Health Consultation

Community Concerns

NORTH RIDGE ESTATES

KLAMATH FALLS, KLAMATH COUNTY, OREGON

EPA FACILITY ID: ORN001002476

MARCH 23, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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.

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HEALTH CONSULTATION

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Prepared by:

Oregon Department of Human Services
Superfund Health Investigation and Education Program
Under Cooperative Agreement with the
The Agency for Toxic Substances and Disease Registry

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Purpose and Health Issues

The Oregon Department of Human Services/Superfund Health Investigation and Education program (ODHS/SHINE), the Agency for Toxic Substances and Disease Registry (ATSDR), the Oregon Department of Environmental Quality (ODEQ), and the U.S. Environmental Protection Agency (EPA) are working together to assess the health risks of exposure to asbestos fibers present in the soil from asbestos containing material (ACM) at the North Ridge Estates residential subdivision in Klamath County, 3 miles north of the city of Klamath Falls. ODHS/SHINE completed health consultations in April 2003 and May 2004 that determined the site to be a ***public health hazard*** due to the large amount of friable asbestos-containing material (ACM) throughout the surface of the subdivision. ODHS/SHINE recommended 1) that the site be fully characterized in terms of amount, type and distribution of asbestos containing material and that asbestos levels in the soil near suspected disposal sites be measured and 2) that outdoor air sampling be conducted, particularly during dry and windy conditions and during simulation of soil-disturbing activities.

The ACM are remnants from the demolition of the Marine Recuperational Barracks, a complex of more than 80 buildings built in 1944 to provide care for marines recovering from tropical diseases [1] (Figure 1). More than 56 tons of ACM fragments were removed from the property surface in 2002. In 2003 an additional 7 tons ACM was removed from the surface of the site, and 77 tons of ACM was removed from nine properties where areas of concentrated ACM debris (referred to as "hot spots") were identified [2]. In 2003, 5 more tons of ACM and soil were removed from burial test pits and disposed as asbestos waste [3], and in 2004 in order to stabilize identified burial piles, 1.5 tons of ACM and soil disposed as asbestos waste [3]. At the time of this report, a total of 140.5 tons of ACM and soil have been removed from the site. Fragments continue to be found throughout the subdivision. Underground asbestos-insulated piping and at least five known disposal sites with asbestos-containing material have also been identified on several lots [4]. Sampling of the ACM confirmed that the fragments were composed of 10% to 90% asbestos [5]. The ACM fragments were determined to be friable [6] as they had been fragmented through demolition and weathering and were crumbling and deteriorating to the touch.

Since 2003 a number of public meetings have been held to provide residents of North Ridge Estates and other community members with information related to the plan for remediation of the site as well as risk assessments that have been conducted. Both publicly and privately, residents have expressed a variety of concerns related to how the presence of asbestos containing materials may have or could in the future affect their health and the health of their children. The purpose of this health consultation is to summarize these concerns and respond to specific themes and questions that have been raised by North Ridge Estates residents and their advocates.

Background – Site Description and History

Klamath Falls is located in South Central Oregon in a high desert area (elevation of 4,500 feet). Vegetation in the area is sparse, with some scattered ponderosa pines and sagebrush. Soil is volcanic and rocky in places. The climate is relatively dry, with an average annual rainfall of 13.2 inches.

North Ridge Estates is a 422-acre subdivision located three miles north of the City of Klamath Falls and includes homes on both sides of Old Fort Road (Figure 2). There are a total of 25 households that are situated within the footprint of the contaminated area. This includes a total of 79 residents, including 39 children (13 children age 6 years or younger). Several homes sit east of Old Fort Road, as well as a five-unit apartment building, and additional North Ridge Estates lots. Land to the west, north, and east of the subdivision is zoned for forestry, grazing, and agriculture. According to the 2000 U.S. Census, there are 98 residents, including 14 children ages 6 years and younger, within ½-mile of the property. A number of other residents, in neighboring homes outside the footprint of the development, could also be affected.

The site was originally built to house the Marine Recuperational Barracks and the buildings were occupied from 1944–1946 by the military. From 1964-1966 the Oregon Technology Institute (now called the Oregon Institute of Technology) occupied the site, and the property has been privately owned since that time. The property was purchased in 1977 by MBK partnership, the present property developer. Most of the buildings were demolished in the mid- to late-1970s and 1980's, and home construction began in the subdivision in 1993.

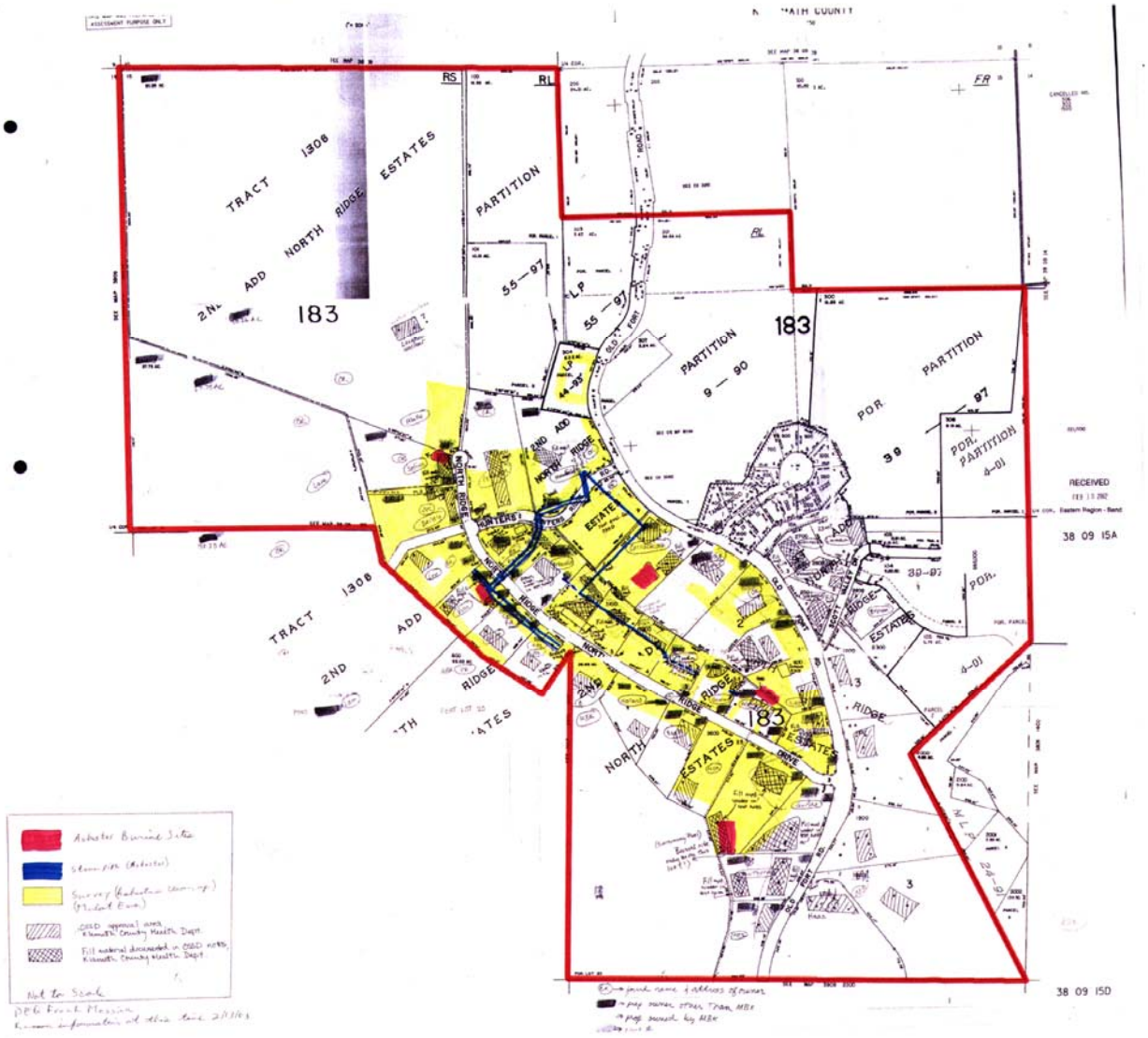
FIGURE 1 – FORMER MARINE RECUPERATIONAL BARRACKS

