S. female population (SMR=1.18; 95% CI, 0.87–1.58), but the SRR analysis does (SRR=1.46; 95% CI, 1.21–1.77). And neither the SMR nor the SRR analysis demonstrates that the ZIP Code 94560 male population had statistically significantly different rates of death from prostate cancer than the U.S. male population (SMR=0.83; 95% CI, 0.49–1.34 and SRR=0.91; 95% CI, 0.69–1.19).

Discussion

Five limitations of this analysis are worth discussion and exploration because they might (1) affect the accuracy of the results, (2) limit the ability of the analyses to observe an excess of asbestos-related disease attributable to vermiculite processing at the Newark plant, if one exists, or (3) limit the degree to which this analysis can serve as an indicator of community exposure to Libby asbestos.

1. **The SIR, SMR, and SRR results might be biased if the analyses do not account for the ways that the Newark and U.S. population differ with respect to other risk factors for asbestos-related diseases (such as race/ethnicity, socioeconomic status, and smoking).**

As discussed previously, this analysis does not account for all the ways that the Newark population differs from the U.S. population with respect to risk factors for diseases that can be caused by exposure to asbestos. As a result, this analysis might not accurately identify an excess or lack of excess of disease attributable to asbestos exposure.

To assess whether the Newark and U.S. populations differ with respect to other risk factors for asbestos-related disease, CDHS gathered information from the U.S. Census. **Table E–1** shows that the population in census tract 4446 differs substantially from the U.S. population in terms of race/ethnicity and socioeconomic status (measured by education level and poverty status). So, too, does the ZIP Code 94560 population differ substantially from the U.S. population in terms of these characteristics. No information on smoking rates in the study populations is available. That said, however, smoking has historically been less common in California [15], and, since the late 1980s, smoking rates in California have been declining more rapidly than the rest of the country [16]. Smoking rates also tend to be higher among people of low socioeconomic status [17] and tend to differ by race and ethnicity [18-20]. Using these statewide trends, it is likely that the smoking rates in the Newark study populations are different from those in the U.S. population.

It is not possible to predict whether or how the combined racial, ethnic, and socioeconomic differences between the study and U.S. populations could bias the analysis (in other words, whether they could be masking a true elevation in rates of asbestos-related disease.) However, any conclusions drawn from this health statistics review could be made more definitively if these differences were accounted for in the SIR, SMR, and SRR analyses.

2. **The results of the analyses might be inaccurate if the study populations are larger or smaller than they are assumed to be.**

Information on the size of the study populations during the study periods (1986–1995 for the cancer statistics review and 1989–1998 for the mortality statistics review) is needed to calculate the SIR, SMR, and SRRs as well as the 95% CIs. Information on the size of the populations in census tracts and ZIP codes is collected by the U.S. Census once every decade, but not during the intervening years. Therefore, to calculate the statistical measures of comparison, ATSDR made the customary assumption that the size of the study populations in 1990 (as determined by the U.S. Census) represents the average size of the populations during the study periods.

If this assumption does not hold true, then the results of the SIR, SMR, and SRR analyses will be biased (inaccurate). Specifically, if the size of the study populations in 1990 is smaller than the average size of the study populations during the study periods, then the SIR, SMR, and SRR will be inaccurately high numbers, and the statistical tests might falsely indicate a statistically significant excess of disease. And, conversely, if the size of the study populations in 1990 is larger than the average size of the study populations during the study periods, then the SIR, SMR, and SRR will be inaccurately low numbers, and the statistical tests might falsely indicate a lack of disease excess.

Without knowing the true size of the study populations during the study periods, it is not possible to predict whether these statistical measures might be biased or how they might be biased. Still, it is possible to obtain some sense of whether any bias is occurring by referring to information on the size of these populations during U.S. Census years (e.g. 1980, 1990). According to U.S. Census data, the census tract 4446 population grew by 60% between 1980 and 1990 and by 13% between 1990 and 2000 [21]. If these trends represent the growth of the census tract population between 1986 and 1995, then the assumed size of the cancer statistics review study population is smaller than the actual size. This difference will bias the values of the SIR, SRR, and 95% CIs in a way that makes them higher than they actually are.

