

# Radiographic Changes Associated with Exposure to Erionite in Road Gravel in North Dakota

*Prepared For:*

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and  
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## **List of Abbreviations and Definition of Terms**

ATSDR	Agency for Toxic Substances and Disease Research
CT	computed tomography
EPMA	electron probe microanalysis
f/cc	(exposure to asbestos) fibers per cubic centimeter of air
fibre/ml	(air concentration of asbestos) fibers per millimeter
HRCT	high resolution computed tomography
IARC	International Agency for Research on Cancer
IRB	Institutional Review Board
LLE	loss of life expectancy <sup>7</sup>
mSv	(radiation exposure) millisievert
NDDoH	North Dakota Department of Health
NDGS	North Dakota Geological Survey
NHANES II	National Health and Nutrition Examination Survey II
OSHA	Occupational Safety and Health Administration
PA	posterior-anterior
ROS	reactive oxygen species
SEM/EDS	scanning electron microscopy with energy dispersive X-ray analysis
U.S.	United States
UCCM	University of Cincinnati College of Medicine
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

## **Executive Summary**

Erionite is a naturally occurring, microscopic, fibrous mineral. Like asbestos, erionite may pose health risks to those who breathe in the fibers. There are indications that erionite may be associated with increased risks of fibrogenic lung disease, lung cancer and mesothelioma, a rare type of respiratory cancer usually related to asbestos exposure. Although toxic effects were documented in a study of three small villages in Turkey in the 1970s, there have been few studies of erionite in the United States. Over the past few decades, gravel pits have been excavated in western North Dakota where naturally occurring deposits of erionite are found. The gravel was used to surface local county roads, parking lots and other areas.

The principal goal of this study was to determine the prevalence of chest radiographic abnormalities, including pleural and interstitial changes, among residents of western North Dakota thought to have potential increased exposure to road gravel containing erionite. It was hypothesized that gravel and road workers, and frequent drivers (i.e., mail carriers, bus drivers, delivery drivers, and law enforcement officers) exposed to erionite in road gravel will have a significantly increased prevalence of pleural and interstitial changes when compared to the background unexposed population.

Current or former residents of western North Dakota with possible exposure to road gravel containing erionite were contacted via local newspaper releases and public outreach efforts. Potential subjects completed an eligibility survey designed to identify erionite exposure based upon occupational and environmental history, duration of potential exposure, and time since initial exposure. Trained interviewers from the University of Cincinnati College of Medicine (UCCM) then administered an occupational and pulmonary medical history questionnaire.

A total of 34 subjects went on to have a chest x-ray and high resolution computed tomography (HRCT) scan. The HRCT scan is a more sensitive and specific technique than the standard chest radiograph for detecting pleural and interstitial changes consistent with asbestos-like fiber exposure. Chest X-rays and HRCT scans were evaluated independently by three board certified chest radiologists and “B” readers at the UCCM.

Chest X-ray results did not indicate a significant increase in interstitial changes or localized pleural changes above background prevalence. The HRCT scan results did indicate a significant increase in *interstitial changes* above background prevalence. The observed prevalence was 17.6% (n=6, p<0.01) compared to 1.5% for male urban transportation workers with low cumulative asbestos fiber exposure. It is noted that of this group of six participants, five had gravel pit and/or road maintenance as the primary exposure pathway. For reasons of short latency and atypical distribution of interstitial changes, two of this group of six were excluded from statistical analysis. A significant increase in *interstitial changes* above background prevalence remained. The observed prevalence was 12.5% (n=4, p<0.01). Two participants with gravel pit and/or road maintenance as the primary exposure pathway had both interstitial changes and bilateral localized pleural changes. This group of two indicated an increase in *localized pleural changes* above background prevalence but the increase was not significant. The observed prevalence was 6.1% (n=2, p=0.31) compared to 3.4% for the same group of male urban transportation workers. It is noted that a 3<sup>rd</sup> participant with a potential road maintenance exposure pathway also had localized pleural changes but was excluded from this statistical analysis because of reported previous exposure to asbestos.

These study results suggest occupational exposure to road gravel containing erionite, particularly for workers employed in road maintenance or gravel pits, could result in pleural and possible interstitial changes that are historically associated with commercial asbestos exposure. Based on the known health impact from exposure to erionite in Turkey and more recently Mexico, precautionary measures should be considered to limit occupational exposure to gravel containing erionite, particularly for road maintenance and gravel pit workers.

## 1.0 INTRODUCTION

### 1.1 Erionite

Erionite, a naturally occurring fibrous mineral, is found in volcanic ash that has been altered by weathering and ground water, and it forms brittle, wool-like fibrous masses in the hollows of rock formations, see Figure 1. It is the most commonly occurring of the approximately 40 zeolite group of minerals and has been demonstrated in animal studies to have greater carcinogenic potential than crocidolite and chrysotile asbestos fibers (Carbone et al 2002, Maltoni et al 1982, Wagner et al 1985). Erionite is categorized as a Group I carcinogen by the International Agency for Research on Cancer (IARC 1987). The toxicity and carcinogenic potential of erionite is associated with its *in vivo* durability, respirable size, and hexagonal structure with a surface area approximately 20 times larger than crocidolite asbestos. Further, the accumulation of iron on the surface of erionite following respiratory epithelium deposition results in the production of reactive oxygen species (ROS) (Eborn & Aust 1995, Emri et al 2002, Fach et al 2002).

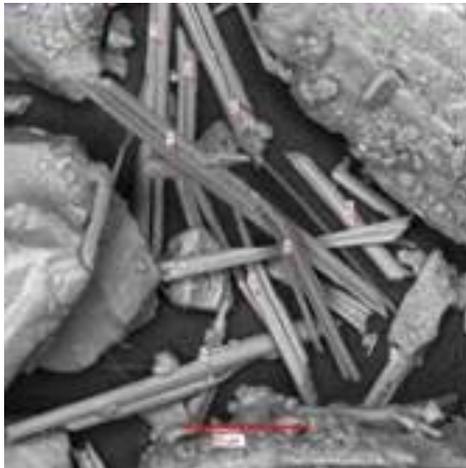


Figure courtesy of NDDoH

**Figure 1: Erionite (500X magnification)**

In contrast to commercial asbestos where exposure occurs primarily in occupational settings, exposure to erionite throughout the world is reportedly infrequent and principally through environmental pathways.

## **1.2 Epidemiology**

Epidemiologic data on the toxicity of erionite primarily arises from the study of three villages located in the Cappadocian region of Central Anatolia in Turkey where erionite was excavated from local volcanic tuffs to create storage areas and for use in construction material (Baris & Grandjean 2006). In these villages malignant mesothelioma and other outcomes associated with asbestos exposure, including localized and diffuse pleural thickening and interstitial fibrosis were observed to be significantly increased compared to unexposed villages (Emri et al 2002, Baris & Grandjean 2006, Baris 1991). Among residents of these erionite exposed villages the prevalence of calcified pleural changes using standard chest radiographs was significantly higher (9.3%) than residents of Turkish villages with environmental asbestos exposure (5.4%) and residents of villages unexposed to either erionite or environmental asbestos (<1%) (Emri et al 2002).

Fibrous zeolite deposits are common in the Intermountain West region of the United States (U.S.) including areas of Nevada, California, Arizona, Colorado, Idaho, New Mexico, North Dakota, South Dakota, Utah, and Wyoming (Sheppard 1996, Ilgren et al 2008a). Exposure to erionite in North America is thought to be rare though a case of extensive parenchymal and pleural fibrosis was noted in a road construction worker and resident of Utah in an area rich in zeolite deposits (Rom et al 1983). A lung biopsy confirmed the presence of fibrous and nonfibrous particles with a composition consistent with erionite (Rom et al 1983). Recently, two cases of mesothelioma in individuals born in Mexico had confirmed high lung burdens of fibrous erionite (Ilgren et al 2008a, Ilgren et al 2008b). Epidemiologic studies of erionite exposure have been conducted in Turkey, but there have been few studies of erionite exposure in the including areas of Nevada, California, Arizona, Colorado, Idaho, New Mexico, North Dakota, South Dakota, Utah, Wyoming. Following the discovery of erionite in samples of road dust near Battle Mountain, Nevada a review of chest radiographs (n = 275) from a local community hospital was conducted. In this study the prevalence of pleural plaques was found to be 1.8% with no pleural calcifications identified (Rom et al 1983).

In North Dakota gravel deposits that contain erionite are located in or near the Arikaree, Brule and Chadron geologic formations corresponding to the Chalky Buttes, Little Badlands and Killdeer Mountain areas in Slope, Stark and Dunn counties of North Dakota. These geologic

formations are also present in other high buttes in western North Dakota, though testing has not been conducted to confirm the presence of erionite. Over the past few decades, gravel pits have been excavated in areas where naturally occurring deposits of erionite are found and the gravel used to surface local roads, parking lots, and other areas. Ambient and activity-based air sampling and indoor dust sampling conducted by the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (USEPA) has confirmed the presence of erionite in gravel in some of these areas (USEPA 2009).

In response to a request from the North Dakota Department of Health (NDDoH) the USEPA, in collaboration with the Agency for Toxic Substances and Disease Registry (ATSDR) and the UCCM, initiated an investigation of the possible health effects of erionite exposure in Dunn and surrounding counties in western North Dakota. The objective of this study was to identify early chest radiographic changes historically associated with asbestos exposure in North Dakota residents with a prolonged potential exposure to road gravel containing erionite. Figure 2 shows the erionite area of concern.

In response to a request from USEPA, concurrent to the medical study described in this report, ATSDR performed a statistical analysis of mesothelioma rates in North Dakota, compared to rates in other regions of the United States. The technical memorandum that describes the analytical methodology and results is shown in Appendix 1. The study concluded that there was no increase in incidence of mesothelioma, or evidence of a geographic cluster of mesothelioma, in Dunn County and contiguous counties.

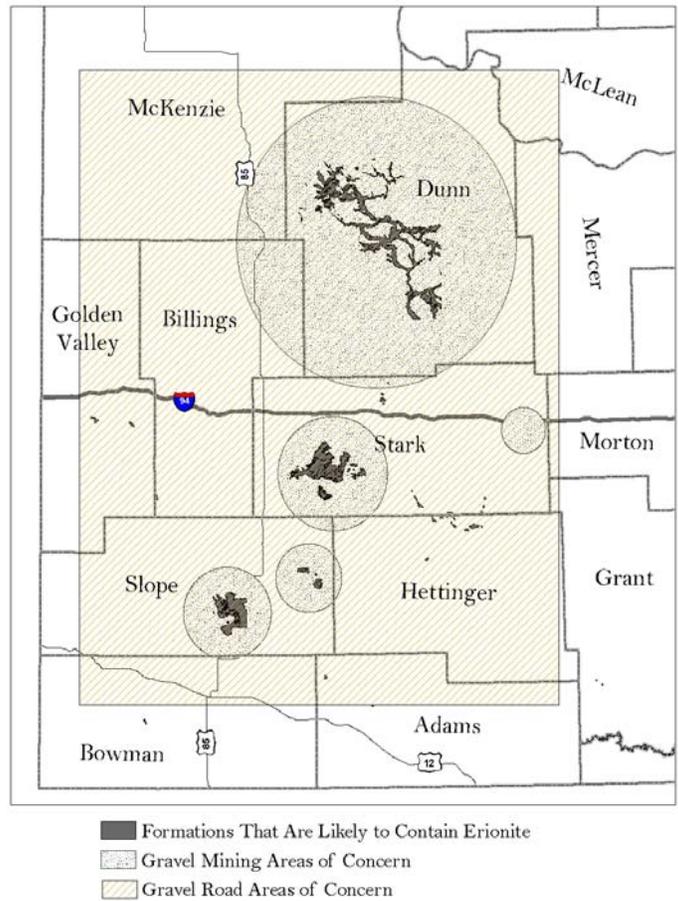


Figure courtesy of NDDoH

Figure 2: Western North Dakota Erionite Area of Concern

## **2.0 INVESTIGATOR ROLES**

USEPA Region 8, at the request of NDDOH, funded this study of exposed workers to determine whether a significant health risk to this exposed population and the greater population of western North Dakota is likely. EPA contracted Dr. James E. Lockey of the UCMM as principal investigator. Dr. Lockey is board certified in pulmonary and occupational medicine and has over 25 years experience in occupational and environmental medicine and pulmonary medicine and has served as Director of Occupational and Environmental Medicine at the UCCM. Dr. Lockey has extensive experience with studies of occupational and environmental exposure to naturally occurring asbestos-like fibers as well as man-made vitreous fibers. He had responsibility for the overall scientific integrity of the study, was available to answer questions from study participants, and provided letters summarizing the results of each participant's chest radiograph and HRCT scan along with appropriate health counseling.