(Photo courtesy of the Klamath County Museum)

In the late 1970's, ODEQ responded to a complaint of openly accumulated asbestos debris at the property and observed a bulldozer/CAT driving over four to six acres of demolition debris described as a great amount of "white, fluffy" insulation materials being blown by strong winds [7]. Since the local landfill reportedly would not accept asbestos materials, and due to concern about health risks to workers in removing such a large quantity of materials, ODEQ agreed to allow the property owner to dispose of the asbestos-contaminated materials on-site. An EPA compliance order in 1979 required that coverage and maintenance of the disposal site conform to the National Emission Standards for Hazardous Air Pollutants (NESHAP) requirements for

inactive waste sites [8]. There is no indication in records available for review that NESHAP requirements for proper disposal were met. In addition, there was no indication in the records reviewed by ODHS/SHINE that locations of ACM disposal sites have ever been recorded on property deeds or similar documents, as was required by the 1979 EPA Compliance Order.

FIGURE 2 – NORTH RIDGE ESTATES SITE MAP



In June 2001, ODEQ received a complaint of two large piles (180 linear feet) of asbestos-insulated pipe on the surface of a lot being developed in North Ridge Estates [9]**.** The ODEQ inspector observed "white to pale brown colored platy looking" fragments on the lot and on other lots throughout the subdivision. Samples of the piping and fragments were taken, and found to contain from 10% to 90% asbestos. A notice of non-compliance was issued to the property developer, and the piping piles were removed from the property surface by the developer in the summer of 2001.

In response to these violations, ODEQ and MBK Partnership entered into a Mutual Agreement and Order on Consent in May 2002 [10]. Under the terms of the order, MBK agreed to:

- Complete a survey of properties in the subdivision to identify any visible ACM and to identify the locations of underground asbestos-containing pipe and ACM disposal sites;
- Inform property owners if their lots contain exposed or buried ACM;
- Remove exposed ACM (approximately 50 tons);
- Either remove ACM from sites where ACM was buried pursuant to the EPA-authorized cleanup, or record on property deeds the presence and locations of those burial sites;
- Record on property deeds the location of underground asbestos-containing pipe; and,
- Pay a $10,484 civil penalty.

In 2002, ODHS/SHINE conducted a public health consultation [11]**.** This consultation concluded that the site constituted a ***past and present public health hazard***, due to the amount and distribution of friable asbestos at the site. ODHS/SHINE recommended 1) that the site be fully characterized in terms of amount, type and distribution of asbestos containing material and that asbestos levels in the soil near suspect areas be measured and 2) that outdoor air sampling be conducted, particularly during dry and windy conditions and during simulation of soil-disturbing activities.

In April 2003, at the request of ODEQ, the U.S. Environmental Protection Agency (USEPA) became involved at the site, and initiated a time critical removal action (TCRA) [12]**.** Over 7 tons (15,700 lbs.) of ACM were removed from the property surface from June through October 2003 [3]**.**

In May 2003, the USEPA issued an Administrative Order on Consent, which identified the MBK Partnership and its individual partners as the responsible parties for the contaminated site. In the order, MBK was required to:

- Remove visible asbestos containing material;
- Provide a burial site location and stabilization plan;
- Develop a Health and Safety plan for the site;
- Develop a Streamlined Risk Assessment plan (SRA); and,
- Develop a Quality Assurance and Sampling plan to support removal action and the SRA

From August 2003 to August 2004, the EPA conducted a series of sampling events to test soil, indoor air, indoor dust, outdoor ambient air, and outdoor air during soil disturbing activity. These sampling events were conducted in order to develop a risk assessment estimating the risk of asbestos-related illness the asbestos-contaminated soil posed to residents and others at the site.

In May 2005, the EPA initiated a temporary relocation of local residents who expressed an interest and willingness to be moved during the summer months. This relocation was initiated for three reasons. First, because it is a drier and windier time of year, second because it is a time when children are home from school and therefore have a greater likelihood to be outdoors and exposed to the soil and third, because the initial workplan for the RI/FS was due to begin and activities associated with additional sampling and or clean-up could increase soil disturbance.

In June 2005, a group of NRE residents plus the State of Oregon and the US EPA reached a tentative settlement agreement with the individual partners of MBK, the entity identified as the

responsible party for the contamination of the site. Under the terms of the tentative settlement, most of the homeowners will be bought out and will relocate from the development. There are a few homeowners who have elected to stay.

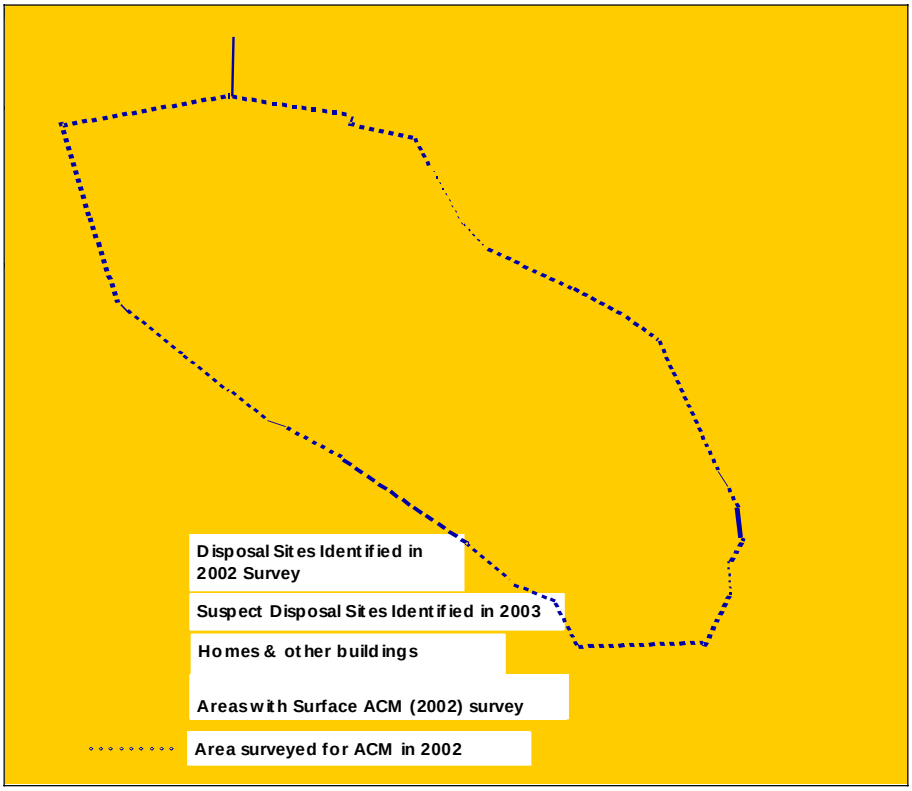
In July 2005, under the terms of the settlement agreement, the PRP was relieved of the responsibility and the US EPA assumed primary responsibility for the evaluation and clean up of the site. At the time of this report, the US EPA is evaluating possible mechanisms for fully characterizing and remediating the site, including conducting a Remedial Investigation and Feasibility Study (RI/FS) or an Engineering Evaluation and Cost Analysis (EECA). Regardless of the method chosen, the additional sampling will be done in order to fully characterize the site in terms of extent and distribution of contamination and a remediation plan developed to clean up the site. The continued presence of residents at the site will be an important consideration in the remedies chosen, and may well effect the type of remedial actions.