The ZIP Code 94560 population grew 12% between the years 1990 and 2000 [21]. If this trend represents the growth of this population during the years 1989 and 1998, then the assumed size of the mortality statistics review study population is smaller than the true size. This difference will bias the values of the SMR, SRR, and 95% CIs in a way that makes them higher than they actually are.

In summary, if more accurate information on population size was used in the analysis, then the values of the SIRs, SMRs, and SRRs would be lower than they were in these results: the incidence and mortality rates in the Newark study populations might be even lower, in comparison to the rates in the U.S. population, than this analysis indicates.

3. **The analysis might fail to observe a true excess of asbestos-related cancer and disease if the study populations include people who could not have been exposed to asbestos from the processing of vermiculite at the Newark plant.**

This health statistics review would ideally evaluate the health status of only those people who were exposed to asbestos from the processing of Libby vermiculite at the Newark plant, assuming that off-site contamination and exposure did occur. The effect of including people who were not exposed to asbestos in the study population is to lessen the ability to see an excess of asbestos-related disease in the population. This happens because the people who were never exposed to asbestos can make the population appear healthier than it would otherwise appear if they were not included in the analysis.

Due to several reasons (such as lack of information on whether asbestos pollution from the Newark plant occurred, lack of information on how far the asbestos pollution would have traveled in the air, and restrictions on the geographic area for which cancer and mortality statistics are available), it is likely that this health statistics review evaluated the occurrence of asbestos-related cancers and death in a population that included people who were never exposed to asbestos. Therefore, the SIRs, SMRs, SRRs and 95% CIs are likely to be smaller numbers than they would be if unexposed people were not included in the study population. The incidence and mortality rates in the Newark population might be higher, in comparison to the rates in the U.S. population, if the study populations only included people who were exposed to Libby asbestos from the processing of Libby vermiculite at the Newark plant.

4. **The analysis might fail to observe a true excess of asbestos-related cancers and disease, attributable to vermiculite processing at the Newark plant if the study periods do not correspond to the years that this excess of disease would be expected to occur.**

The diseases caused by exposure to asbestos take many years to develop. Current knowledge is that lung cancer will develop 20 to 30 years after exposure to asbestos, mesothelioma will develop 30 to 40 years after exposure, and asbestosis will develop 10 to 20 years after exposure. The Newark plant received shipments of Libby vermiculite between the years 1967 and 1992. Therefore, we would expect that any lung cancer caused by exposure to Libby asbestos would occur between 1987–2022, any mesothelioma caused by exposure to Libby asbestos would occur between 1997–2032, and any asbestosis caused by exposure to Libby asbestos would occur between 1977–2012.

This health statistics review evaluated the incidence rates and mortality rates from asbestos-related diseases between the years 1985–1996 and 1989–1998, respectively. These study periods do not correspond entirely to the years that disease caused by exposure to Libby asbestos is most likely to occur (see **Table E–4**). Therefore, it is possible that this analysis did not find an excess of asbestos-related disease in the Newark community because this excess of disease has not yet occurred.