In addition, Dr. Patrick Ryan of the UCCM served as the study epidemiologist and project coordinator. Dr. Ryan is an environmental health epidemiologist at the UCCM. Dr. Ryan has served as epidemiologist, statistician, and project coordinator on numerous studies of environmental and occupational exposures. Dr. Ryan had responsibility for the recruitment and management of study participants, as well as the coordination of the chest radiographs and HRCT scan scheduling and results. He also maintained health data and was responsible for data analysis.

Staff from the NDDoH provided technical and logistical support to the study. Staff from ATSDR provided additional technical expertise. A local hospital, the St. Joseph's Hospital and Health Center, Dickinson, ND was contracted to perform chest radiographs and HRCT scans. Waterstone Environmental Hydrology and Engineering provided study coordination and support.

### **3.0 STUDY OBJECTIVES**

The principal goal of this study was to determine the prevalence of chest radiographic abnormalities, including pleural and interstitial changes, among residents of western North Dakota thought to have potential increased exposure to road gravel containing erionite. This goal was accomplished by the medical evaluation of enrolled subjects that included a detailed occupational and pulmonary medical questionnaire, followed by a chest x-ray and HRCT scan.

It was hypothesized that gravel and road workers, and frequent drivers (i.e., mail carriers, bus drivers, delivery drivers, and law enforcement officers) exposed to erionite in road gravel will have a significantly increased prevalence of pleural and interstitial changes when compared to the background unexposed population. The study design was a cross-sectional study of workers with identified jobs thought to result in increased potential for exposure to airborne gravel dust containing erionite.

## **4.0 MATERIALS AND METHODS**

### **4.1 Risks and Benefits**

The risk associated with participation in this study was minimal. Chest radiographs and HRCT scans are routine tests used to identify abnormalities within the chest and lung associated with exposure to asbestos and asbestos-like fibers. A typical chest X-ray represents an exposure of approximately 10 mrem or the equivalent of background radiation an average person is exposed to in 10 days. The HRCT scans are conducted in both the prone and supine positions representing an exposure of approximately 1.3 mSv per scan for a total of 2.6 mSv. The loss of life expectancy (LLE) based on this exposure for all cancer with the exception of leukemia is 0.0030 years.

The benefits associated with participation in this study included chest radiographs and chest HRCT scans and interpretations. All initial radiographic findings were reviewed by Dr. James Lockey. Participants needing immediate medical attention based upon initial radiographic findings were notified by phone and letter by Dr. James Lockey with the participant's local physician notified if necessary. In addition, all participants received a personal summary letter from Dr. James Lockey summarizing the results of their occupational and pulmonary medical history questionnaire, chest radiograph and HRCT, accompanied with appropriate counseling, where necessary. These summary letters included contact information for local North Dakota resources where the subject may obtain medical follow-up, in cases where no personal physician or medical insurance are available.

At the completion of the study, all subjects enrolled in the medical study, including those not selected for participation in the radiographic portion of the study, but who completed the occupational and pulmonary medical questionnaire, will receive a letter summarizing the results of the study and, if requested, a copy of this report and a copy of the academic paper submitted to peer review journal.

This study will provide valuable data regarding exposure to erionite contained in gravel in western North Dakota. The targeted population being recruited for this study reflects those individuals with the potential for high prolonged erionite exposure and prolonged time from initial erionite exposure. The minimal risk involved with chest X-rays and HRCT scans is offset by the potential findings, particularly in the high exposed recruited populations. The results of this study have economic and health implications and will help elucidate whether erionite in gravel is a concern for the health of residents of this area.

#### **4.2 Study Population**

Current or former residents of western North Dakota with possible exposure to road gravel containing erionite were eligible to participate in this study. Potential participants were identified via local newspaper releases and outreach efforts. Two news releases were provided to local media with information regarding the study and contact information for interested residents. Information regarding the study and a question and corresponding answer sheet regarding erionite and the purpose of the study was distributed by mail to residents of the study area. Mailings with study information were also distributed to local companies with workers likely exposed to road gravel including gravel pit companies, county road equipment maintenance facilities, and delivery companies. In addition, study information and flyers were posted in local businesses, post offices, schools, county maintenance offices, and medical clinics in Stark, Slope, and Dunn counties of North Dakota. Outreach efforts and study recruitment also included the distribution of study information in person to school superintendents, postal carriers, delivery truck drivers, churches, county offices, and local police departments. A follow-up recruitment effort was initiated by requesting subjects who had already completed the eligibility questionnaire to provide study information to interested family members, co-workers, and other individuals who may be exposed to gravel dust. All study information and eligibility questionnaires were posted on the NDDoH website for potential participants to return by mail.

Appendix 2 presents a summary of recruitment methodology and contains the letters, press releases and information packets distributed to the public.

Potential subjects completed an eligibility survey designed to identify participants hypothesized, *a priori*, to have the highest potential for exposure to gravel containing erionite based upon occupational and environmental history, duration of potential exposure, and time since initial exposure. Occupations initially identified included working in gravel pits, working in road maintenance, or an occupation requiring frequent driving on gravel roads in the study area (e.g. mail carrier, school bus driver, law enforcement officer). Eligibility questionnaires were returned by mail and reviewed to assess respondents most likely to have the highest potential exposure based upon the following criteria:

- 1) Job history and task
- 2) Latency – longest time period since initial potential exposure
- 3) Duration – longest duration of potential exposure
- 4) Absence of reported exposure to non-erionite fibers (i.e. asbestos).

#### **4.3 Data Collection and Exposure Assessment**

All eligible participants were informed of the study purpose, procedures, risks, and benefits and given the opportunity to ask questions either by phone, mail, or email. The study protocol, procedures, recruitment materials, and informed consent documents were approved by the University of Cincinnati Medical Institutional Review Board (IRB), USEPA IRB, the NDDoH IRB and North Dakota Healing Arts Screening Program for radiographic procedures. All subjects signed an informed consent document prior to study participation.

The final draft of this manuscript with demographic information has been reviewed by the NDDoH IRB in order to ensure the confidentiality of participants who live in this sparsely populated area.

Trained interviewers from the UCCM administered an occupational and pulmonary medical history questionnaire by phone to obtain information regarding potential past exposure to road gravel containing erionite and/or asbestos. Appendix 3 contains a copy of this questionnaire. Participants were queried if they had ever had a full or part-time job in a gravel pit, as a road maintenance worker, as a school bus driver, mail carrier, delivery truck driver, or in any other

job where they may have been exposed to gravel or gravel dust. For each reported occupation the subject was asked the start and end date of employment (month/year), job tasks, and their frequency of driving on gravel roads in the study area. Co-exposure to asbestos or asbestos-like fibers was assessed by report of having worked in job tasks associated with asbestos exposure, such as a pipe fitter, plumber, brake repair person, insulator, dry wall finisher, carpenter, roofer, electrician, welder, and/or vermiculite worker. Road maintenance workers were asked to report the frequency of working in the road equipment maintenance facility changing brake pads or clutch pads. In addition, a pulmonary medical questionnaire was administered that queried participants regarding demographic characteristics, smoking status, pulmonary symptoms, and medical conditions that could impact their pulmonary health status. Participants with no to minimal potential erionite exposure were excluded from follow-up radiographic evaluation.

#### **4.4 Data Analysis**

The principal goal of this study was to determine the prevalence of chest radiographic abnormalities, including pleural and interstitial changes, among residents of western North Dakota thought to have potential increased exposure to road gravel containing erionite. There was no formal unexposed comparison group proposed in this study. Therefore, the prevalence of the primary outcome variables (lung and chest wall pleural changes detected by chest radiograph) were compared to previously published rates as identified in the medical literature for general populations. The primary objective of the data analysis was to characterize the prevalence of the main health outcomes in this population and determine if the observed prevalence is significantly greater than would be expected in the general unexposed background populations.

The anticipated sample of 42 was determined by assuming the background prevalence of pleural and interstitial changes to be 3.9% and 1.6%, respectively based on chest radiographs. In order to detect an approximate 5-fold increase in pleural changes among this exposed population, a sample size of 21 is required with the assumption of a one tailed alpha equal to 0.05 and 80% power. Similarly, with 80% power and one tailed alpha equal to 0.05, a sample size of 42 is required to detect an approximate 6-fold increase in the prevalence of interstitial changes in the cohort. Thus, the anticipated sample size of 42 would provide sufficient power

using the standard chest radiograph to detect increased prevalence of pleural and possibly interstitial changes in this study.

The HRCT scan is a more sensitive and specific technique than the standard chest radiograph for detecting pleural and interstitial changes consistent with asbestos-like fiber exposure. This technique allows differentiation between localized pleural thickening and pleural adipose tissue. Pleural adipose tissue can have a similar appearance to asbestos-like fiber induced localized pleural thickening. Identification of localized pleural thickening in a non-asbestos exposed individual would be a sensitive indicator of fiber induced pleural changes. The use of the HRCT scan substantially increased the power to detect both pleural and parenchymal changes related to mineral fiber exposure in comparison to standard chest radiographs.

Results of the data collection including the occupational and pulmonary medical history questionnaire, chest radiograph, and chest HRCT scan were presented in a descriptive format. The general data analysis strategy proceeded from descriptive data analysis to hypothesis testing. The initial analysis included the generation of descriptive statistics (i.e. means, medians, proportions, range, etc). Chi-square tests were employed to test the null hypotheses that the observed prevalence of chest wall and lung abnormalities by chest radiograph is equal to the expected number of chest wall and lung abnormalities in unexposed populations. All analysis was conducted using SAS (SAS Institute, Cary, NC).

#### **4.5 Data Protection and Privacy**

Unique subject identification numbers were assigned to all subjects, and subjects were subsequently referred to by these identification numbers only. Questionnaires were conducted by phone and entered directly into a secure database. The results of chest radiographs and HRCT scans were forwarded to study investigators by the health professional at St. Joseph Hospital and the University of Cincinnati radiologist, and entered into the database. The database had built-in validity and range checks for all entered data. The database was created and stored on the secure server located in the Department of Environmental Health at the University of Cincinnati. The database is password protected. All confidential information collected during the course of the study including name, date of birth, address, and phone

numbers is stored in secure electronic databases. Hard copies of data collected (i.e., disc containing radiographic data, screening questionnaire) is stored in locked cabinets in locked rooms accessible to the investigators only. All reports and/or manuscripts resulting from this study include general summary information for study subjects as a group and do not identify specific individuals.

#### **4.6 Participant Compensation**

There was no cost to the subjects for the chest x-ray and HRCT scan. Direct costs associated with participation in the study were travel related expenses to obtain a chest X-ray and HRCT scan. Participants received \$100 upon completion of the chest x-ray, and chest HRCT scan to cover transportation costs to and from the St. Joseph Hospital and Health Center in Dickinson, North Dakota.

#### **4.7 Radiographic Evaluation**

Posterior-anterior chest X-rays and high resolution computed tomography (HRCT) scans were conducted at a single facility in the local area. The consistency and quality of each chest X-ray was evaluated by the radiology facility and poor quality films were immediately repeated. In addition to standard film screen chest X-rays, subjects completed a HRCT scan at the same visit with supine and prone images without intravascular infusion of contrast material. Scans were completed in both positions in order to differentiate subtle subpleural irregular opacities related to normal vascular hydrostatic pressure from permanent interstitial fibrotic changes. HRCT scans were conducted as these are more sensitive and specific when compared to chest X-rays for the identification of pleural and interstitial changes associated with asbestos-like fiber exposure (Miles et al 2008, Staples et al 1989). A customary clinical radiologic interpretation of the chest X-rays and HRCT scan was provided by the radiologist on site. All customary interpretations indicating a need for immediate medical attention were followed-up by letter and phone to the subject to provide counseling and directing the participant to an appropriate source of medical care. HRCT scans were transferred directly to compact disc from the scanner in Digital Imaging and Communications in Medicine (DICOM) compatible format and transferred along with chest X-rays to the UCCM.

Chest X-rays were evaluated independently by three board certified chest radiologists and “B” readers at the UCCM. The radiologists were blinded with regard to the study objectives including the exposure of interest, subject’s age, gender, and smoking history. All chest X-ray interpretations were conducted according to the 2000 International Labour Office (ILO) Classification of Radiographs of Pneumoconiosis. HRCT scans were evaluated for the presence or absence of unilateral/bilateral discrete or diffuse pleural thickening with or without calcification and irregular interstitial changes consistent with asbestos exposure. A subject was classified as having a pleural changes if two of three B-Readers identified 1) diffuse pleural thickening (thickening of the pleural membrane that includes blunting of the costophrenic angle with or without calcification) and/or 2) localized pleural thickening, i.e. pleural plaques, with or without calcification along the chest wall, diaphragm, and/or pericardium, not otherwise classified as diffuse pleural thickening. Interstitial abnormalities were defined by the presence of round or irregular parenchymal opacities profusion category 1/0 or greater based on the chest X-rays and the presence or absence of parenchymal findings consistent with asbestosis on the HRCT scans (ILO 2002). All participants received a medical summary letter with their individual results and appropriate health counseling where indicated.