Sampling and Site Characterization

From July through November of 2003 EPA collected soil, air, and dust samples to test for asbestos and lead. The results from this sampling project were used for preliminary risk assessment [13]. The report assessed the potential for excess risk of cancer associated with asbestos exposure at North Ridge Estates. However, the report suggested that additional analysis should be considered**.**

The ability to accurately calculate risk to residents of North Ridge Estates due to exposure to asbestos fibers in the soil has been severely hampered by limited information as to the amount and distribution of asbestos-containing materials (ACM) that is buried at the site. Some burial sites have been identified, and the location of steam pipe wrapped in asbestos has been identified, (Figure 3) but the total amount of has not been estimated. The fact that the site has not been fully characterized in terms of the distribution, and concentration of asbestos fibers in the soil suggests that more sampling is necessary to fully assess the risk to local residents and their children. The plan to sample the soil and air while simulating typical activities that residents might engage in was determined to be an important step in evaluating risk at this site.

FIGURE 3 – LOCATIONS OF SURFACE ACM & DISPOSAL SITES



Note: Figure three does not represent all ACM present at the site, only those areas that have been surveyed, or where ACM has been removed.

In July 2004 the EPA conducted an additional sampling project designed to mimic ordinary activities that local residents might engage in that might release asbestos fibers into the breathing space of a person disturbing the soil. These activities included a simulation of child's play (Figure 4), weed trimming (Figure 5), and roto-tilling [14]**.** The EPA reported that the "sampling event demonstrated that asbestos fibers in soil at NRE are released into the breathing zone when certain outdoor activities are conducted. In most cases, the detected levels of fibers do not exceed the screening level corresponding to a 1 in 10,000 excess lifetime cancer risk; however, protocol structure concentrations (fibers less than or equal to 0.5 um in diameter and greater than or equal to 5 um in length) in one of three samples analyzed for the weed trimming slightly exceeded the screening level."

FIGURE 4 - ACTIVITY-BASED SAMPLING - CHILD'S PLAY SCENARIO

FIGURE 5 - ACTIVITY-BASED SAMPLING - WEED-TRIMMING

In March 2005, a witness to the demolition of the site that took place from 1977-1979 came forward and identified a pattern of demolition and burial of ACM. His account of the demolition leaves little doubt that substantial amounts of ACM are buried on site in locations that were

previously not identified. This includes ACM moved from demolition sites (where it could not be accommodated by the landscape) to a nearby former firing range and adjacent properties that are not part of the North Ridge Estates footprint. In addition to the ACM burial sites that were identified by this witness, he reported that workers who were conducting the demolition and burial of ACM were hired by MBK (not an asbestos abatement contractor) and wore no protective equipment to prevent inhalation of asbestos fibers.

Site characterization was recommended in the first public health consultation conducted for North Ridge Estates. The location of burial sites of ACM is a critical link both to understanding the sources of risk but also to planning for remediation of the site. We still do not know with adequate certainty the relationship between ACM in specific burial sites and concentrations of asbestos fibers both within and outside the footprint of the development. Alone, removal or containment of ACM located in burial sites is not likely to sufficiently reduce the risk of asbestos exposure since current evidence suggests the asbestos is widely dispersed. More evidence to fully understand the concentration and distribution of asbestos fibers in the soil is needed.

Community Concerns

Throughout the period of time that health and regulatory agencies have been involved at the North Ridge Estates site, agency representatives have been in communication with residents and other community members. A variety of concerns have been expressed by local residents, some related to health and some related to legal and financial issues stemming from the contamination. The purpose of this consultation is to identify and address those concerns that relate to health effects from past, present or future exposures to contaminants of concern.

In May 2005, in order to better understand and address concerns of residents at North Ridge Estates, the Oregon Department of Health began a process of identifying concerns expressed by residents and other community members. Records of public meetings, and other documents prepared by the EPA and ODEQ, as well as previous health consultations prepared by the SHINE program were reviewed to identify specific health-related themes, concerns and questions raised by community members. These themes included:

1. Past exposures to asbestos and other contaminants (for adults, children and construction workers);
2. Medical screening options and recommendations;
3. Psychological and emotional stress associated with living at NRE;
4. Efficacy of risk-reducing measures; and
5. Understanding the results of sampling and modeling activities.

SHINE staff developed an interview guide to be used with EPA staff and residents of North Ridge Estates to verify that the above health concerns reflected residents' actual concerns, and to learn if residents had additional concerns. The interview guide included two open-ended questions about health concerns in general to allow the residents to talk about the health concerns most important to them. Five open-ended questions asking about each of the previously identified concerns were also included in the guide. SHINE staff interviewed 6 residents, whose degree of concern of exposure to asbestos contamination ranged from minimal to very high. Most interviewees had children, though varying in ages. SHINE staff documented detailed notes on the residents' responses.

1. PAST EXPOSURES TO ASBESTOS AND OTHER CONTAMINANTS

Information about past levels of exposure to asbestos fibers at North Ridge Estates is not directly available. However, we do have methods for estimating what levels of exposure residents and others may have experienced. Exposure to asbestos can result in increased risk of developing changes in the lungs, asbestosis, lung cancer, or mesothelioma. The levels of asbestos in air that lead to lung disease depend on several factors. The most important of these are; (1) how much asbestos you were exposed to, (2) how long you were exposed, (3) how long it has been since your exposure started, and (4) whether you smoked cigarettes. Our ability to assess the risk for exposure to asbestos fibers in based on some key factors related to the specific kinds of asbestos that were handled, the frequency of activities the person may have been involved in, and whether that person is an adult or a child.

Adults

For adults living in North Ridge Estates, one primary risk of exposure is engaging in activities where a person disturbs the soil and then breathes dust-laden air. Such activities include, landscaping, gardening, weed-whacking, and roto-tilling. The activity-based sampling that mimicked gardening, weed-whacking, and roto-tilling indicated that risk for inhalation of asbestos fibers while engaging in these activities is below levels of concern. This risk assessment was based on the amount of time that residents may have engaged in these activities, the amount of soil disturbed while engaging in these activities and the concentration of asbestos fibers detected in the soil while simulating these activities.

Another potential source of exposure is the handling and moving of asbestos containing material either during or after home construction. It is known that some residents moved debris found on their properties. Direct handling of aircell, a type of insulation that traps air in small spaces designed to retain heat, which is known to contain amosite asbestos, and asbestos-wrapped piping which may contain amosite, are of particular concern. In 2004, a model for estimating risk was created by a consultant for the PRP. This model, reported in “Final Soil Sampling Results and Preliminary Risk Assessment for the North Ridge Estates Site Klamath Falls” [15] noted an increased risk for “playing with asbestos”. The report also noted this exposure pathway is very uncertain, and very conservative assumptions were made when developing this model of an exposure pathway. While there is no way to know the asbestos content of this debris that may have been handled, the most conservative assumption we can make in evaluating increased risk to human health is that the debris contained asbestos. With that in mind, issues to consider as to the risk that moving this material poses are:

- How much debris was moved,
- If the soil was disturbed to excavate partially embedded debris,
- How friable (any asbestos-containing material that can be crumbled, pulverized or reduced to powder by hand pressure when dry) the material was that was being handled, and
- Whether any type of breathing protection was used (masks, etc.)