Table E–4. Years That Disease Due to Exposure to Libby Asbestos From Vermiculite Processing at the Newark Plant Would Be Expected To Occur (Assuming That Hazardous Exposure Occurred), and Number of Study Period Years During Which Exposure-Related Disease Is Expected To Occur

Disease	Years during which asbestos-related disease is most likely to occur (based on latency period)	Number of years of overlap between the study period and the years that asbestos-related disease is most likely to occur	
		Cancer Statistics Review (1986–1995)	*Mortality Statistics Review (1989–1998)*
Cancer of the lung and bronchus	1987–2022	9	10
Mesothelioma	1997–2032	0	2
Asbestosis	1977–2012	—	10

5. **The results of the health statistics review can serve as an indicator of community exposure to Libby asbestos only if the study populations include the people who were living near the Newark plant at the time that Libby vermiculite was processed.**

According to the protocol for this health statistics review, finding a statistically significant elevation in asbestos-related disease in a community would alert CDHS and ATSDR to the possibility that community members might have been exposed to asbestos as a result of the facility's handling or processing of vermiculite from Libby. This interpretation is based on an assumption that the study population consists of people who were exposed to Libby asbestos. Therefore, this interpretation is appropriate only if the study populations include the people who were living near the Newark plant during the time that Libby vermiculite was processed.

Cancer registry and vital statistics records do not collect information on residential history. Therefore it is not possible to determine whether the people in the study populations lived near the Newark plant during the years that Libby vermiculite was processed. However, information on population mobility from the U.S. Census can provide some insight into the likelihood that the study populations included the people who were living near the Newark plant during the years that Libby vermiculite was processed (1967–1992).

According to the 2000 U.S. Census, at least 36% and as many as 58% of the people residing in census tract 4446 in 2000 moved into their homes prior to 1992, and at least 38% and as many as 56% of the people residing in ZIP Code 94560 in 2000 moved into their homes prior to 1992 [22]. Therefore, the study populations are likely to include people who were living near the Newark plant during the years of potential exposure. Interpreting the results of this health statistics review as an indicator of past community exposure is therefore appropriate.

Summary

The cancer statistics review did not find any evidence that the census tract 4446 population experienced statistically significantly higher incidence rates of asbestos-caused cancers (lung cancer and mesothelioma) than the U.S. population during the years 1986–1995. The SIR and SRR results for the remaining cancers evaluated in this review indicate that an excess of asbestos-related cancers in this Newark population is not being obscured by physician misdiagnosis or discrepancies between the way that cancer diagnoses are reported to the CCR and SEER.

The mortality statistics review did find inconsistent evidence that the ZIP Code 94560 population experienced higher mortality rates from asbestos-related diseases than the U.S. population during the years 1989–1998. The SRR analysis indicated that the ZIP Code 94560 population had a 17% higher rate of death from lung and bronchus cancer and a 349% higher rate of death from asbestosis than the U.S. population, and that these differences were statistically significant. The SMR analysis also showed that the ZIP Code 94560 population had higher rates of death from these diseases than the U.S. population, but the statistical tests for this analysis indicated that these differences were consistent with normal variation in disease occurrence and therefore not unusual (not statistically significant). Although there were no recorded deaths from mesothelioma in the ZIP Code 94560 population, it is conceivable that deaths from mesothelioma were misdiagnosed and recorded as cancer – no site specified. If this were the case, then the ZIP Code 94560 population also had higher rates of death from mesothelioma, as measured by the SMR and the SRR. However, statistically speaking, only the SRR analysis found this elevation to be beyond what is considered normal.

Digestive organ cancers have been inconclusively linked to asbestos exposure in previous studies. This analysis found that the ZIP Code 94560 population had higher rates of death from digestive organ cancers than the U.S. population, as measured by the SMR and the SRR. However, statistically speaking, only the SRR analysis found the difference between the rates in the ZIP Code and U.S. populations to be unusual, given normal variation in the occurrence of these cancers.

The results of the mortality statistics review do not suggest that asbestos exposure led to premature or increased rates of death from respiratory and pulmonary diseases (chronic obstructive pulmonary disease, other diseases of the respiratory system, and diseases of the pulmonary circulation). There is also no evidence that the results are biased due to differences in the way that information on mortality is reported to the California Department of Health Services' Office of Vital Records and the National Center for Health Statistics.