#### **4.8 Statistical Analysis**

The observed prevalence of interstitial and pleural changes was compared to published background rates using the exact Binomial test assuming a one-tailed hypothesis test. The background prevalence of pleural changes observed on chest X-ray was designated as 3.9% based upon the prevalence of any pleural changes consistent with pneumoconiosis observed by chest X-ray in the National Health and Nutrition Examination Survey II (NHANES II) among male and female adults ages 35-74 (Rogan et al 2000). The prevalence of interstitial changes observed on chest X-ray was compared to a background prevalence of 1.6% of small opacities, profusion category 1/0 or greater as reported by Meyer et al. (Meyer et al 1997) and calculated as a pooled prevalence for six North American populations of males and females ages 15-84 (Meyer et al 1997).

The prevalence of interstitial changes observed on HRCT was compared to a background rate of 1.5% as observed in a HRCT/CT study of male transportation workers over the age of 49 employed in France (Ameille et al 2007). The average cumulative asbestos fiber exposure in

this comparison population was 1.7 +/- 2.3 fibers / ml-years and the average latency period was 34.2 years (Ameille et al 2007). The prevalence of pleural abnormalities, and specifically, bilateral localized pleural changes consistent with asbestos exposure was reported in this same study to be 10.8% and 3.4%, respectively (Ameille et al 2007). As the observed pleural changes in the present study were bilateral, the background rate for comparison was assumed to be 3.4%.

## **5.0 RESULTS**

### **5.1 Study Participants and Exposure**

In total, 41 individuals completed the eligibility questionnaire and all were invited to participate in the study. Of these, 93% (n = 38) completed the informed consent process and were contacted to complete the occupational and environmental questionnaire and pulmonary medical questionnaire. Two of these subjects withdrew, however. Of the 36 remaining participants who completed the study questionnaire, one was not eligible due to minimal exposure to road gravel and one did not complete the radiographic evaluation. Two participants had recent CT scans (one conventional, one HRCT) for unrelated medical reasons and these were used. For one subject an accompanying chest X-ray was obtained. Thus, the final study cohort consisted of 34 participants. Of the final study population, 76.5% (n = 26) were male and the average age was 61 (range 40 to 80). Multiple exposure pathways were reported for 47% (n = 16) of the participants. These were subsequently ranked by potential exposure to road gravel containing erionite. The most frequently reported primary exposure pathway at 44.1% (n = 15) was having worked in gravel pits and/or road maintenance (Table 1). Occupations with frequent driving or participants who reported their primary source of exposure to be frequent driving comprised 20.6% (n = 7) followed by ranching/farming at 17.6% (n = 6) and “other” exposure pathways at 17.6% (n = 6). The average time from initial exposure and average duration of exposure via the primary exposure pathways was 34 years (range 3 to 67 years) and 22 years (range 0.8 to 63 years), respectively (Table 1).

### **5.2 Chest X-rays**

As shown in Table 1, the observed prevalence of interstitial changes consistent with pneumoconiosis was 3.0% (n = 1) among the 33 available chest X-rays and was not significantly increased when compared to the assumed population prevalence of 1.6% (p = 0.41). The chest X-ray in one individual (participant 31) demonstrated right middle lobe-only interstitial changes (Table 2). The HRCT demonstrated diffuse bilateral predominantly mid and upper lung zone findings more typical of non-asbestos related changes. No pleural changes were noted. The primary exposure pathway was road maintenance (duration 30 years, latency 33 years) and the secondary exposure pathway was frequent driving (Table 2). Activities with

potential confounding exposure included intermittent welding and working in the road equipment maintenance facility. No other medical condition potentially impacting the lung was reported by this participant who never smoked.

The prevalence of localized pleural changes observed on chest X-ray was 3.0% (n = 1) and was not significantly increased above the background prevalence of 3.9% (p = 0.73). One individual (participant 12) demonstrated extensive bilateral localized pleural changes with calcification (Table 2). Similar findings without interstitial changes were noted on the HRCT. The primary exposure pathway associated with this participant was work in road maintenance (duration 38 years, latency 39 years). In addition, confounding asbestos exposure occurred during service as a boiler technician in the U.S. Navy.

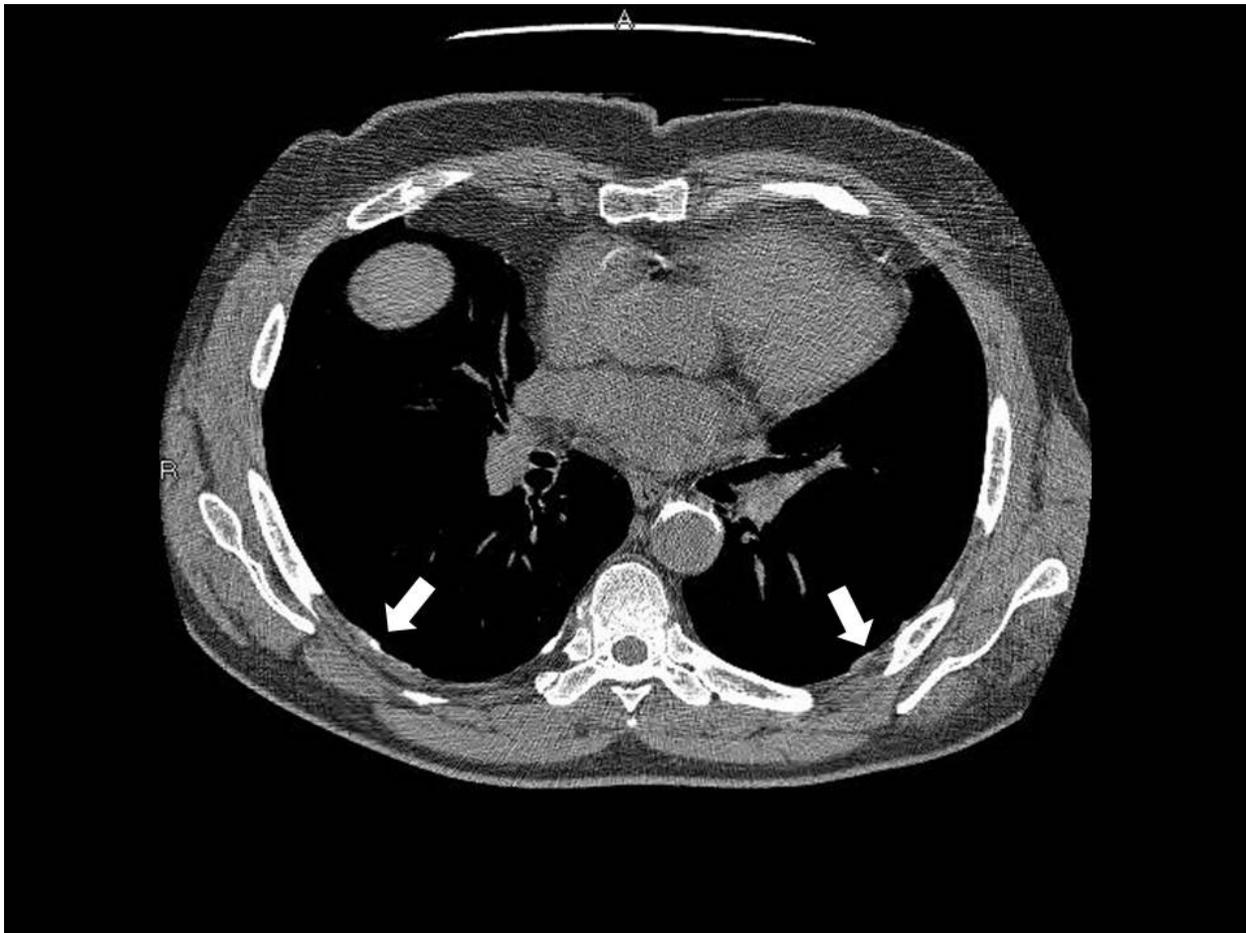
### **5.3 High-Resolution Computed Tomography**

The prevalence of interstitial changes observed on HRCT was 17.6% (n = 6) and was significantly increased (p < 0.01) compared to a prevalence of 1.5% based on HRCT scans in male transportation workers with low cumulative asbestos fiber exposure (20). Of these, gravel pit and/or road maintenance was the primary exposure pathway for five with one individual's exposure pathway (participant 25) being a rancher and farmer (Table 2). Five of the six individuals with interstitial changes were identified on HRCT only with participant 31 having been identified on both chest radiograph and HRCT. Four of the six (participants 25, 31, 33, 35) had interstitial changes alone; of these, two reported being a current or former smoker (participants 25 and 35) at 41 and 40 pack-years, respectively, and one (participant 33) had an occupational history of working in the coal mining industry for 23 years and only three years from initial potential exposure to road dust. Two of the six individuals (participants 14 and 24) had both bilateral localized pleural changes with calcification and interstitial changes. Removal of participant 33 due to minimal time period from initial exposure to road gravel and participant 31 due to atypical distribution of interstitial changes (Table 2) results in a prevalence of interstitial changes of 12.5% (n = 4, p < 0.01).

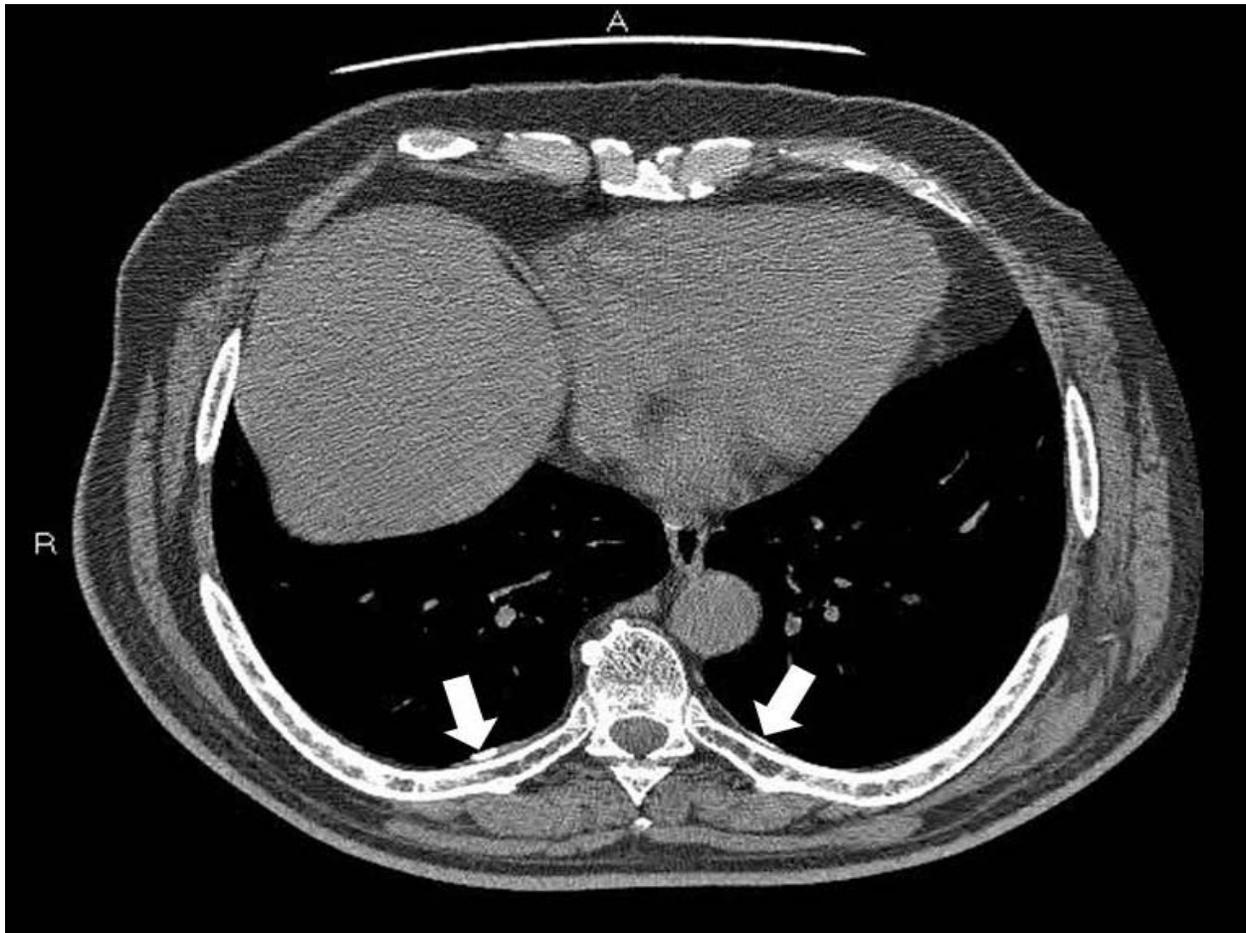
Two individuals (participants 14 and 24) had both mild bilateral localized pleural changes with calcification and minimal unilateral and bilateral lower lobe interstitial changes based on HRCT.