Children

In general, SHINE and ATSDR recognize that infants and children may be more vulnerable than adults to exposures to contaminants in air, water, soil, or food. This vulnerability is a result of the following factors:

- Children may engage in behaviors that adults are unlikely to engage in, such as playing on debris piles, exploring abandoned environments and playing in soil or water that may be contaminated,
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Infants and children have different absorption, metabolism and excretion rates that can influence how they deal with chemical exposure, and
- Infants and children have longer remaining lifespan in which the expression of toxicity (especially cancer) can occur.

Because children are more likely to play in the soil, to be close to the soil (because of their size and the type of activities they are likely to engage in) and because of biologic factors (such as higher rate of respiration), risk to children was specifically considered when assessing asbestos exposure. The child's play activity that was simulated as part of the activity-based sampling project is an example. Analysis of the samples taken during the child's play scenario did indicate an increased level of risk to children playing in the soils at North Ridge Estates, and so parents are urged to continue restricting their children's outdoor activities as advised in the first consultation prepared by ODHS/SHINE.

Some parents have expressed concerns about the kinds of exposures their children may have experienced prior to any information about the need for restricting children's exposure to soil. While it cannot be known at this time whether any individual child inhaled asbestos fibers while playing outdoors, it is important to understand that the risk estimates developed for the child's play scenario were based on the amount of exposure a child would have if he or she played in the dirt 2 hours/day, 270 days per year, for 10 years. Based on this estimated exposure, data collected (Table 1) during an activity-based sampling event that simulated child's play indicated a slightly elevated risk for health effects in children. More detail on this increased risk can be found in the description of the data in section 5 *("Making sense of the data that have come from sampling and modeling activities"*) below.

<u>Construction Workers</u>

Construction workers are another group of specific concern, and fall into two categories; 1) Those who participated in the demolition of buildings and burial of asbestos containing materials, and 2) those who worked on the construction of new buildings and/or landscaping of new home sites. Of course, individuals may belong to one or both groups. The group of workers who demolished buildings and handled asbestos containing material composed of amosite fibers (e.g. steam-pipe insulation) is the group about which we are most concerned. Handling of pipe wrapped in asbestos and handling of aircell are also activities of particular concern.

2. MEDICAL SCREENING OPTIONS AND RECOMMENDATIONS (15)

As noted in the previous section, those people we are most concerned as having been exposed to the harmful effects of asbestos include adults who handled asbestos containing material, children who played in the soil and construction workers who participated in the demolition of the buildings and burial of asbestos containing material. Residents and others who are concerned that they may have been exposed to asbestos can inform their medical provider so they can offer appropriate preventive care and watch for early signs of disease. If the time since first exposure is greater that 10 years (the minimum latency for asbestos-related lung changes), or symptoms of

respiratory disease are present, the physician may recommend persons in these groups consult with a specialist who has expertise in asbestos-related disease.

Asbestos-related conditions can be difficult to identify. Healthcare providers usually identify the possibility of asbestos exposure and related health conditions, like lung and pleural disease, by taking a thorough medical history. This includes looking at the person's medical, work, cultural, and environmental history. If a medical provider suspects an asbestos-related health condition, he or she can use a number of tools to help make the actual diagnosis. The most common tool is a chest x-ray but other diagnostic tools include pulmonary function tests, biopsy/Bronchoscopy, and CT Scans. As with any health concern, individuals are advised to seek care from a doctor or other healthcare provider. ATSDR physicians are available to provide advice to individuals' private physicians if requested. ATSDR and SHINE are developing outreach programs to educate local health care providers about asbestos-related disease.

The Oregon Department of Health and ATSDR suggests the following important steps for minimizing risks of asbestos-related disorders:

- Minimize or avoid further exposure to any form of asbestos,
- Stop smoking and avoid tobacco smoke (second hand),
- Get regular medical care, and
- Consider appropriate vaccines (such as influenza and pneumonia) based on physician recommendations to prevent other pulmonary infections.

3. PSYCHOLOGICAL STRESS

Psychological stress and associated health effects, is a well-documented phenomenon in communities living near hazardous waste sites [16, 17]**.** Studies have found that individuals in communities affected by hazardous substances may experience fear and uncertainty over the possible health effects of exposure, feelings of loss of control, and anger over loss of security and safety within the community. Over time, psychological stress may lead to major depression, chronic anxiety, or post-traumatic stress disorder as well as physical changes such as increased blood pressure, heart rate, and changes in stress hormones [18]**.** Researchers have also concluded that stress may result in a decreased effectiveness of the immunological system [19].

Community members may also feel confused trying to understand government documents and frustrated over the lengthy clean-up process. The effect on social relationships also represents a stressor. Social stressors include community conflict over who is to blame and what actions to take. Finally, there may be serious concerns among communities over economic losses including property devaluation, doctor bills, and business losses [20]**.**

Residents of North Ridge Estates have indicated in public meetings and to agency employees that they are having similar experiences as those mentioned above. Several themes emerged during interviews with residents, including:

- Fear and anxiety for their health and the health of their children,
- Anger at those responsible for the contamination,
- Anxiety and loss due to devaluation of property,
- Feelings of helplessness and loss of control, and

- Alienation from former neighbors and others who were formerly friends.

Naturally, fear and uncertainty related to the effects of asbestos on their health, and particularly the health of their children, is a major concern expressed by the residents of North Ridge Estates. Since asbestos-related illness can take many years to develop, residents face an open-ended period of anxiety related to the health of their children, and their own health as well.

Residents expressed anger at the parties who are responsible for the contamination. Since the responsible parties have been prominent in the larger community for years, this situation provoked social stressors. This situation had a very divisive effect on the community. Residents grouped together according to what they thought should be done about the contamination. One resident said that he no longer fraternized with any of his neighbors. The conflict manifested itself in the children's social life as well. One resident said that their children were arguing about who was right. As Klamath Falls is a small community, the divisiveness was reported to have rippled from the neighborhood to the entire community. While social divisiveness may be in part a result of the stressful situation, it may also create more stress on individuals and families.

Financial stress was another major theme that came up in meetings and interviews with residents. Homeowners at North Ridge Estates watched the values of their homes plummet. Those who believe that their children's health is at risk living at North Ridge Estates, feel compelled to leave. Because of the property devaluation, most families are not in a position to do so.

For a variety of reasons (from health concerns to the ability to relocate) many residents expressed a sense of helplessness and loss of control over their lives and the lives of their children. This sense of helplessness may have contributed to many resident's overall sense of negative psychological impact from living at the North Ridge Estates development.

4. EFFICACY OF RISK-REDUCING MEASURES

Since early 2003, SHINE has encouraged residents at North Ridge Estates to employ a number of preventive measures to reduce risk of exposure from disturbing the soil and asbestos containing material. Many residents, both during the interviews and in other communication reported practicing these risk-reducing measures. These guidelines include strategies for reducing exposure to soil both in homes and out of doors. The following is a list of recommended measures.

<u>Reducing Risk Inside Your Home</u>

- Use outside door mats to wipe feet.
- Take off your shoes before entering your home.
- Wash hands and face thoroughly with soap and water after working or playing in the soil, especially before eating.
- Damp mop and wet wipe surfaces often to control dust.
- Keep windows and doors closed on windy days.

<u>Reducing Risk Outside Your Home</u>

- Avoid play activity in the dirt, move play to paved areas or lawn.
- Cover bare patches of dirt with bark, sod or other material, or fence off area.
- Dampen dusty soils before gardening.
- Do not eat or drink in contaminated areas.
- Keep pets off of exposed dirt so they don't track it into the house.

The risk posed by the asbestos at North Ridge Estates is a function of the fiber toxicity and an individual's exposure to the fibers. The risk-reducing strategies are intended to decrease the potential for exposure to the fibers. Different factors, including number and consistency of preventive strategies employed, can influence the individual exposure [21].