A very similar protocol to the one used in this health statistics review identified a statistically significant excess of asbestos-related disease in the Libby, Montana, community. If the Newark study populations were similar to the Libby community in terms of level of exposure to Libby asbestos, population mobility, and other characteristics, then this type of analysis would be expected to also be able to detect a statistically significant excess of asbestos-related disease in the Newark community.

The Newark study populations differ from the Libby community in ways that increase the limitations of this type of analysis. Therefore, although the results of this health statistics review could be correctly reflecting that the health of the Newark community was not impacted by exposure to Libby asbestos, the lack of consistent evidence of disease excess could be due to any or all of the following reasons.

This analysis did not account for the ways in which the Newark and U.S. populations differ with respect to other risk factors for asbestos-related disease.

The assumptions about the size of the Newark study populations made the incidence and mortality rates in the Newark study populations appear more similar to the rates in the U.S. population than they truly are.

The study populations included people who were never exposed to Libby asbestos from the Newark plant, which also made the incidence and mortality rates in the Newark study populations appear more similar to the rates in the U.S. population than they truly are.

Given the years that exposure to Libby asbestos would have occurred, combined with the amount of time that asbestos-related disease takes to develop, this analysis might be failing to observe an excess of disease or death because the time period it evaluates precedes the time period that most of the disease attributable to Libby asbestos would occur.

These limitations do not negate the statistically significant excess of death from asbestos-related disease observed in this analysis, and the findings do not rule out the possibility that community members might have been exposed to hazardous levels of asbestos as a result of the facility's handling or processing of Libby vermiculite.

Conclusions

The number of people who were diagnosed with potentially asbestos-related cancers among the population living in the census tract of the W.R. Grace vermiculite-processing facility in Newark between 1986-1995 was not statistically significantly greater than would be expected, given the normal variation in the occurrence of cancer. The review used two different methods for comparison, which yielded similar results.

The mortality review analyzed the number of persons who died from potentially asbestos-related diseases living in the zip code of the facility between the years 1989-1998. These results were inconsistent. One method of comparison, the standardized rate ratio, found that mortality rates for cancer of the lung and bronchus, asbestosis, digestive organs, and chronic obstructive pulmonary disease, were statistically higher than that of the US population, although the other method of comparison, the standardized mortality ratio, did not.

The review did not find consistent evidence of elevated asbestos-related illness in the population near the W.R. Grace facility. However, the lack of consistent evidence of disease excess could be due to limitations of the analysis, rather than a lack of effect. These limitations include differences in risk factors for asbestos-related disease between the Newark population and the comparison population, changes in the persons living near the facility over time, and the long time period it may take for disease to develop following asbestos exposure.

Public Health Action Plan

The public health action plan is a collection of activities intended to ensure that this health statistics review also provides a plan of action to mitigate and to prevent adverse effects on human health resulting from exposure to asbestos from Libby vermiculite. Some activities have already been taken by CDHS or ATSDR. Others activities are either ongoing or planned for the future.

Actions Completed

CDHS conducted a needs assessment with the Alameda County Health Officer and Environmental Health Department, the goals of which were to educate the departments about the vermiculite health statistics review project, to obtain information about the extent and level of stakeholder concerns, to develop an information dissemination plan, and to identify ways that CDHS can support local efforts or activities pertaining to the Newark PlantNewark plant.

CDHS disseminated information materials on consumer products made with Libby vermiculite to increase public awareness of the potential for adverse health effects and ways to reduce or avoid current or future exposure to asbestos from this source.

CDHS briefed the Occupational Health Branch (of CDHS) about the asbestos contamination of Libby vermiculite, the facilities in California that processed this vermiculite, and the potential for workers at these facilities to have been exposed to asbestos.

Information on the potential for exposure and ways to reduce exposure to asbestos in vermiculite consumer products was included in this health consultation and provided to the Alameda County Health Officer and Environmental Health Director.