Both were ex-smokers at 3 and 7 pack-years, respectively, and the primary exposure pathways were gravel pits and/or road maintenance. Neither of these participants reported any potential past asbestos exposure. Representative HRCT images are shown in Figure 3 (participant 14) and Figure 4 (participant 24). As mentioned previously, one participant with a history of previous asbestos exposure and work in road maintenance (participant 12) had extensive localized pleural changes with calcification on both chest X-ray and HRCT (Figure 5). The total of three (8.8%) participants with bilateral localized pleural changes based on HRCT scans results in an elevated but not significant ( $p = 0.11$ ) increase when compared to a prevalence of bilateral localized pleural changes of 3.4% among low exposed urban transportation workers based on CT scans ( Ameille et al 2007). The primary exposure pathway was gravel pits and/or road maintenance for these three participants with an average duration and latency of 19 years and 29 years, respectively. Removal of participant 12 due to previous asbestos exposure results in an observed 6.1% prevalence ( $n = 2$ ) of localized pleural changes.

For reference purposes, Figure 6 presents an HRCT scan from a healthy individual with no interstitial changes or localized pleural changes.



**Figure 3:** Mild bilateral localized pleural changes including calcification (Participant 14). Individual had no reported past history of asbestos exposure and worked five years in road maintenance.



**Figure 4:** Mild bilateral localized pleural changes including calcification (Participant 24). Participant had no reported past history of asbestos exposure and worked 14 years in gravel pits and/or road maintenance.



**Figure 5:** Extensive bilateral localized pleural changes including calcification (Participant 12). Participant had history of asbestos exposure as a boiler technician in the U.S. Navy and 38 years in road maintenance.



**Figure 6:** HRCT scan from a healthy individual with no interstitial changes or localized pleural changes.

## **6.0 DISCUSSION AND CONCLUSIONS**

This study has identified within the U.S. the presence of interstitial and bilateral localized pleural changes with calcification in two workers with prolonged occupational exposure to road gravel that contains fibrous erionite. The HRCT changes in these two sentinel cases are minimal but are consistent with erionite exposure involving the parietal pleura and lung parenchyma.

The prevalence of interstitial and pleural changes on chest X-ray in background populations can range from 0.21 -1.9% and 0.0 – 6.8%, respectively, depending upon the case definition, occupational history, age, gender, and geographic location of the population (Ameille et al 2007, Castellan et al 1985, Hillerdal 1997). In this study, the prevalence of interstitial and pleural changes observed by chest X-ray was not significantly increased. The use of HRCT, a more sensitive and specific radiographic technique with the potential to depict subtle pleural and interstitial changes (Aberle et al 1988) not yet evident on standard chest X-rays resulted in a significantly increased prevalence of interstitial changes (17.6%) and an increased, though not significantly, prevalence of localized bilateral pleural changes with calcification (8.8%). However, the lack of corresponding pleural changes in four of six individuals with interstitial changes in combination with prolonged smoking history in two, atypical interstitial pattern in one, and short latency from initial potential erionite exposure in one makes it unlikely the minimal interstitial changes in these four are related to fibrous erionite exposure (American Thoracic Society 2004).

Environmental exposure to erionite has been studied in three villages located in the Cappadocian region of Turkey where the fiber is present in volcanic tuffs used for building materials (Emri et al 2002). Resident exposure to erionite within the ambient air in these villages occurs 24 hours per day through normal activities of daily living (Emri et al 2002). In the Turkish studies, the prevalence of calcified pleural plaques related to erionite exposure on chest X-ray was 9.3% (Emri et al 2002). Within our study, the prevalence of bilateral localized pleural changes with calcification on chest X-ray and HRCT was 3.0% and 8.8%, respectively. Exposure to erionite in the Turkish villages has also been associated with diffuse interstitial fibrosis, bronchial carcinoma (Emri et al 2002), and malignant mesothelioma (Metintas et al 1999).

Gravel samples collected from North Dakota were compared to samples obtained from central Turkey for fiber concentration, fiber length, width, and aspect ratio. The samples were also analyzed to determine mineral chemistry using electron probe microanalysis and scanning electron microscopy with energy dispersive x-ray analysis. Mineral structure was determined using x-ray diffraction. The results of these analyses confirmed the presence of erionite in gravel utilized in western North Dakota and that the erionite fibers from North Dakota were similar in morphology, mineral chemistry, and mineral structure to the fibers obtained from central Turkey (USEPA 2009). Fiber concentrations in North Dakota following activity-based sampling transportation scenarios (e.g. driving cars and school buses on gravel roads) ranged from 0.0107 – 0.0391 f/cc (phase contrast microscopy equivalent) with an average of 0.0249 f/cc. Stationary air samplers located near the road measured concentrations ranging from 0 – 0.0012 f/cc with an average of 0.0008 f/cc. These activity based and stationary sampling results may under-represent levels to which road maintenance workers are exposed particularly during gravel pit and road grading activities. In another study of worker exposure to gravel-containing naturally occurring asbestos in gravel in Alaska, road grader operators were found to have the highest exposure. Of 564 breathing zone time-weighted average samples obtained, 3% indicated fiber exposure at or near the Occupational Safety and Health Administration permissible exposure limit of 0.1 f/cc using the National Institute of Occupational Safety and Health 7400 phase contrast microscopy procedure (Perkins et al 2008). Additional analysis on select samples indicated approximately 40% of the fibers were tremolite or actinolite asbestos using transmission electron microscopy analysis.

There are potential limitations to this study including the limited sample size and lack of quantitative airborne erionite exposure characterization of the participants. The purpose of this study was to recruit a population with the greatest potential for exposure to road gravel containing erionite. Through extensive recruitment efforts in this sparsely populated area of North Dakota, we were able to elicit participation of 15 individuals (44%) with a high potential for prolonged exposure to gravel. Other potentially exposed residents of the area were subsequently enrolled to increase sample size and variability of occupations. In contrast to many occupational studies, the lack of personal sampling data is a study limitation. Nevertheless, this study provides evidence of a likely association in two individuals between working in road maintenance and/or gravel pits with potential erionite exposure and mild

bilateral localized pleural changes with calcification and corresponding minimal lower lobe interstitial changes based on HRCT.

Another potential limitation is the lack of background rates of HRCT scan findings consistent with asbestos related pleural changes either in North Dakota or the U.S. population in general. Our findings of bilateral pleural changes, however, in two participants (6.1%) with past potential erionite exposure is similar to that found in the French urban transportation workers (3.4%) based on HRCT/CT scans and who had relatively low cumulative asbestos exposure. The average age and time from initial potential mineral fiber exposure between the French transportation workers and our participants was similar. In addition, HRCT is a more specific methodology to detect pleuroparenchymal changes consistent with asbestos exposure (Sargent et al 1984). Thus, it is unlikely that there has been an over-estimation of the HRCT scan findings.

In summary, these study results suggest occupational exposure to road gravel containing erionite, particularly for workers employed in road maintenance or gravel pits, can result in pleural and possible interstitial changes historically associated with commercial asbestos exposure. Based on the known health impact from exposure to erionite in Turkey and more recently Mexico, precautionary measures should be considered to limit occupational exposure to gravel containing erionite particularly in road maintenance and gravel pit workers. A North Dakota State registry should also be considered as a partnership between local health care providers and the NDDoH to monitor the rate of radiographic changes potentially associated with erionite exposure in specific geographical locations within North Dakota. In those workers involved with road maintenance and gravel pit work with gravel containing erionite, an environmental monitoring and pulmonary medical surveillance program should also be considered.

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## **Tables**

Table 1: Summary of Chest Radiographic Changes by Exposure Pathway

Table 2: Co-exposures, Smoking History, and Health History among Subjects with Radiographic Changes

**Table 1: Summary of Chest Radiographic Changes by Exposure Pathway**  
Radiographic Changes Associated with Exposure to Erionite in Road Gravel in North Dakota

Exposure Pathway	Number of Subjects	Average Duration (Standard Deviation) [years]	Average Latency (Standard Deviation) [years]	X-ray		HRCT	
				Interstitial Changes (Pathway Prevalence)	Pleural Changes (Pathway Prevalence)	Interstitial Changes (Pathway Prevalence)	Pleural Changes (Pathway Prevalence)
Gravel Pit / Road Maintenance	15	20 (17)	31 (15)	1 (6.7%)	1 (6.7%)	5 (33.3%)	3 (20.0%)
Frequent Driving [Note 1]	7	13 (8)	32 (15)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Rancher / Farmer	6	35 (18)	40 (15)	0 (0.0%)	0 (0.0%)	1 (16.7%)	0 (0.0%)
Other [Note 2]	6	24 (20)	40 (18)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
<b>Total</b>	<b>34 [Note 3]</b>	<b>22 (17)</b>	<b>34 (15)</b>	<b>1 (3.0%)</b>	<b>1 (3.0%)</b>	<b>6 (17.6%)</b>	<b>3 (8.8%)</b>

**Notes**

- [1] Includes mail carriers, delivery truck drivers, and other occupations where frequent driving was reported
- [2] Includes oil field workers, residents, and other occupations
- [3] Includes one subject with HRCT only and one subject with conventional CT and chest x-ray

**Table 2: Co-exposures, Smoking History, and Health History Among Subjects with Chart Radiographic Changes**  
 Radiographic Changes Associated with Exposure to Erionite in Road Gravel in North Dakota

Participant	Primary Exposure Pathway	Duration (years) [Note 1]	Latency (years) [Note 1]	Ever Smoked?	Current Smoker?	Pack-years	Other Exposure	Other Pulmonary Conditions / Symptoms	X-ray (# B-readers identifying abnormality / 3)		HRCT (# B-readers identifying abnormality / 3)	
									Interstitial Changes	Pleural Changes	Interstitial Changes	Pleural Changes
12	1) Road Maintenance	38	39	Yes	Yes	44	Road maintenance shop, Boiler technician in U.S. Navy with intermittent asbestos exposure (~20 times total, 3-4 hours each)	Pneumonia/pleurisy, acute benign pericarditis, shortness of breath walking up slight hill	None	Bilateral chest wall and diaphragmatic plaques with calcification (3/3)	None	Bilateral chest wall and diaphragmatic plaques with calcification (3/3)
14	1) Road Maintenance 2) Rancher/Farmer	5	19	Yes	No	3	None reported	Shortness of breath walking up slight hill	None	None	Right lower lobe interstitial changes (2/3)	Bilateral chest wall plaques with calcification (3/3)
24	1) Gravel Pits / Road Maintenance	14	30	Yes	No	7	None reported	Chest tightness when walking	None	None	Bilateral lower lobe interstitial changes (2/3)	Bilateral chest wall plaque with unilateral chest wall calcification (3/3)
25	1) Rancher /Farmer	33	49	Yes	Yes	41	None reported	Phlegm, emphysema, hoarse/difficulty swallowing, shortness of breath walking up slight hill	None	None	Bilateral lower lobe interstitial changes (2/3)	None
31	1) Road Maintenance 2) Delivery Truck Driver	30	33	No	No	-	Road maintenance shop, Intermittent welding (~5x / month) as part of road maintenance occupation	Shortness of breath walking up slight hill	Right middle lobe opacities r/u, profusion 1/1 (2/3)	None	Diffuse bilateral predominately mid and upper zone fibrous with mild honeycomb more typical of non-asbestos related changes (3/3)	None
33	1) Road Maintenance	3	3	No	No	-	Coal mine heavy equipment operator (23 years duration, 34 years latency)	None	None	None	Bilateral lower lobe interstitial changes (2/3)	None
35	1) Road Maintenance 2) Rancher / Farmer	32	39	Yes	No	40	None reported	Phlegm, pneumonia as a child, emphysema	None	None	Bilateral lower lobe and right middle lobe interstitial changes (2/3)	None

**Note**

[1] Calculated for occupation / exposure with with highest rank of a priori likelihood of exposure to erionite

**Appendix 1:**

**Technical Memorandum - Statistical Analysis of Mesothelioma Rates in North Dakota  
Compared with Rates in Other Regions of the United States**

## ATSDR TECHNICAL ASSISTANCE FORM

Preparer's Name: Ted Larson  
Affiliation: Division of Health Studies/ATSDR

**Site: Dunn County Erionite, Dunn County, ND (Cost Recovery # 80MK)**

Requestor's Name: Charlie Partridge, USEPA, Region 8

Date of Request: 1/20/2010

Request:

***Epidemiological/statistical analysis of mesothelioma rates in North Dakota, compared with other regions of the U.S. (North Dakota State cancer registry data provided by Charlie Partridge).***

ATSDR Response:

March 26, 2010

Attached are results from analysis of North Dakota tumor registry data for mesothelioma (see the attached spreadsheet "Dunn Co ND Erionite site mesothelioma registry eval 032410.xls"). These results are expressed as incidence rates which are defined as the number of new cases per unit of person (or population) time at risk. Because most diseases are affected by demographic variables, especially age, it is important to standardize incidence rates for the underlying demographics of the population being studied. Also, note that incidence should not be confused with risk (or probability).