In addition to the practicality of preventive strategies to reduce risk, there are also factors involved in the decision to engage in them. The reasons behind the health decisions people make can influence the effectiveness of the decision [22]. Research in the area of behavior decision-making indicates the following cognitive process have a significant impact on the likelihood that a person will make and adhere to health behavior decisions, specifically:

- Perception of the risk,
- Structuring of problem,
- Perception and evaluation of the potential consequences posed by behavior change,
- Assessment of the probability of positive or adverse outcome, and
- Personal or cognitive biases.

The efficacies of preventive strategies are subjective to many factors, and depend on everything from an individual's reason for engaging in them to whether or not the risk-reducing strategy has become a habit. Overall, in considering cumulative risk to asbestos fibers at North Ridge, the exposure potential increases over time. Although single event exposure potential is low, preventive measures undertaken on a routine basis can make a difference in individual exposure.

5. MAKING SENSE OF THE DATA THAT HAVE COME FROM SAMPLING AND MODELING ACTIVITIES

When ODHS/SHINE prepared the initial health consultation for this site, we determined the site to be a public health hazard. This determination was made because common sense indicated that the presence of friable asbestos containing material could translate into a completed exposure pathway for inhalation of asbestos fibers. It is important to note here that the determination of the site as a public health hazard does not mean that people have been harmed by living at the site or by being exposed to the soils that have been contaminated by asbestos containing material (ACM). Whether people have been harmed is not known at this time because of the long latency period for asbestos-related illness to manifest. The determination of the site as a public health hazard served an important function in mobilizing state (ODEQ) and federal (USEPA) environmental agencies to measure the risk posed by asbestos at the site, and to confirm the need for action to remediate the site because of the potential health hazard that asbestos posed to residents and others. These agencies have taken actions, as described earlier in this document, to measure and characterize the risk that asbestos poses to adults and children who live at and near the site, as well as the risk to others who have worked at the site.

When available, ATSDR prefers to rely on measured exposure data, rather than modeled estimates of exposure, to evaluate the potential for health effects to occur. Based on available exposure data, exposure to soil at North Ridge does not appear to result in a significantly increased risk of developing asbestosis. Air samples collected during soil disturbing activities were used to estimate risks of developing cancer from exposure to soil (Table 1) [23].

TABLE 1 – ESTIMATED ADDITIONAL LIFETIME THEORETICAL CANCER RISK FOR EXPOSURES MEASURED DURING SOIL-DISTURBING ACTIVITY EVENT

Exposure Pathway	Scenario specifics	Additional Lifetime Cancer Risk
Child playing in soil	2 hours/day, 270 days/year for 10 years	about 1 in 10,000*
Weed Trimming	10 hours/day, 50 days/year for 30 years	about 1 in 10,000*
Roto-tilling	10 hours/day, 50 days/year for 30 years	**about 5 in 1,000,000***
Ambient Air	Ambient air monitors were located approximately 100 feet from soil disturbing activities	No fibers detected

*These risk estimates are the highest end of the range as compared to other activity-based samples collected during this sampling event.

Cancer risks are estimated as probabilities. An additional theoretical risk of 1 in 1,000,000 means that if a population of one million people is exposed to a contaminant over a lifetime, we might see one additional case of cancer in that population. A 1 in 10,000 additional theoretical risk means that if a population of 10,000 people is exposed over a lifetime we might see one additional case of cancer. According to the American Cancer Society, U.S. men have slightly less that a 1 in 2 lifetime risk of developing cancer. For women the risk is a little more than 1 in 3 [25].

At North Ridge, the available data indicate that for a population of 10,000 children who dig in the soil for 2 hours a day, 270 days a year, for 10 years, we might see one cancer case attributable to exposure to asbestos fibers. We might see one cancer case attributable to asbestos in a population of 10,000 adults who trim weeds 10 hours a day 50 days a year for 30 years, and five cancer cases attributable to asbestos in a population of 1,000,000 adults who till the soil 10 hours a day, 50 days a year for 30 years. Overall, we consider the risk of someone getting cancer from their exposure to asbestos at this site to be low.

Public Review

This health assessment was initially released on September 27, 2005, and was available for public comment until October 27, 2005. The document was sent to North Ridge Estates homeowners and residents, and other residents in the surrounding neighborhoods. It was also sent to representatives of the EPA and DEQ. The document was also available on the web at http://www.healthoregon.org/superfund. Two sets of comments were received; one from the USEPA and one from a resident of North Ridge Estates. In general, the comments highlighted areas of the document that needed clarification, and were used to revise language or better clarify terms. In other instances, the comments pointed to incomplete information, such as the amount of ACM removed from the site. In this instance, the document was revised to include more and better information about removal actions completed through 2005. In another instance the comments pointed to areas of confusion related to risk; specifically, how modeled data and data measured during activity-based sampling differed relative to estimating risk to children living at

the site. In this case, the issue was fully addressed under number 5 of the "Community Concerns" section called *"Making Sense of Data……"*so it was not addressed further.

Conclusions

1. Although there is variability to the intensity, the majority of residents at North Ridge Estates have some level of concern related to asbestos exposure. Concern over the future health of the children living at North Ridge is a primary concern expressed by the adults.
2. Most residents experience some level of psychological or emotional distress from living at the development, which is associated with uncertainty and fear related to health effects, financial impact from the loss of value of their property, and the divisiveness this situation created among neighbors and others in the Klamath Falls community who were previously on very good terms.
3. Efforts to assess theoretical risk by collecting air, dust and soil samples and the reporting of measured and modeled data may have had the unintended effect of creating more confusion and uncertainty in the minds of residents.
4. The initial determination of this site as a public health hazard was warranted in order to interrupt the potential that residents might be exposed to asbestos fibers in soil and air. Subsequent data collected through activity-based sampling events have helped to better determine and describe the actual risks to adults and children living and working at the site. Based on these data we consider the risk of someone getting cancer from their exposure to asbestos at this site to be low.
5. Although the majority of residents plan to permanently relocate, many of the health concerns will be ongoing because of past exposures.
6. The site and nearby areas have not been fully characterized in terms of the distribution and types of asbestos present. Additional work is needed to fully evaluate the risk posed by asbestos containing material and asbestos contaminated soils at the site.

Recommendations

1. Medical providers caring for residents and others who may have been exposed to contaminated soil at North Ridge Estates should be provided with information and resources to monitor and care for people at risk for asbestos-related illnesses.
2. Residents with acute psychological or emotional distress related to living at North Ridge Estates may benefit from social or psychological support. Local mental health professionals should be provided with information on supporting people who have been exposed to environmental hazards.
3. Data that inform risk estimates should be presented to the public in ways that are understandable, and clearly state the value and reliability the data and how it is being used to evaluate risk.
4. Residents and others who may have been exposed to asbestos or asbestos-contaminated soils should receive regular information about clean-up of the site and any health related information regardless of whether or not they reside at North Ridge Estates.
5. As a precaution, North Ridge Estates residents should continue to practice steps to avoid exposure to soil. Avoid bringing soil into your home and keep from disturbing asbestos containing material, burial sites and soil.

Public Health Action Plan

The Public Health Action Plan for the site contains a description of actions that have been or will be taken by ODHS/SHINE and other government agencies at the site. The purpose of the Public Health Action Plan is to ensure that this public health consultation both identifies public health hazards and provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ODHS/SHINE to follow up on this plan to ensure that it is implemented.