Ongoing Actions

CDHS will continue to provide technical assistance related to the vermiculite health statistics review to the Alameda County Health Officer and Environmental Health Director on the vermiculite health statistics review.

Planned Actions

ATSDR has funded health statistics reviews in 25 states with facilities that received Libby vermiculite. Once all of the results from participating states have been received, ATSDR will compare the SRRs for all the sites examined in order to identify trends that might not be apparent when each facility is evaluated individually. The results of the health statistics reviews will also be evaluated in combination with all information on environmental exposures to asbestos produced by research by the National Asbestos Exposure Review project of ATSDR. ATSDR will distribute the results of these analyses to contributing state health departments and other interested parties.

Using the results of ATSDR's review of health statistics for all vermiculite facilities nationwide, CDHS will conduct follow-up activities with the Alameda County Health Officer and

Environmental Health Departments. The specifics of these activities will depend on what is learned from the nationwide review.

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Addendum 1. Standardized Incidence Ratio

The standardized incidence ratio (SIR) is a measure that compares the incidence rate of disease in two populations. In this health statistics review the SIR compares, for the time period 1986 through 1995, the number of people who were diagnosed with a type of cancer while residing in census tract 4446 and the number of people expected to be diagnosed with cancer if the incidence rate of cancer in the census tract 4446 population was the same as the incidence rate in the U.S. population. The SIR was calculated to account for ways in which census tract 4446 and U.S. populations differ in terms of age and sex.

The SIR is calculated in two steps.

Step 1. The expected number is calculated by (1) multiplying the incidence rate in various age and sex groups in the U.S. population by the number of people in those age and sex groups in the census tract 4446 population, and then (2) summing the products to obtain the total number of expected cases in the census tract 4446 population.

Step 2: The SIR is calculated by dividing the actual number of people who were diagnosed with cancer by the expected number.

These steps are demonstrated in the accompanying table for all types of cancer.

	U.S. incidence rate for all types of cancer 1986–1995		Number of persons in census tract 4446 1986-–1995		Number expected to have any type of cancer in census tract 4446 1986–1995
STEP 1					
Females					
0 to 4	0.000188	×	14,260	=	2.7
5 to 9	0.000097	×	11,620	=	1.1
10 to 14	0.000116	×	11,010	=	1.3
15 to 19	0.000205	×	11,820	=	2.4
20 to 24	0.000351	×	13,990	=	4.9
25 to 29	0.000605	×	14,260	=	8.6
30 to 34	0.000948	×	13,290	=	12.6
35 to 39	0.001601	×	10,750	=	17.2
40 to 44	0.002631	×	7,730	=	20.3
45 to 49	0.004182	×	5,790	=	24.2
50 to 54	0.005868	×	4,370	=	25.6
55 to 59	0.008014	×	3,700	=	29.7
60 to 64	0.010734	×	3,990	=	42.8
65 to 69	0.013577	×	3,380	=	45.9
70 to 74	0.016334	×	2,170	=	35.4
75 to 79	0.018378	×	1,540	=	28.3
80 to 84	0.019683	×	1,060	=	20.9
85 & up	0.019640	×	1,590	=	31.2
Males					
0 to 4	0.000216	×	2,610	=	3.2
5 to 9	0.000123	×	1,950	=	1.6
10 to 14	0.000124	×	1,540	=	1.4
15 to 19	0.000210	×	1,600	=	3.0
20 to 24	0.000333	×	2,440	=	6.1
25 to 29	0.000573	×	5,330	=	10.3
30 to 34	0.000871	×	4,430	=	13.1
35 to 39	0.001191	×	3,340	=	14.7
40 to 44	0.001630	×	2,610	=	14.5
45 to 49	0.002697	×	1,890	=	16.7
50 to 54	0.004991	×	1,140	=	23.7
55 to 59	0.008856	×	640	=	32.2
60 to 64	0.014763	×	560	=	45.3
65 to 69	0.022620	×	550	=	57.9
70 to 74	0.030244	×	310	=	48.7
75 to 79	0.035267	×	180	=	36.3
80 to 84	0.038441	×	230	=	21.1
85 & up	0.037822	×	40	=	16.3
Total number of expected cases:					***721.2***
STEP 2					