### **METHOD**

We calculated statewide mesothelioma incidence using standard methods (<http://wonder.cdc.gov/wonder/help/cancermort-v2005.html>) using two population weights to standardize results. First, we calculated age- and sex-adjusted standardized incidence for white cases occurring 1999–2005, the years for which comparison data were readily available for whites (n=56; <http://wonder.cdc.gov/cancer-v2005.HTML>). Second, we calculated age-standardized incidence for all races adjusted using the 2000 U.S. Standard Population (<http://seer.cancer.gov/stdpopulations/stdpop.19ages.html>) for cases occurring 1997–2007 (n=80), 1999-2007 (n=72), and 1999-2005 (n=58). To accompany the incidence point estimates, we calculated 95% gamma confidence intervals (<http://wonder.cdc.gov/wonder/help/cancer/FayFeuerConfidenceIntervals.pdf>).

Note that the International Classification of Disease code for mesothelioma was not widely used until 1999 and many state cancer registries had significant data quality issues as recently as the late 1990s. As a check of the state incidence results, we also calculated standardized mortality for the time period 1995-2005.

To check for geographic clusters of mesothelioma possibly related to erionite exposure, we calculated crude incidence for counties with more than 5 cases, and age- and sex-adjusted incidence was calculated for regions where we thought a geographic cluster of erionite-related mesothelioma were most likely to occur: Dunn and contiguous counties and the Southwest Public Health Unit (PHU). Note that we excluded Mountrail County from former region because the Missouri River/Lake Sakakawea is a significant physical barrier between it and Dunn and contiguous counties. Also note that the Southwest PHU includes Dunn, Slope and Stark Counties—all of the North Dakota counties with significant erionite deposits.

We considered calculating incidence by occupation, but there did not appear to be excess of any type of occupation and we consequently thought the cell counts would be too small to be meaningful.

## **RESULTS**

The tab “Incidence 1” shows age- and sex-standardized state mesothelioma incidence among whites, 1999-2005, which was 1.2 per 100,000 (95% CI 0.6, 1.9) and is very similar to the 1999–2002 national incidence for all races (Larson et al. 2007, “Incidence and Descriptive Epidemiology of Mesothelioma in the United States, 1999–2002”) and the 2001–2005 national incidence for whites (1.2 per 100,000) (National Program for Cancer Registries, [http://apps.nccd.cdc.gov/DCPC\\_INCA/DCPC\\_INCA.aspx](http://apps.nccd.cdc.gov/DCPC_INCA/DCPC_INCA.aspx) ). Similarly, the age-standardized incidence for all races 1997-2007 was 1.0 per 100,000, 1999-2007 was 1.3 per 100,000, and 1999-2005 was 1.2 per 100,000 (see tab “Incidence 2”). Note that the 95% confidence intervals are all very wide due to the small number of cases and all include the national incidence.

Not unexpectedly given the short survival time of mesothelioma, age- and sex-adjusted mortality in ND was virtually the same as incidence and is similar to the national rate (Bang et al. 2006, “Malignant Mesothelioma Mortality in the United States, 1999–2001”; see tab “Mortality”). The age- and sex-adjusted North Dakota mesothelioma mortality was 1.2 per 100,000 (95% CI 0.6, 1.9).

For the period 1999-2005, only three ND counties, Burleigh, Cass and Ward, had 5 or more cases (see tab “Counties”). However, none are in close proximity to Dunn County. Note that Dunn County had no cases 1997-2007. We did not calculate adjusted incidence for the Southwest Public Health Unit, the PHU containing Dunn County, because it only had three cases. For the period 1999-2005, Dunn and contiguous counties had 6 cases with an adjusted incidence of 1.4 per 100,000 (95% CI 0.8, 2.2; see the “Regions” tab).

This regional incidence is greater than the state and national incidences but should be interpreted with caution: the 95% confidence interval is wide due to small numbers of cases and contains the national incidence.

## **CONCLUSION**

To summarize, the data available from the ND registry do not indicate an increased state incidence of mesothelioma. In addition, there was no clear evidence of a geographic cluster of mesothelioma for Dunn and contiguous counties.

Please let us know if you have questions or comments.

Mesothelioma incidence among whites in North Dakota, 1999-2005. Population weights from U.S. national data for whites, 1999-2005.  
 United States Cancer Statistics, 1999-2005 Mesothelioma Incidence Results (whites)

sex	age	obs	pop'n	pop'n weight	Crude Rate
Female	< 1 year		9,984,253	0.006489455	Suppressed
Female	1-4 years		39,181,234	0.025466586	Suppressed
Female	5-9 years		49,900,265	0.032433624	Suppressed
Female	10-14 years		51,949,220	0.033765381	Suppressed
Female	15-19 years	Suppressed	51,184,208	0.033268147	Suppressed
Female	20-24 years	Suppressed	50,232,623	0.032649646	Suppressed
Female	25-29 years	22	48,712,189	0.031661411	0
Female	30-34 years	30	52,597,248	0.034186579	0.1
Female	35-39 years	63	57,102,309	0.037114729	0.1
Female	40-44 years	113	60,791,782	0.039512772	0.2
Female	45-49 years	149	57,581,227	0.037426011	0.3
Female	50-54 years	212	51,756,769	0.033640294	0.4
Female	55-59 years	290	42,924,072	0.027899315	0.7
Female	60-64 years	324	34,130,027	0.022183458	0.9
Female	65-69 years	458	29,180,079	0.018966146	1.6
Female	70-74 years	563	27,600,500	0.017939469	2
Female	75-79 years	717	25,289,724	0.016437536	2.8
Female	80-84 years	606	19,414,501	0.012618823	3.1
Female	85+ years	444	18,972,678	0.012331652	2.3
Female	Total	4,007	778,484,908		0.5
Male	< 1 year	Suppressed	10,475,886	0.006809001	
Male	1-4 years		41,157,795	0.02675129	
Male	5-9 years		52,558,370	0.03416131	
Male	10-14 years	Suppressed	54,778,495	0.035604322	Suppressed
Male	15-19 years	Suppressed	54,430,079	0.035377862	Suppressed
Male	20-24 years	Suppressed	53,746,767	0.034933731	Suppressed
Male	25-29 years	16	51,600,851	0.033538952	0
Male	30-34 years	31	54,828,658	0.035636926	0.1
Male	35-39 years	67	58,489,204	0.038016168	0.1
Male	40-44 years	123	61,242,623	0.039805805	0.2
Male	45-49 years	238	57,151,308	0.037146577	0.4
Male	50-54 years	510	50,588,767	0.032881129	1
Male	55-59 years	937	41,053,920	0.026683774	2.3
Male	60-64 years	1,477	31,534,945	0.020496736	4.7
Male	65-69 years	1,979	25,692,255	0.016699169	7.7
Male	70-74 years	2,693	22,438,310	0.014584205	12
Male	75-79 years	3,192	18,183,977	0.011819021	17.6
Male	80-84 years	2,407	11,885,976	0.007725516	20.3
Male	85+ years	1,427	8,211,892	0.005337475	17.4
Male	Total	15,112	760,050,078		2
Total		7,754,513	1,538,534,986	1	1.2

ND mesothelioma incidence 99-05 from ND registry Comparison: US, 1999-2005 Incidence Results (whites)

SEX	age	meso obs	pop'n	pop'n weight(US)	rate	for variance calc'n	
Female	< 1 year		22,941	0.006489455		0	0
Female	1-4 years		92,743	0.025466586		0	0
Female	5-9 years		123,569	0.032433624		0	0
Female	10-14 years		136,495	0.033765381		0	0
Female	15-19 years	0	159,117	0.033268147		0	0
Female	20-24 years	0	162,127	0.032649646		0	0
Female	25-29 years	0	113,167	0.031661411		0	0
Female	30-34 years	0	113,897	0.034186579		0	0
Female	35-39 years	0	134,232	0.037114729		0	0
Female	40-44 years	0	160,341	0.039512772		0	0
Female	45-49 years	0	159,216	0.037426011		0	0
Female	50-54 years	1	134,217	0.033640294	2.50641E-07	0.000221	
Female	55-59 years	1	105,402	0.027899315	2.64694E-07	0.00034	
Female	60-64 years	1	87,438	0.022183458	2.53705E-07	0.000516	
Female	65-69 years	1	81,929	0.018966146	2.31495E-07	0.000644	
Female	70-74 years	4	80,362	0.017939469	8.92933E-07	0.002775	
Female	75-79 years	0	73,501	0.016437536		0	0
Female	80-84 years	3	62,489	0.012618823	6.0581E-07	0.003805	
Female	85+ years	1	73,840	0.012331652	1.67005E-07	0.001098	
Male	< 1 year		24,004	0.006809001		0	0
Male	1-4 years		97,029	0.02675129		0	0
Male	5-9 years		129,758	0.03416131		0	0
Male	10-14 years		145,491	0.035604322		0	0
Male	15-19 years	0	172,201	0.035377862		0	0
Male	20-24 years	0	183,296	0.034933731		0	0
Male	25-29 years	0	128,617	0.033538952		0	0
Male	30-34 years	0	122,481	0.035636926		0	0
Male	35-39 years	0	139,144	0.038016168		0	0
Male	40-44 years	1	161,783	0.039805805	2.46044E-07	0.000155	
Male	45-49 years	1	165,386	0.037146577	2.24605E-07	0.000163	
Male	50-54 years	2	143,529	0.032881129	4.58181E-07	0.000424	
Male	55-59 years	1	108,800	0.026683774	2.45255E-07	0.000344	
Male	60-64 years	4	84,572	0.020496736	9.69434E-07	0.002308	
Male	65-69 years	3	73,335	0.016699169	6.83132E-07	0.00245	
Male	70-74 years	10	67,921	0.014584205	2.14723E-06	0.010095	
Male	75-79 years	8	57,255	0.011819021	1.65142E-06	0.011822	
Male	80-84 years	7	40,033	0.007725516	1.35085E-06	0.022634	
Male	85+ years	7	34,119	0.005337475	1.09506E-06	0.038438	

age adj rate= 1.173749798  
variance= 0.098230759  
max weight= 0.039805805

CI\* calc'd in SAS:  
lower 95% CI 0.642098438  
upper 95% CI 1.906661764

\*See <http://wonder.cdc.gov/wonder/help/cancer/FayFeuerConfidenceIntervals.pdf>  
and [http://www.doh.wa.gov/data/guidelines/CI\\_images/gamma\\_part\\_sas.txt](http://www.doh.wa.gov/data/guidelines/CI_images/gamma_part_sas.txt)

Mesothelioma incidence in North Dakota for all races for various year ranges. Population weights from the 2000 U.S. Standard Population.