Public health actions that have been taken include the following:

- ODHS/SHINE prepared two health consultations; one to address the historical and current health concerns related to asbestos contamination and exposure, and the other to address health concerns related to exposure to lead.
- ODHS/SHINE developed and distributed a poster with specific recommendations for residents to reduce exposures to asbestos. (See Appendix C.) Additional information materials on health effects of exposure to asbestos were provided and distributed at the meetings and in response to requests by residents.
- ODEQ and EPA, in consultation with public health agencies, have been diligently working to evaluate options for sampling and cleanup of the site that protect public health and reduce risks of exposure and to respond to community concerns.
- ODHS/SHINE reviewed and provided comments to EPA on sampling plans, burial site removal plans, preliminary assessment, statement of work, and risk management plans. ODHS/SHINE regularly participates in conference calls with EPA and ODEQ.
- ODHS/SHINE co-sponsored public meetings and conducted site visits in September 2002, January 2003, May 2003, January 2004, October 2004, March 2005.
- ODHS/SHINE and ATSDR conducted a site visit with EPA and ODEQ and met with residents in October 2003.
- Educational materials on health effects of asbestos exposure and ways to minimize exposure to asbestos and reduce health risks were provided to the community by ODHS/SHINE in partnership with the local health department.

The public health actions to be implemented follow:

- ODHS/SHINE and ATSDR will continue to provide assistance to regulatory agencies during planning for site sampling and cleanup.
- State and local public health agencies will participate in future public meetings to provide updated information and respond to questions and concerns.
- ODHS/SHINE will continue to respond to the community's concerns and questions.
- ODHS/SHINE will continue to develop fact sheets and other educational materials as indicated.
- ODHS/SHINE will develop an outreach and education plan to provide information and resources to medical and mental health providers in the area.

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Appendix A - Asbestos Overview

Asbestos is a general name applied to a group of silicate minerals consisting of thin, separable fibers. Different criteria are used to identify asbestos fibers, depending on the context.

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. Regulated amphibole minerals include amosite, tremolite, actinolite, anthophylite, and crocidolite [27]. According to the Oregon Department of Environmental Quality (ODEQ), amphibole asbestos fibers are more difficult than chrysotile fibers to subdue with wetting. At North Ridge Estates, the insulation on underground piping is primarily amosite (an amphibole form of asbestos). The asbestos in the fragments of transite siding/CAB, vinyl tile, and roofing materials at the site is the chrysotile form of asbestos. Soil on the property has been sampled and determined to contain both chrysotile and amphibole asbestos [13].

Asbestos fibers do not have any detectable odor or taste. They do not dissolve in water, do not evaporate, and are resistant to heat, fire, and chemical and biological degradation. They are generally not broken down to other compounds in the environment and will remain virtually unchanged over long periods. Asbestos fibers may break into shorter pieces or separate into a larger number of individual microscopic fibers as a result of physical processes. Small diameter fibers and fiber-containing particles may remain suspended in the air for a long time and be carried long distances by wind before settling.

Asbestos Health Effects

*Inhalation of Asbesto*s

When asbestos fibers are breathed in, they may get trapped in the lungs. In general, health risks increase with longer exposure and greater amounts of asbestos fibers in the exposures. Short-term high-level or chronic low-level asbestos inhalation exposures have been associated with lung cancer, mesothelioma, and pleural disorders [25]. Breathing any type of asbestos increases the risk of the following health effects:

Malignant mesothelioma – Cancer of the lining of the lung (pleura) and the lining of other internal organs. This cancer can spread to tissues surrounding the lungs or other organs. Most of the mesothelioma cases are attributable to asbestos exposure [27]. Mesothelioma can occur with low asbestos exposure; however, very low background environmental exposures carry only an extremely low risk [24]. An estimated 1,500 cases of mesothelioma per year occur in the United States (compared with an average of 130,000 cases of lung cancer per year). Latency periods for mesothelioma due to asbestos exposure are generally 20–30 years or more.

Lung cancer – Cancer of the lung tissue. The exact mechanism relating asbestos exposure with lung cancer is not completely understood [27]. The combination of tobacco smoking and asbestos exposure greatly increases the risk of developing lung cancer. Latency periods are generally 10–30 years or more for lung cancer.

Noncancer effects – these include *asbestosis*, where asbestos fibers lodged in the lung cause scarring and reduce lung function; *pleural plaques*, localized or diffuse areas of thickening of the pleura (lining of the lung); *pleural thickening*, extensive thickening of the pleura which restricts 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 [27]. Either heavy exposure for a short time or lower exposure over a longer period may result in asbestosis; some cases have resulted from intense 1-day exposure [25]. No minimal risk levels (MRL) have been determined for inhalation or oral exposure to asbestos for any duration [27]. Latency periods for the development of asbestos-related nonmalignant respiratory effects are usually 15–40 years from the time of initial exposure to asbestos.

There is not enough evidence to conclude whether inhalation of asbestos increases the risk of cancers at sites other than the lungs, pleura, and abdominal cavity [27].

Amphibole asbestos may be more toxic than chrysotile asbestos, mainly because of physical characteristics that allow chrysotile to be broken down and cleared from the lungs, whereas amphibole is not removed and builds up to high levels in lung tissue [28]. Some researchers believe the resulting increased duration of exposure to amphibole asbestos may significantly increase the risk of mesothelioma and, to a lesser extent, asbestosis and lung cancer.

Ingestion and Dermal Exposure to Asbestos

Ingestion of asbestos causes little or no risk of noncancer effects [27]. There is some evidence, however, 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.

Skin nodules (corns) from handling asbestos-containing materials can also occur [25].

Current Standards, Regulations, and Recommendations for Asbestos

ODEQ and other regulatory agencies commonly define “asbestos-containing materials” as any material with greater than 1% bulk concentration of asbestos [29]. It is important to note that 1% is not a health-based level, but instead represents the practical detection limit in the 1970s when Occupational Safety and Health Administration (OSHA) regulations were created. Studies have shown that disturbing soils containing less than 1% amphibole asbestos can suspend fibers at levels of health concern [25].

Friable asbestos (asbestos that is crumbly and can be broken down to suspendable fibers) is listed as a hazardous air pollutant on EPA’s Toxic Release Inventory [30]. EPA has determined that, if severely damaged, otherwise non-friable materials can release significant amounts of asbestos fibers.

Low levels of asbestos can be detected in almost any air sample. In rural areas, for example, there are typically 10 fibers in a cubic meter (fibers/m^3) of outdoor air. (A cubic meter is about the amount of air someone breathes in 1 hour.) Health professionals often report the number of

fibers in cubic centimeters (f/cc); 10 fibers per cubic meter is the equivalent of 0.00001 f/cc. Typical levels found is cities are about 10 times higher. Close to an asbestos mine or factory, levels may reach 10,000 fibers/m^3 (or 0.01 f/cc) or higher. Levels could also be above average near a building being torn down or renovated that contains asbestos products or near a waste site where asbestos is not properly covered up or stored to protect it from wind erosion [27].

Asbestos is a known human carcinogen. EPA has calculated an inhalation unit risk for cancer of 0.23 per f/cc of asbestos [31]. (These criteria are currently under review by EPA.) The concentration resulting in an increased lifetime cancer risk of 1 in 10,000 is 0.0004 f/cc; the concentration resulting in an increased lifetime cancer risk of 1 in 1 million is 0.000004 f/cc.

OSHA has set a permissible exposure limit (PEL) for workers of 0.1 f/cc for asbestos fibers greater than 5 μm in length (1 μm is about 1/25,000 of an inch) and with a length-to-width ratio greater than 3:1, as determined by phase contrast microscopy (PCM) [31]. This value represents a time-weighted average (TWA) exposure level based on 8 hours a day for a 40-hour workweek; at or above this level, an employer must take action to reduce employee exposure. In addition, OSHA has determined an exposure limit for workers to no more than 1 f/cc as averaged over a sampling period of 30 minutes.