$$\textbf{SIR} = \frac{552}{721.2} = 0.77$$

Addendum 2. Standardized Rate Ratio

The standardized rate ratio (SRR) compares the incidence or the mortality rate for a disease in two populations. For the cancer statistics review, the SRR compares the number of people in the United States who were diagnosed with a type of cancer and the number of people expected to be diagnosed if the U.S. population had the same incidence rate as the census tract 4446 population. For the mortality statistics review, the SRR compares the number of people in the United States who died from a disease and the number of people expected to die if the U.S. population had the same mortality rate as the ZIP Code 94560 population.

The SRR is calculated in a way that accounts for ways in which the study populations and the U.S. population differ in terms of age and sex. The SRR is calculated in two steps.

Step 1. the expected number of cases or deaths in the U.S. population is calculated by (1) multiplying the incidence or mortality rate in each age and sex group in the study population by the number of people in those age and sex groups in the U.S. population and then (2) adding the products.

Step 2. The SRR is calculated by dividing the expected number of cases or deaths (calculated in step 1) by the actual number of cases or deaths that occurred.

These steps are shown in the accompanying table for the mortality rate of all types of cancer.

	ZIP Code 94560 mortality rate, cancer - all types, 1989–1998		Number of people in the United States 1989–1998		Expected number of deaths in the United States 1989–1998
STEP 1					
Females					
0 to 4	0.000059	×	93,966,244	=	5,583.3
5 to 9	0.000000	×	91,867,322	=	0.0
10 to 14	0.000000	×	89,304,231	=	0.0
15 to 19	0.000000	×	87,811,833	=	0.0
20 to 24	0.000000	×	90,427,466	=	0.0
25 to 29	0.000049	×	98,755,306	=	4,876.8
30 to 34	0.000200	×	108,681,120	=	21,725.4
35 to 39	0.000200	×	107,902,167	=	21,623.7
40 to 44	0.000641	×	98,780,341	=	63,275.7
45 to 49	0.000460	×	82,737,629	=	38,040.3
50 to 54	0.001649	×	67,120,643	=	110,714.5
55 to 59	0.002740	×	57,368,622	=	157,174.3
60 to 64	0.003748	×	54,716,238	=	205,069.4
65 to 69	0.005111	×	54,396,949	=	278,028.9
70 to 74	0.007764	×	48,337,651	=	375,292.3
75 to 79	0.007836	×	39,220,867	=	307,327.7
80 to 84	0.037288	×	27,563,804	=	1,027,802.9
85 & up	0.011628	×	24,880,271	=	289,305.5
Males					
0 to 4	0.000000	×	98,444,382	=	0.0
5 to 9	0.000064	×	96,375,416	=	6,162.1
10 to 14	0.000000	×	93,779,769	=	0.0
15 to 19	0.000079	×	92,727,275	=	7,289.9
20 to 24	0.000066	×	93,916,511	=	6,178.7
25 to 29	0.000099	×	99,300,884	=	9,788.2
30 to 34	0.000047	×	107,836,073	=	5,072.3
35 to 39	0.000127	×	106,638,555	=	13,532.8
40 to 44	0.000530	×	96,528,396	=	51,189.3
45 to 49	0.000948	×	79,706,353	=	75,551.0
50 to 54	0.001628	×	63,474,519	=	103,358.9
55 to 59	0.002395	×	52,786,640	=	126,435.1
60 to 64	0.004874	×	48,333,937	=	235,562.5
65 to 69	0.008924	×	44,815,676	=	399,929.9
70 to 74	0.019672	×	36,773,021	=	723,403.7
75 to 79	0.010833	×	26,482,551	=	286,894.3
80 to 84	0.009836	×	15,345,068	=	150,935.1
85 & up	0.034483	×	9,774,311	=	337,045.2
Total number deaths expected in United States					***5,444,169.4***
STEP 2					

$$\textbf{SRR} = \frac{\textbf{5,444,169.4}}{\textbf{5,259,810}} = \textbf{1.04}$$