Age	2000 US Standard Population (Census P25-1130)	pop'n wt
00 years	3,794,901	0.013818
01-04 years	15,191,619	0.055316
05-09 years	19,919,840	0.072532
10-14 years	20,056,779	0.073031
15-19 years	19,819,518	0.072167
20-24 years	18,257,225	0.066478
25-29 years	17,722,067	0.06453
30-34 years	19,511,370	0.071045
35-39 years	22,179,956	0.080762
40-44 years	22,479,229	0.081852
45-49 years	19,805,793	0.072117
50-54 years	17,224,359	0.062718
55-59 years	13,307,234	0.048454
60-64 years	10,654,272	0.038794
65-69 years	9,409,940	0.034264
70-74 years	8,725,574	0.031772
75-79 years	7,414,559	0.026998
80-84 years	4,900,234	0.017843
85+ years	4,259,173	0.015509
Total	274,633,642	1

North Dakota, 1997-2007

ND obs 97-97	ND pop'n 97_07	ND rate 97-07	for variance calc'n
0	362660	0	0
0	383992	0	0
0	431012	0	0
0	515412	0	0
0	552709	0	0
0	384610	0	0
0	366528	0	0
0	423488	0	0
1	491837	1.6642E-07	2.484E-05
1	504021	1.43084E-07	2.75114E-05
4	440246	5.69841E-07	0.000144869
2	343769	2.81901E-07	0.000120069
6	273037	8.52511E-07	0.000566448
8	242779	1.12905E-06	0.000961714
18	231567	2.46965E-06	0.002446558
14	203738	1.85519E-06	0.002545215
15	160816	1.66427E-06	0.005227559
11	170714	9.99298E-07	0.004154818
80	age adj rate=	1.01312179	

Lower 95% CI= 0.778999353  
 Upper 95% CI= 1.410996859  
 variance= 0.0162196  
 max wt= 0.081851695

North Dakota, 1999-2007

ND obs 99-07	ND pop'n 99-07	ND rate 99_07	for variance calc'n
0	294364	0	0
0	308638	0	0
0	346480	0	0
0	417858	0	0
0	460349	0	0
0	313998	0	0
0	296814	0	0
0	336348	0	0
1	395365	2.04272E-07	3.09011E-05
1	413447	1.97974E-07	3.35383E-05
3	367572	5.88596E-07	0.000130134
2	288263	4.35141E-07	0.000143188
6	225819	1.28743E-06	0.00068489
7	197755	1.37322E-06	0.001033088
15	187025	2.74805E-06	0.00252436
13	166160	2.48575E-06	0.002897913
14	131694	2.87008E-06	0.005957979
10	141556	1.26048E-06	0.004555124
72	age adj rate=	1.345099134	

Lower 95% CI= 1.095095549  
 Upper 95% CI= 1.75097364  
 variance= 0.017991115  
 max wt= 0.081851695

North Dakota, 1999-2005

ND obs 99-05	ND pop'n 99-05	ND rate 99-05	for variance calc'n
0	228263	0	0
0	245962	0	0
0	276908	0	0
0	330344	0	0
0	350208	0	0
0	238695	0	0
0	234558	0	0
0	269547	0	0
1	319312	2.56338E-07	3.82611E-05
1	323323	2.2305E-07	4.28869E-05
3	277728	6.77471E-07	0.000172231
2	213912	4.53032E-07	0.000192957
6	170511	1.36511E-06	0.000907045
4	154384	8.8775E-07	0.000756179
14	147845	3.00858E-06	0.002980445
9	130404	1.8633E-06	0.002556348
10	102279	1.74452E-06	0.00547962
8	107741	1.15154E-06	0.004787816
58	age adj rate=	1.163070409	

Lower 95% CI= 0.915622328  
 Upper 95% CI= 1.570692393  
 variance= 0.017911379  
 max wt= 0.081851695

Mesothelioma mortality among whites in the United States, 1999-2005. Population weights from national data for whites, 1999-2005.

Sex	Age	Deaths	Pop'n	Pop'n weight	Crude rate
Female	< 1 year		10,595,818	0.006458031	
Female	1-4 years		41,596,244	0.02535244	
Female	5-9 years		53,049,701	0.032333193	
Female	10-14 years		55,298,274	0.033703673	
Female	15-19 years	Suppressed	54,546,707	0.033245601	Suppressed
Female	20-24 years	Suppressed	53,523,733	0.03262211	Suppressed
Female	25-29 years	Suppressed	51,855,737	0.031605485	Suppressed
Female	30-34 years	Suppressed	56,083,179	0.034182064	Suppressed
Female	35-39 years	27	61,063,250	0.03721736	0
Female	40-44 years	57	64,983,688	0.039606823	0.1
Female	45-49 years	89	61,529,811	0.037501724	0.1
Female	50-54 years	138	55,353,332	0.03373723	0.2
Female	55-59 years	218	45,840,527	0.027939283	0.5
Female	60-64 years	258	36,447,152	0.022214127	0.7
Female	65-69 years	341	31,163,195	0.018993615	1.1
Female	70-74 years	459	29,457,052	0.01795374	1.6
Female	75-79 years	596	26,968,899	0.016437239	2.2
Female	80-84 years	538	20,691,480	0.012611223	2.6
Female	85+ years	387	20,232,994	0.012331781	1.9
Female	Total	3,132	830,280,773		<b>0.4</b>
Male	< 1 year		11,118,438	0.006776562	
Male	1-4 years		43,701,420	0.026635521	
Male	5-9 years		55,880,789	0.034058709	
Male	10-14 years		58,311,839	0.035540407	
Male	15-19 years	Suppressed	57,997,646	0.035348909	Suppressed
Male	20-24 years	Suppressed	57,246,318	0.034890984	Suppressed
Male	25-29 years	Suppressed	54,895,552	0.033458218	Suppressed
Male	30-34 years	Suppressed	58,408,594	0.035599378	Suppressed
Male	35-39 years	51	62,499,310	0.038092623	0.1
Male	40-44 years	79	65,438,673	0.039884131	0.1
Male	45-49 years	171	61,079,876	0.037227494	0.3
Male	50-54 years	376	54,153,792	0.033006124	0.7
Male	55-59 years	720	43,895,566	0.026753851	1.6
Male	60-64 years	1,239	33,717,576	0.020550481	3.7
Male	65-69 years	1,688	27,453,053	0.016732325	6.1
Male	70-74 years	2,304	23,944,772	0.014594068	9.6
Male	75-79 years	2,890	19,357,624	0.011798253	14.9
Male	80-84 years	2,181	12,624,724	0.007694627	17.3
Male	85+ years	1,376	8,713,190	0.005310591	15.8
Male	Total	13,101	810,438,752		<b>1.6</b>
Total			1,640,719,525		<b>1</b>

Mesothelioma mortality in ND registry among whites, 1999-2005, comparison: US mortality 1999-2005

sex	age	obs	ND pop'n	pop'n weight (US)	rate	for variance calc'n	
female	15-19 years	0	159,117	0.033245601	0	0	
female	20-24 years	0	162,127	0.03262211	0	0	
female	25-29 years	0	113,167	0.031605485	0	0	
female	30-34 years	0	113,897	0.034182064	0	0	
female	35-39 years	0	134,232	0.03721736	0	0	
female	40-44 years	0	160,341	0.039606823	0	0	
female	45-49 years	0	159,216	0.037501724	0	0	
female	50-54 years	1	134,217	0.03373723	2.51363E-07	0.000221	
female	55-59 years	1	105,402	0.027939283	2.65074E-07	0.00034	
female	60-64 years	1	87,438	0.022214127	2.54056E-07	0.000515	
female	65-69 years	1	81,929	0.018993615	2.3183E-07	0.000643	
female	70-74 years	4	80,362	0.01795374	8.93643E-07	0.002772	
female	75-79 years	0	73,501	0.016437239	0	0	
female	80-84 years	3	62,489	0.012611223	6.05445E-07	0.003807	
female	85+ years	1	73,840	0.012331781	1.67007E-07	0.001098	
male	15-19 years	0	172,201	0.035348909	0	0	
male	20-24 years	0	183,296	0.034890984	0	0	
male	25-29 years	0	128,617	0.033458218	0	0	
male	30-34 years	0	122,481	0.035599378	0	0	
male	35-39 years	0	139,144	0.038092623	0	0	
male	40-44 years	1	161,783	0.039884131	2.46529E-07	0.000155	
male	45-49 years	1	165,386	0.037227494	2.25095E-07	0.000162	
male	50-54 years	2	143,529	0.033006124	4.59923E-07	0.000422	
male	55-59 years	1	108,800	0.026753851	2.45899E-07	0.000344	
male	60-64 years	4	84,572	0.020550481	9.71976E-07	0.002302	
male	65-69 years	3	73,335	0.016732325	6.84489E-07	0.002445	
male	70-74 years	10	67,921	0.014594068	2.14868E-06	0.010088	
male	75-79 years	8	57,255	0.011798253	1.64852E-06	0.011843	
male	80-84 years	7	40,033	0.007694627	1.34545E-06	0.022724	
male	85+ years	7	34,119	0.005310591	1.08954E-06	0.038633	

age adj rate= 1.173452377  
variance= 0.09851345  
max weight= 0.039884131

CI\* calc'd in SAS:  
lower 95% CI 0.641181339  
upper 95% CI 1.907558441

\*See <http://wonder.cdc.gov/wonder/help/cancer/FayFeuerConfidenceIntervals.pdf>  
and [http://www.doh.wa.gov/data/guidelines/CI\\_images/gamma\\_part\\_sas.txt](http://www.doh.wa.gov/data/guidelines/CI_images/gamma_part_sas.txt)

Crude mesothelioma incidence in ND by county

ND county	pop'n (2000 Census)	Est. 7-year pop'n	Frequency 97-07	Frequency 99-05	Crude incidence 99-05
Adams	2,593	18151	0	0	
Barnes	11,775	82425	1	0	
Benson	6,964	48748	0	0	
Billings	888	6216	1	1	
Bottineau	7,149	50043	2	2	
Bowman	3,242	22694	2	2	
Burke	2,242	15694	0	0	
Burleigh	69,416	485912	14	13	2.675381551
Cass	123,138	861966	8	7	0.812096997
Cavalier	4,831	33817	0	0	
Dickey	5,757	40299	0	0	
Divide	2,283	15981	0	0	
Dunn	3,600	25200	0	0	
Eddy	2,757	19299	0	0	
Emmons	4,331	30317	0	0	
Foster	3,759	26313	1	0	
Golden Valley	1,924	13468	0	0	
Grand Forks	66,109	462763	7	4	
Grant	2,841	19887	0	0	
Griggs	2,754	19278	0	0	
Hettinger	2,715	19005	0	0	
Kidder	2,753	19271	2	2	
LaMoure	4,701	32907	1	0	
Logan	2,308	16156	1	1	
McHenry	5,987	41909	1	1	
McIntosh	3,390	23730	1	1	
McKenzie	5,737	40159	1	0	
McLean	9,311	65177	3	2	
Mercer	8,644	60508	3	3	
Morton	25,303	177121	8	3	
Mountrail	6,631	46417	2	1	
Nelson	3,715	26005	1	1	
Oliver	2,065	14455	1	0	
Pembina	8,585	60095	0	0	
Pierce	4,675	32725	1	0	
Ramsey	12,066	84462	0	0	
Ransom	5,890	41230	0	0	
Renville	2,610	18270	0	0	
Richland	17,998	125986	1	1	
Rolette	13,674	95718	1	0	
Sargent	4,366	30562	0	0	
Sheridan	1,710	11970	0	0	
Sioux	4,044	28308	0	0	
Slope	767	5369	0	0	
Stark	22,636	158452	1	0	
Steele	2,258	15806	0	0	
Stutsman	21,908	153356	1	0	
Towner	2,876	20132	0	0	
Traill	8,477	59339	0	0	
Walsh	12,389	86723	3	2	
Ward	58,795	411565	8	7	1.7008249
Wells	5,102	35714	0	0	
Williams	19,761	138327	3	2	
total	642,200	4495400	80	56	1.245717845

Age and sex adjusted mesothelioma incidence among whites by region, 99-05. Population weight from the national white population, 1999-2005.