The National Institute of Occupational Safety and Health (NIOSH) set a recommended exposure limit (REL) for workers of 0.1 f/cc for asbestos fibers greater than 5 μm in length [32]. This REL is a TWA for up to a 10-hour workday in a 40-hour workweek. The American Conference of Government Industrial Hygienists (ACGIH) has also adopted a TWA of 0.1 f/cc as its threshold limit value [33].

The Asbestos Hazard Emergency Response Act (AHERA), passed in 1986, set specific standards for asbestos air quality in schools for allowing re-entry following an asbestos abatement. The AHERA standard of 70 structures per millimeter squared (s/mm^2), is not health-based, but was based on filter contamination levels using filters that were available at that time. Today, filter contamination is considerably less, however the AHERA standard has not been revised [34].

The EPA National Emissions Standards for Hazardous Air Pollutants (NESHAP) program established criteria for identifying asbestos-containing material (ACM) subject to demolition and renovation work practices. Material containing at least 1% asbestos, by volume, is considered ACM and subject to NESHAP regulations. The 1% threshold is also not a health-based standard, but was based on the smallest amount measurable using polarized light microscopy (PLM).

A number of methods are used to measure asbestos content in air and soil. ODEQ staff have been functioning in an advisory role to EPA in evaluating potential sampling methodologies at North Ridge Estates.

Methods for Measuring Asbestos Content

Measuring asbestos content in air samples and in bulk materials that could become airborne involves both quantifying fibers and determining whether the fibers are asbestiform. For air samples, fiber quantification is traditionally done through phase contrast microscopy (PCM) by counting fibers longer than 5 μm and with a length-to-width ratio greater than 3:1. This is the

standard method by which regulatory limits were developed [27]. The disadvantages of this method include the inability to detect fibers smaller than 0.25 μm in diameter and the inability to distinguish between asbestos and nonasbestos fibers.

Asbestos content in bulk samples is determined using polarized light microscopy (PLM). This method uses polarized light to distinguish between asbestos and nonasbestos fibers and between different types of asbestos. Fibers are first quantified through PCM. The PLM method is also limited by resolution; fibers finer than about 1 μm in diameter cannot be identified by PLM.

Scanning electron microscopy (SEM) and, more commonly, transmission electron microscopy (TEM) are more sensitive methods and can detect smaller fibers than light microscopic techniques. One disadvantage of electron microscopic methods is that it is difficult to determine bulk asbestos concentration. There has been a general movement towards using TEM for analysis because of its greater analytical sensitivity and the ability to determine mineralogy. However, current OSHA and EPA regulations and assessments still require PCM or PCM equivalents (PCMe) to be used. So TEM values may be converted to PCMe.

Counting fibers using the regulatory definitions does not adequately describe the risk of health effects, as fiber size, shape, and composition contribute collectively to risks in ways that are still being studied. For example, shorter fibers appear to preferentially deposit in the deep lung, but longer fibers might disproportionately increase the risk of mesothelioma [27, 35]. Fiber diameters greater than 2 μm are considered above the upper limit of respirability and do not contribute significantly to risk [35]. Methods are being developed to assess the risks posed by varying types of asbestos and are currently awaiting peer review.

EPA is currently working with several contract laboratories and others to develop, refine, and test a number of methods, such as PLM, infrared (IR) and SEM, for screening bulk soil samples.

Appendix B: Types of Asbestos-Containing Material found at the North Ridge Estates Subdivision

Cement Asbestos Board (CAB) was used as siding on the former Marine Barracks buildings. CAB is platy in shape with a light to dark brown color; some of the CAB at the site had been painted with light green and yellow paint.

FIGURE 6: CEMENT ASBESTOS BOARD

Vinyl floor tiles (VAT) are 9 by 9 inch tiles that were used on concrete and wooden floors of the former Marine Barracks buildings. Some tiles are red with white swirls, and others are blue. Broken VAT can come in many different platy shape sizes, and may have flat or curved shapes.

FIGURE 7: VINYL FLOOR TILE

Roofing material from the former Marine Barracks buildings is gray and black (the black material is tar).

Figure 8: Roofing Material

Asbestos Containing Steam Pipe is located underground at the site from the former Marine Barracks steam power plant. The asbestos-containing steam pipe is a metal corrugated pipe (8 inches in diameter in some places larger) wrapped in black felt paper (asbestos-containing). The inside of the corrugated pipe is lined with a black felt paper with about two inches of wooly material (90% asbestos). In the center of the wooly material is a metal pipe about 4 inches in diameter.

Figure 9: Asbestos-Containing Steam Pipe

Appendix C – Soil Safety Guidelines Poster

Soil Safety Guidelines

to reduce your risk to contaminants in soil

Take your shoes off!
Don't track dirt in the house

Wash your hands well
after playing and gardening in the dirt

Keep dust down,
damp mop and damp dust regularly

DHS oregon department of human services

For more infomation, visit www.healthoregon.org/superfund

Education Superfund Health Investigation

Adapted with permission from materials created by Public Health Seattle & King County

As a precaution, North Ridge Estates residents should continue to practice steps to avoid exposure to soil. Avoid bringing soil into your home and keep from disturbing asbestos containing material, burial sites and soil. Children who play in dirt and people that engage in other activities that disturb the soil while close to it, are considered to be the most vulnerable.

Public Health recommends that residents continue to follow these guidelines to reduce exposure to contaminated soils:

Inside your home:

- Use outside door mats to wipe feet
- Take off your shoes before entering your home
- Wash hands and face thoroughly with soap and water after working or playing in the soil, especially before eating
- Damp mop and wet wipe surfaces often to control dust
- Keep windows and doors closed on windy days

Outside your home:

- Avoid play activity in the dirt, move play to paved areas or lawn
- Cover bare patches of dirt with bark, sod or other material, or fence off area
- Dampen dusty soils before gardening
- Do not eat or drink in contaminated areas
- Keep pets off of exposed dirt so they don't track it into the house

For information and resources on asbestos exposure:

SHINE webpage
www.healthoregon.org/superfund

ATSDR webpage
www.atsdr.cdc.gov/asbestos

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Appendix D - Glossary of Environmental Health Terms

ACM	**A**sbestos-**c**ontaining **m**aterial. ACM is any material, including particulate matter, that contains more than 1% asbestos as determined using polarized light microscopy (PLM).
Acute Exposure	Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.
Adverse Health Effect	A change in body function or the structures of cells that can lead to disease or health problems.
Amosite Asbestos	A special form of the amphibole mineral that displays separable, long, thin fibers often arranged in parallel in a column or in matted masses. The fibers are generally strong enough and flexible enough to be spun and woven, are heat resistant, and are chemically inert.
Amphibole	A large group of silicate minerals with more than 40–50 members. The molecular structure of all amphiboles consists of two chains of SiO_4 molecules that are linked together at the oxygen atoms. In the earth's crust, amphibole minerals are mostly nonasbestiform; asbestiform amphiboles are relatively rare. See definitions of asbestiform and mineral.
Asbestiform	A habit of crystal aggregates displaying the characteristics of asbestos: groups of separable, long, thin, strong, and flexible fibers often arranged in parallel in a column or in matted masses. Mineralogists call asbestiform amphibole minerals by their mineral name followed by "asbestos." Thus, asbestiform amosite is called amosite asbestos.
Asbestos	A group of highly fibrous minerals with separable, long, thin fibers often arranged in parallel in a column or in matted masses. Separated asbestos fibers are generally strong enough and flexible enough to be spun and woven, are heat resistant, and are chemically inert. See definitions of fibrous and mineral. Currently, U.S. regulatory agencies recognize six asbestos minerals: the serpentine mineral, chrysotile; and five asbestiform amphibole minerals, actinolite asbestos, tremolite asbestos, anthophyllite asbestos, amosite asbestos (also known as asbestiform cummingtonite-grunerite), and crocidolite asbestos (also known as asbestiform riebeckite).
Asbestosis	Interstitial fibrosis of the pulmonary parenchymal tissue in which asbestos bodies (fibers coated with protein and iron) or uncoated fibers can be detected. Pulmonary fibrosis refers to a scar-like tissue in the lung which does not expand and contract like normal tissue. This makes breathing difficult. Blood flow to the lung can also be decreased, and this causes the heart to enlarge. People with asbestosis have shortness of