Addendum 3. Standardized Mortality Ratio

The standardized mortality ratio (SMR) is a measure that compares the mortality rate for a disease in two populations. In this health statistics review, the SMR compares, for the time period 1989 through 1998, the number of people who died from a disease while residing in ZIP Code 94560 to the number of people who would be expected to die if the mortality rate for the disease in the ZIP Code 94560 population were the same as the mortality rate for the disease in the U.S. population. The SMR was calculated in a manner that accounts for ways in which the ZIP Code 94560 and U.S. populations differ in age and sex.

The SMR is calculated in two steps.

Step 1. The expected number of deaths is calculated by (1) multiplying the mortality rate in various age and sex groups in the U.S. population by the number of people in those age and sex groups in the ZIP Code 94560 population, and then (2) summing the products to obtain the total number of expected deaths in the ZIP Code 94560 population.

Step 2: The SMR is calculated by dividing the actual number of deaths that occurred by the expected number (calculated in step 1).

These steps are demonstrated in the accompanying table for death from all types of cancer.

	U.S. mortality rate for all types of cancer 1989–1998		Number of people in ZIP Code 94560 1989–1998		Expected number of deaths in ZIP Code 94560
STEP 1					
Females					
0 to 4	0.000027	×	16,830	=	0.5
5 to 9	0.000026	×	15,820	=	0.4
10 to 14	0.000024	×	13,680	=	0.3
15 to 19	0.000033	×	12,510	=	0.4
20 to 24	0.000045	×	12,330	=	0.6
25 to 29	0.000082	×	20,250	=	1.7
30 to 34	0.000162	×	20,010	=	3.2
35 to 39	0.000319	×	14,970	=	4.8
40 to 44	0.000591	×	14,050	=	8.3
45 to 49	0.001075	×	13,050	=	14.0
50 to 54	0.001851	×	9,700	=	17.9
55 to 59	0.002916	×	8,030	=	23.4
60 to 64	0.004336	×	5,870	=	25.5
65 to 69	0.005933	×	4,500	=	26.7
70 to 74	0.007832	×	3,220	=	25.2
75 to 79	0.009567	×	2,680	=	25.6
80 to 84	0.011546	×	590	=	6.8
85 & up	0.014049	×	860	=	12.1
Males					
0 to 4	0.000031	×	16,870	=	0.5
5 to 9	0.000032	×	15,640	=	0.5
10 to 14	0.000032	×	13,380	=	0.4
15 to 19	0.000047	×	12,720	=	0.6
20 to 24	0.000064	×	15,200	=	1.0
25 to 29	0.000090	×	20,290	=	1.8
30 to 34	0.000145	×	21,260	=	3.1
35 to 39	0.000252	×	15,760	=	4.0
40 to 44	0.000498	×	13,200	=	6.6
45 to 49	0.001033	×	12,660	=	13.1
50 to 54	0.002057	×	10,440	=	21.5
55 to 59	0.003744	×	8,350	=	31.3
60 to 64	0.006262	×	5,540	=	34.7
65 to 69	0.009319	×	3,810	=	35.5
70 to 74	0.012953	×	1,830	=	23.7
75 to 79	0.016628	×	1,200	=	20.0
80 to 84	0.021582	×	1,220	=	26.3
85 & up	0.027371	×	290	=	7.9
Total number of expected deaths:					***429.9***
STEP 2					

$$\textbf{SMR} = \frac{\textbf{381}}{\textbf{429.9}} = \textbf{0.89}$$