Dunn and contiguous counties: McKenzie,Billings,Stark,Mercer,McLean

Southwest Public Health Unit (see map below)

SEX	age	meso obs	pop'n	pop'n weight(US)	rate	for variance calc'n
Female	< 1 year					
Female	1-4 years	0	7394	0.025466586	0	0
Female	5-9 years	0	9180	0.032433624	0	0
Female	10-14 years	0	11735	0.033765381	0	0
Female	15-19 years	0	13033	0.033268147	0	0
Female	20-24 years	0	9261	0.032649646	0	0
Female	25-29 years	0	5927	0.031661411	0	0
Female	30-34 years	0	7284	0.034186579	0	0
Female	35-39 years	0	10338	0.037114729	0	0
Female	40-44 years	0	14115	0.039512772	0	0
Female	45-49 years	0	13531	0.037426011	0	0
Female	50-54 years	0	11646	0.033640294	0	0
Female	55-59 years	0	9294	0.027899315	0	0
Female	60-64 years	0	7533	0.022183458	0	0
Female	65-69 years	0	6958	0.018966146	0	0
Female	70-74 years	1	6924	0.017939469	2.59091E-06	0.008051
Female	75-79 years	0	6378	0.016437536	0	0
Female	80-84 years	0	5545	0.012618823	0	0
Female	85+ years	0	5929	0.012331652	0	0
Male	< 1 year					
Male	1-4 years	0	7994	0.02675129	0	0
Male	5-9 years	0	9775	0.03416131	0	0
Male	10-14 years	0	12825	0.035604322	0	0
Male	15-19 years	0	14432	0.035377862	0	0
Male	20-24 years	0	10192	0.034933731	0	0
Male	25-29 years	0	6097	0.033538952	0	0
Male	30-34 years	0	7169	0.035636926	0	0
Male	35-39 years	0	9689	0.038016168	0	0
Male	40-44 years	1	13489	0.039805805	2.95098E-06	0.001862
Male	45-49 years	0	15072	0.037146577	0	0
Male	50-54 years	0	12878	0.032881129	0	0
Male	55-59 years	0	9850	0.026683774	0	0
Male	60-64 years	0	7692	0.020496736	0	0
Male	65-69 years	1	6532	0.016699169	2.55652E-06	0.009168
Male	70-74 years	1	5907	0.014584205	2.46897E-06	0.011608
Male	75-79 years	0	4899	0.011819021	0	0
Male	80-84 years	1	3866	0.007725516	1.99832E-06	0.033482
Male	85+ years	1	3383	0.005337475	1.57773E-06	0.055381

total  
n=6  
age adj rate= 1.414343752  
variance= 0.119551696  
max weight= 0.039805805

CI\* calc'd in SAS:  
lower 95% CI 0.81988112  
upper 95% CI 2.211489086

SEX	age	meso obs
Female	< 1 year	
Female	1-4 years	0
Female	5-9 years	0
Female	10-14 years	0
Female	15-19 years	0
Female	20-24 years	0
Female	25-29 years	0
Female	30-34 years	0
Female	35-39 years	0
Female	40-44 years	0
Female	45-49 years	0
Female	50-54 years	0
Female	55-59 years	0
Female	60-64 years	0
Female	65-69 years	0
Female	70-74 years	0
Female	75-79 years	0
Female	80-84 years	0
Female	85+ years	0
Male	< 1 year	
Male	1-4 years	0
Male	5-9 years	0
Male	10-14 years	0
Male	15-19 years	0
Male	20-24 years	0
Male	25-29 years	0
Male	30-34 years	0
Male	35-39 years	0
Male	40-44 years	0
Male	45-49 years	0
Male	50-54 years	0
Male	55-59 years	0
Male	60-64 years	0
Male	65-69 years	0
Male	70-74 years	1
Male	75-79 years	1
Male	80-84 years	1
Male	85+ years	0

total  
n=3  
age adj rate= 0 No rate calc'd; only 3 cases  
variance= 0  
max weight= 0

CI\* calc'd in SAS:  
lower 95% CI  
upper 95% CI

\*See <http://wonder.cdc.gov/wonder/help/cancer/FayFeuerConfidenceIntervals.pdf>  
and [http://www.doh.wa.gov/data/guidelines/CI\\_images/gamma\\_part\\_sas.txt](http://www.doh.wa.gov/data/guidelines/CI_images/gamma_part_sas.txt)

Local Health Units - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.ndhealth.gov/localhd/

Local Health Units

- Telephone directory (pdf)
- Summary of services
- Services Calendar
- Satellite Training Calendar
- Video Conference Room/Studio Schedule (Gold Seal Center, Bismarck)
- Training Schedule
- Webcast schedule

[Local Public Health Capacity and Infrastructure SWOT Analysis Survey Form \(Word RTF format\)](#)  
(right click the link and select "Save Target As" to save the document on your computer)

### Local Public Health Units

Click on your county to access local public health unit information

County	Health Unit Type
Divide	City/County Health Department
Burke	City/County Health Department
Renville	City/County Health Department
Bottineau	City/County Health Department
Wells	City/County Health Department
Towner	City/County Health Department
Chamberlain	City/County Health Department
Pembina	City/County Health Department
Williams	City/County Health Department
Mountrail	City/County Health Department
Ward	City/County Health Department
McHenry	City/County Health Department
Pierce	City/County Health Department
Benson	City/County Health Department
Ramsey	City/County Health Department
Thompson	City/County Health Department
McKenzie	City/County Health Department
McLean	City/County Health Department
Sheldon	City/County Health Department
Wells	City/County Health Department
Eddy	City/County Health Department
Nelson	City/County Health Department
Grand Forks	City/County Health Department
Dunn	City/County Health Department
Mercer	City/County Health Department
Griggs	City/County Health Department
Steele	City/County Health Department
Traill	City/County Health Department
Goodrich	City/County Health Department
Billings	City/County Health Department
Oliver	City/County Health Department
Burleigh	City/County Health Department
Foster	City/County Health Department
Stutsman	City/County Health Department
Barnes	City/County Health Department
Cass	City/County Health Department
Slope	City/County Health Department
Hettinger	City/County Health Department
Morton	City/County Health Department
Logan	City/County Health Department
La Moure	City/County Health Department
Hansom	City/County Health Department
Richland	City/County Health Department
Bozeman	City/County Health Department
Adams	City/County Health Department
Orrick	City/County Health Department
Sioux	City/County Health Department
Emmons	City/County Health Department
McIntosh	City/County Health Department
Dickey	City/County Health Department
Sargent	City/County Health Department
SW PHU	Multi-County Health District

Done

Adobe Updater  
Updates are ready to be installed.

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**Appendix 2:**  
**Recruitment Methodology**

Recruitment Methodology

Attachment A: News Release dated March 9, 2010

Attachment B: Letter to Local Companies dated March 6, 2010

Attachment C: Informational Fact Sheet

Attachment D: Medical Study Question and Answer Sheet

Attachment E: Erionite Medical Study Flyer

Attachment F: Initial Screening Questionnaire

## **Recruitment Methodology**

The NDDoH and EPA led efforts to identify potential subjects eligible for enrollment in this study. Primary recruitment was announced in a News Release dated March 9, 2010 (Attachment A) given to the media including local newspapers. The News Release included information regarding the study and contact information for interested residents to obtain more information.

Subsequent recruitment efforts included the following:

- 1) A letter dated March 6, 2010 (Attachment B) was mailed to local companies identified through public records likely to have had employees who may have been exposed to road gravel containing erionite. These industries included gravel pit companies, county maintenance workshops, and delivery companies.
- 2) A mass mailing distribution was performed throughout the study areas in Stark, Slope and Dunn County as well as Watford City which borders Dunn County and Bowman which borders Slope County. The total mailing was 7,940. The mailings contained an “Informational Fact Sheet” (Attachment C) and the “Medical Study Question and Answer Sheet” (Attachment D). These packets included basic information regarding the study, and contact details at the NDDoH and EPA if more information was required.
- 3) From May 18 through the 21, EPA held impromptu meetings with the local county maintenance workshops, school superintendants, postal carriers, churches and county sheriff departments throughout Stark, Slope and Dunn County as well as Watford City and Bowman with regards to the recruitment efforts. Copies of the Erionite Medical Study flyer (Attachment E) and the “Initial Screening Questionnaire” (Attachment F) were provided to those EPA met with and both documents were posted in various businesses, post offices, schools, county maintenance offices and medical clinics, throughout Stark, Slope and Dunn County as well as Watford City and Bowman.
- 4) The “Informational Fact Sheet” (Attachment C), “Medical Study Question and Answer Sheet” (Attachment D), and “Initial Screening Questionnaire” (Attachment F) were also made available on the NDDoH website for interested persons to download and return by mail (NDDoH 2010).
- 5) The NDDoH also answered public questions at two home shows in the area. The home shows were at Bismark on March 13-15, 2009 and Dickinson April 19-19, 2009. Staff

took calls from local print media that led to articles in the Dickinson Press and Bismarck Tribune, see Attachment G for some press articles. NDDoH staff met with County Commissioners and Road Superintendents from the areas of interest on Jan 12, 2009. NDDoH staff presented the issue to a legislators, physicians and other interested parties as follows:

- Meeting with the legislators early 2009
- Letters sent to physicians
- Webinar presented to the LPHU on March 6, 2009 which was taped and placed on the website
- Presentation to the WSI (Workforce Safety and Insurance) group on June 26th.
- Meeting at Medcenter One (hospital/clinics) on February 27

**Appendix 2 - Attachment A:  
News Release dated March 9, 2010**



**NORTH DAKOTA**  
DEPARTMENT *of* HEALTH

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## NEWS RELEASE

For Immediate Release:  
March 9, 2009

For More Information, Contact:  
Mark Dihle  
Division of Air Quality  
North Dakota Department of Health  
Phone: 701.328.5188  
E-mail: [mdihle@nd.gov](mailto:mdihle@nd.gov)

Steve Way, On-Scene Coordinator  
Emergency Response Program  
U.S. EPA Region 8  
Phone: 303.312.6723  
E-mail: [way.steven@epa.gov](mailto:way.steven@epa.gov)

### **State Health Department and EPA Seek Participants for Study To Determine Health Risks Associated With Erionite in Gravel**

BISMARCK, N.D. – The North Dakota Department of Health and the U.S. Environmental Protection Agency (EPA) are seeking participants for a study measuring the risk, if any, of breathing dust from gravel containing the fiber erionite.

Erionite is a fibrous mineral with some properties similar to asbestos, but is not regulated as a form of asbestos. Like asbestos, erionite may pose health risks to those who breathe in the fibers.

In 2006, the Department of Health and the North Dakota Geological Survey initiated an investigation of naturally-occurring erionite deposits located in rural areas near the Killdeer Mountains, Chalky Buttes and Little Badlands mountain areas in Dunn, Slope and Stark counties. The erionite-containing gravel deposits have been used for gravel sources for rural county roads and other areas for several decades.

“The possible health affects of exposure to erionite in North Dakota have not been studied,” said Mark Dihle, environmental scientist with the Department of Health’s Division of Air Quality. “For this study, we are hoping to recruit people who have 20 or more years of high exposure to dust that contains erionite in western North Dakota. This includes people who have worked in gravel pits, processed gravel, worked on road crews or who drove gravel roadways for a major part of their job. If someone believes they may qualify for this study, we encourage them to apply.”

-- more --

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600 E. Boulevard Ave. Dept. 301, Bismarck, North Dakota 58505-0200  
Phone: 701.328.2372 Fax: 701.328.4727 E-mail: [health@nd.gov](mailto:health@nd.gov)

*Visit the health department home page at [www.ndhealth.gov](http://www.ndhealth.gov).*

The study, which will begin in March 2009, will begin with an initial screening questionnaire. Based on criteria related to employment history, work locations, exposure time and other variables, some people will be selected to continue in the study by completing an occupational and medical questionnaire. Some of these participants will then be selected to have chest X-rays and CT scans. Chest X-rays and CT scans conducted as part of the medical study will be provided free; however, any follow-up medical care that may be identified based on the results in the study would be the responsibility of each individual participant.

People interested in participating in the study can go to [www.ndhealth.gov/EHS/Erionite/](http://www.ndhealth.gov/EHS/Erionite/) for more information and to find the initial screening questionnaire. Interested volunteers should print the questionnaire and mail it back to the North Dakota Department of Health. Interested participants also can contact the Department of Health to have a copy mailed to them directly. The initial screening questionnaires should be completed and submitted to the Department of Health before April 17, 2009.

The Department of Health and EPA are working with medical investigators from the University of Cincinnati to conduct the study. Anyone who qualifies based on the results of the initial screening questionnaire will be contacted by the University of Cincinnati investigators with further information and instructions. All personal information collected through the study will be kept confidential. Results of the study will assist officials in determining potential health risks associated with North Dakota erionite exposure and will be used to make informed decisions about the continued use of gravel containing erionite.

For more information regarding erionite or this study, please contact Mark Dihle, North Dakota Department Health, at 701.328.5188.

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*Please note: To access archived news releases and other information, visit the North Dakota Department of Health Press Room at [www.nddohpressroom.gov](http://www.nddohpressroom.gov).*

**Appendix 2 - Attachment B:**

**Letter to Local Companies dated March 6, 2010**



March 3, 2009

To Whom It May Concern:

Subject: North Dakota Erionite Medical Study

The North Dakota Department of Health (NDDoH) would like to take the opportunity to make your company aware of an upcoming medical study of workers potentially exposed to erionite contained in gravel used in portions of western North Dakota.

The study is designed to determine if there are any chest X-ray and chest CT scan changes in workers who have had the highest potential for exposure, such as persons who have worked in gravel pits or on road crews. It is hoped that the results of this study will assist public and private decision-makers in making informed decisions about the continued use of erionite-containing gravel. We are requesting your assistance in sharing this information with your current and past employees who may be eligible for the study.

Beginning in 2006, NDDoH and the North Dakota Geological Survey investigated naturally-occurring erionite deposits located in rural areas near the Killdeer Mountains, Chalky Buttes and Little Badlands areas in Dunn, Slope and Stark counties. The erionite-containing gravel deposits have been used for gravel sources for rural county roads and other areas for several decades. Erionite is a fibrous mineral with some properties similar to asbestos, but is not regulated as a form of asbestos. Like asbestos, erionite may pose health risks to those who breathe in the fibers. Erionite is a known human carcinogen.