	breath, often accompanied by a persistent cough. Asbestosis is a slow-developing disease that can eventually lead to disability or death in people who have been exposed to high amounts of asbestos over a long period. Asbestosis is not usually of concern to people exposed to low levels of asbestos.
ATSDR	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia, that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level	An average or expected amount of a chemical in a specific environment, or amounts of chemicals that occur naturally in a specific environment.
Cancer	A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control.
Carcinogen	Any substance shown to cause tumors or cancer in experimental studies.
Chronic Exposure	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Chrysotile Asbestos	A fibrous member of the serpentine group of minerals. Chrysotile asbestos fibers are flexible and have a curved morphology. It is the most common form of asbestos used commercially, also referred to as white asbestos.
Completed Exposure Pathway	See Exposure Pathway.
Concentration	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant	See **Environmental Contaminant**.
Dermal Contact	A chemical getting onto your skin (see **Route of Exposure**).
Dose	The amount of a substance to which a person might be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day.”
Dose / Response	The relationship between the amount of exposure (dose) and the resultant change in body function or health.
Duration	The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.
Environmental Media	Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.
U.S. Environmental Protection Agency (EPA)	The federal agency that develops and enforces environmental laws to protect the environment and the public's health.
Epidemiology	The study of the different factors that determine how often, in how many people, and in which people will disease occur.
Exposure	Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see **Route of Exposure**.)
Exposure Assessment	The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.
Exposure Pathway	A description of the way a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having five parts: 1. Source of contamination, 2. Environmental media and transport mechanism, 3. Point of exposure, 4. Route of exposure, and 5. Receptor population. When all five parts of an exposure pathway are present, it is called a Completed Exposure Pathway. Each of these five terms is defined in this Glossary.
Fiber	Any slender, elongated mineral structure or particle. For the purposes of counting asbestos fibers in air samples, regulatory agencies commonly count particles that have lengths >5 µm and length:width ratios >3:1 as fibers. For detecting asbestos fibers in bulk building materials, particles with length:width ratios >5:1 are counted as fibers.
Fibrous	A mineral habit with crystals that look like fibers. A mineral with a fibrous habit is not asbestiform if the fibers are not separable and are not long, thin, strong, and flexible.
Frequency	How often a person is exposed to a chemical over time; for example,

every day, once a week, twice a month.

Friable ACM — Friable **a**sbestos-**c**ontaining **m**aterial is any asbestos-containing material that can be crumbled, pulverized or reduced to powder by hand pressure when dry. Friable asbestos material includes any asbestos-containing material that is shattered or subjected to sanding, grinding, sawing, abrading, or has the potential to release asbestos fibers.

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

Health Consultation (HC) — A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with **Public Health Assessment**].

Health Education — Programs designed with a community to help the community know about health risks and how to reduce these risks.

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

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

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

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

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

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

Mineral — Any naturally occurring, inorganic substance with a crystal structure.

MRL — **M**inimal **R**isk **L**evel. An estimate of daily human exposure—by a specified route and length of time—to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL

	should not be used as a predictor of adverse health effects.
NESHAP	**N**ational **E**mission **S**tandards for **H**azardous **A**ir **P**ollutants are EPA emission standards for hazardous air pollutants.
No Apparent Public Health Hazard	The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals could have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.
No Public Health Hazard	The category used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.
NPL	The **N**ational **P**riorities **L**ist is a list kept by EPA of the most serious uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or at least looked at to see if people can be exposed to chemicals from the site.
Oregon Department of Environmental Quality (ODEQ)	The state agency that develops and enforces environmental laws to protect the environment and public health.
ODHS – Oregon Department of Human Services	The state public health agency; ODHS has a cooperative agreement with ATSDR to conduct health assessments and consultations at Superfund/NPL and other hazardous waste sites in Oregon.
Parenchymal	Cells in a tissue or organ that are responsible for the function of the tissue or organ.
PLM	**P**olarized **L**ight **M**icroscopy is standard method used to quantify asbestos fibers.
Pleura	A thin lining or membrane around the lungs or chest cavity. This lining can become thickened or calcified in asbestos-related disease.
Pleural	Having to do with or involving the pleura.
Pleural calcification	As a result of chronic inflammation and scarring, pleura becomes thickened and can calcify (or harden). White calcified areas can be seen on the pleura by x-ray.
Pleural cavity	The cavity, defined by a thin membrane (the pleural membrane or pleura), which contains the lungs.
Pleural effusion	Cells (fluid) can ooze or weep from the lung tissue into the space between the lungs and the chest cavity (pleural space) causing a pleural

	effusion. The effusion fluid can be clear or bloody. Pleural effusions might be an early sign of asbestos exposure or mesothelioma and should be evaluated.
Pleural plaques	Localized or diffuse areas of thickening of the pleura (lining of the lungs) or chest cavity. Pleural plaques are detected by chest x-ray, and appear as opaque, shiny, and rounded lesions.
Pleural thickening	Thickening or scarring of the pleura that might be associated with asbestos exposure. In severe cases, the normally thin pleura can become thickened like an orange peel and restrict breathing.
Point of Exposure	The place where someone can come into contact with a contaminated environmental medium (air, water, food, or soil). Some examples include the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.
Public Health Assessment (PHA)	An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with **Health Consultation**].
Public Health Hazard	The category is used in PHAs and HCs for sites with certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.
Public Health Hazard Criteria	PHA/HC categories given to a site which tell whether people could be harmed by conditions at the site. Each are defined in the Glossary. The categories are: ▪ Urgent Public Health Hazard ▪ Public Health Hazard ▪ Indeterminate Public Health Hazard ▪ No Apparent Public Health Hazard ▪ No Public Health Hazard
Pulmonary interstitial fibrosis	Scar-like tissue that develops in the lung parenchymal tissue in response to inhalation of dusts of certain types of substances such as asbestos.
Route of Exposure	The way a chemical can get into a person's body. The three exposure routes are: ▪ breathing (also called inhalation), ▪ eating or drinking (also called ingestion), and ▪ getting something on the skin (also called dermal contact).
SHINE	**S**uperfund **H**ealth **In**vestigation and **E**ducation program. The Oregon Department of Human Services program that works with communities and

	agencies to evaluate and prevent health effects from exposure to hazardous substances.
Source (of Contamination)	The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.
Superfund	See **NPL.**
Toxic	Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.
Toxicology	The study of the harmful effects of chemicals on humans or animals.
Tumor	Abnormal growth of tissue or cells that have formed a lump or mass.
Urgent Public Health Hazard	This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects. This category requires quick intervention to stop people from being exposed.

Certification

The Superfund Health Investigation and Education Program of the Oregon Department of Human Services prepared the North Ridge Estates Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This document is in accordance with approved methodology and procedures. Editorial review was performed by the cooperative agreement partner.

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I have reviewed this health consultation, as the designated representative of the Agency for Toxic Substances and Disease Registry and concur with its findings.

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