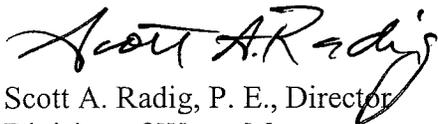
NDDoH requested assistance from the U.S. Environmental Protection Agency (EPA) to investigate the situation and evaluate the potential that erionite in the gravel poses a health risk to residents in these areas. The investigation showed that erionite fibers can become airborne when disturbed, such as with driving, and that the fibers are of a size that can be easily inhaled. While there have been no documented health-related impacts from erionite exposure in North Dakota to date, the NDDoH has decided to implement a focused medical study to get a better indication of potential health risks related to erionite exposure.

The medical study will consist of an occupational and pulmonary medical questionnaire, chest X-rays and CT scans of voluntary participants that meet specific criteria related to employment history, job responsibilities, exposure time, and other variables. Not all participants who complete an initial screening questionnaire or subsequent occupational and pulmonary medical questionnaire will be selected for chest X-rays and CT scans. Clinical evidence from this study will assist North Dakota officials in determining if there are potential health concerns with ND

individuals with the highest exposure risk. Results from this study may determine whether or not additional study or actions are needed. The study is not intended to provide medical assistance based on a participant's results. However, the individual results of the scans will be shared with the individuals who participate, and it will be their responsibility to further discuss the results and any future medical needs with their health care provider.

The NDDoH intends to distribute the initial screening questionnaire for the medical study in Spring 2009. The NDDoH appreciates your support for this medical study and in sharing this information with your current and past employees. Attached is additional information on the medical study and erionite in western North Dakota. For more information, please contact Mark Dihle, Division of Air Quality, NDDoH at (701) 328-5188 or go to [www.ndhealth.gov/EHS/Erionite](http://www.ndhealth.gov/EHS/Erionite).

Sincerely,



Scott A. Radig, P. E., Director  
Division of Waste Management  
North Dakota Department of Health

SAR:lk  
Enclosures (3)

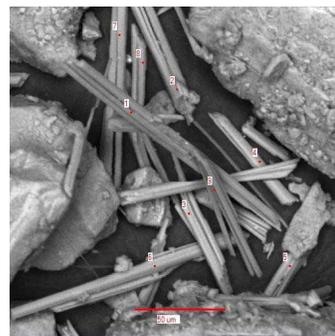
**Appendix 2 - Attachment C:  
Informational Fact Sheet**



## ERIONITE

### **What is erionite?**

Erionite is a naturally occurring, microscopic, fibrous mineral. It usually is found in volcanic ash that has been altered by weathering and ground water. Erionite forms brittle, wool-like fibrous masses in the hollows of rock formations. Its color varies from white to clear, and it looks like transparent, glass-like fibers. Some properties of erionite are similar to the properties of asbestos; however, erionite is not currently regulated by the U.S. Environmental Protection Agency (EPA) as one of the six asbestos fibers.



*Erionite (500X magnification)*

### **Why is erionite a concern?**

Like asbestos, erionite may pose health risks to those who breathe in the fibers. It appears to be associated with increased risks of fibrogenic lung disease, lung cancer and mesothelioma (a rare type of respiratory cancer usually related to asbestos exposure). Although toxic effects were documented in a study of three small villages in Turkey in the 1970s, there have been few studies of erionite in the United States.

### **Why is erionite a concern in North Dakota?**

Over the past few decades, gravel pits have been excavated in western North Dakota where naturally occurring deposits of erionite are found. The gravel was used to surface local county roads, parking lots and other areas. In 2006, the North Dakota Department of Health (NDDoH) learned of the potential health effects of erionite and its occurrence in North Dakota through discussions with the University of North Dakota (UND) and the North Dakota Geological Survey (NDGS). The NDDoH immediately began investigating the situation, in cooperation with the NDGS.

The NDDoH recognizes the potential public health implications of erionite exposure. However, it is important to note that the department has not observed any health-related impacts from erionite exposure in North Dakota.

### **Where are the erionite deposits found in western North Dakota?**

Gravel deposits that contain erionite are located in or near the Arikaree, Brule and Chadron geologic formations, which correspond to the Chalky Buttes, Little Badlands and Killdeer Mountain areas in Slope, Stark and Dunn counties. These geologic formations are also present in other high buttes in western North Dakota, but testing has not been done to see if erionite is present there, as well.

### **What has been done to address the erionite concern?**

Since 2006, testing has been done on samples from Dunn County, the area where North Dakota's naturally occurring erionite first became a concern.

The state tested some of the rock faces of the Killdeer Mountains and nearby gravel piles that had been excavated from areas suspected of containing erionite. Laboratory tests showed that erionite fibers were present in many of the samples. The state met with county commissioners in 2006 to bring the situation to their attention and discuss sampling results. A public meeting also was held to provide local residents with information about erionite in Dunn County. The state asked EPA to conduct an investigation of the possible health effects of erionite exposures in Dunn County.

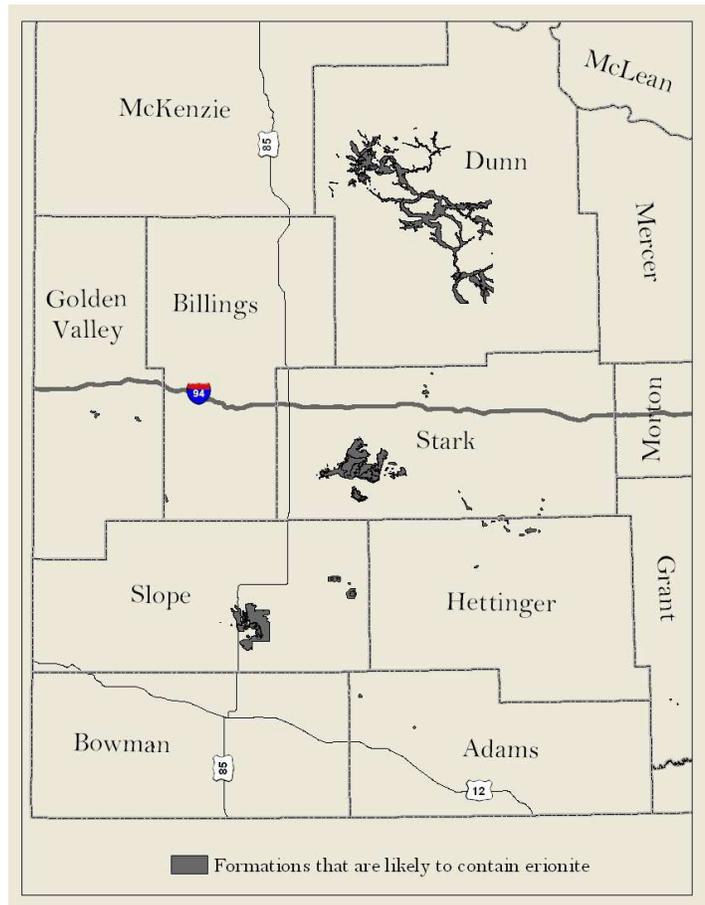
In cooperation with the state, EPA took samples in October 2006 to determine if the erionite in Dunn County is similar to the erionite that has been associated with health effects in other parts of the world. EPA's preliminary testing showed that the erionite fibers are similar and are of a size that can be easily inhaled if they are disturbed and become airborne.

### **What is the next step?**

The NDDoH, in cooperation with EPA, will be conducting further investigations to assess the health effects of erionite exposure in North Dakota. In addition, the NDDoH is working with counties and businesses to restrict further use of gravel containing erionite and is exploring various dust control measures for effectiveness and cost. Guidance plans also are being developed to help businesses and homeowners limit erionite exposure.

### **How do people protect themselves from possible exposure to erionite?**

The extent of the erionite exposure in western North Dakota is unknown, but given the inherently toxic nature of the material, reducing exposure is recommended. Where found, erionite should not be disturbed. Mining should be prohibited in specific areas. Recommendations for county highway departments, businesses and private landowners include finding alternative sources of gravel and limiting or eliminating exposure to erionite fibers.



**For more information, please contact:  
The North Dakota Department of Health  
Division of Waste Management at 701.328.5166, or  
the Environmental Protection Agency, Region 8,  
at 1.800.227.8917.**

**Appendix 2 - Attachment D:  
Medical Study Question and Answer Sheet**

# NORTH DAKOTA ERIONITE QUESTION AND ANSWER SHEET

March, 2009



NORTH DAKOTA  
DEPARTMENT of HEALTH



This information sheet is meant to provide answers to questions people may have in regards to the North Dakota erionite medical health study.

**Question:** Why is this research being done?

**Answer:** The purpose of this medical study is to try to get an indication of whether health problems related to erionite exposure in the western parts of North Dakota are observed.

**Question:** What is erionite?

**Answer:** Erionite is a fibrous mineral with some properties similar to asbestos, but is not regulated as a form of asbestos fiber.

**Question:** Why is erionite a concern?

**Answer:** Like asbestos, erionite may pose health risks to those who breathe in the fibers for long periods of time. Exposure appears to be associated with increased risk of fibrogenic lung disease (a condition in which mineral dusts cause thickening or scarring of lung tissue), lung cancer and mesothelioma (a rare type of respiratory cancer usually related to asbestos exposure). According to the World Health Organization, International Agency for Research on Cancer, erionite is a known human carcinogen and has been associated with numerous health effects and deaths in Turkey.

**Question:** Who is conducting the research?

**Answer:** The U.S. Environmental Protection Agency and North Dakota Department of Health have contracted with the University of Cincinnati to implement the study.

**Question:** Who can volunteer for the study?

**Answer:** Health related problems from exposure to erionite can depend on how much erionite a person is exposed to and for how long. This study is targeted toward individuals that have worked in high erionite exposed environments such as road maintenance crews, professional drivers (e.g., mailman, school bus driver, delivery drivers), gravel pit workers and possibly other professions exposed to erionite containing gravel.

**Question:** How will participants be selected?

**Answer:** Participants will be selected based on a number of criteria, including employment history, job responsibilities, exposure time, medical history and other variables.

**Question:** What would a participant be expected to do?

**Answer:** All participants will need to

*(Continued on page 2)*

complete a questionnaire over the phone regarding your occupational and medical history, and information on other exposures you may have experienced, as well as be available for a chest x-ray and high-resolution computed tomography (HRCT) scan, both of which will be paid for by the study.

**Question:** Are there any risks from participating in the medical testing?

**Answer:** The risk associated with participation in this study is minimal. Chest radiographs and HRCT are routine tests used to identify abnormalities within the chest and lung associated with exposure to asbestos and asbestos-like fibers.

**Question:** Does it cost to volunteer for the study?

**Answer:** No.

**Question:** If I participate, will my information be kept confidential?

**Answer:** Yes. The data from the study may be published; however, no names will be identified. Only those individuals directly involved in the implementation of this study will have access to gathered information.

**Question:** How long will the study take?

**Answer:** Completion of all parts of the study should take no more than 4 hours. You will be in the research study for approximately one to three months depending upon when you decide to complete all parts of the study.

**Question:** If I participate in the study and am found to have health problems related to erionite exposure, what happens then?

**Answer:** Individual results will be shared with the participants, but it will be the

participant's responsibility to further discuss the results and any future medical needs with their own health care provider.

**Question:** How can a person protect themselves from possible exposure to erionite?

**Answer:** The extent of the erionite exposure in western North Dakota is unknown, but given the toxic nature of the material, reducing exposure is recommended. Recommendations for county highway departments, businesses and private landowners include finding alternative sources of gravel and limiting or eliminating exposure to erionite fibers.

**Question:** When will the study begin?

**Answer:** The initial screening questionnaire is expected to be available in March, 2009.

For more information regarding erionite in North Dakota, please contact either:

Mark Dihle  
North Dakota Department of Health  
Air Quality Division  
918 E. Divide 2nd Floor  
Bismarck, ND 58501  
mdihle@nd.gov  
(701) 328-5188

Libby Faulk  
Community Involvement Coordinator  
U.S. EPA Region 8 (8OC)  
1595 Wynkoop St.  
Denver, Colorado 80202  
faulk.libby@epa.gov  
(303) 312-6083

**Appendix 2 - Attachment E:  
Erionite Medical Study Flyer**

# NORTH DAKOTA ERIONITE UPDATE AND MEDICAL STUDY INFORMATIONAL SHEET

March, 2009



NORTH DAKOTA  
DEPARTMENT of HEALTH



## **Background**

In 2006, the North Dakota Department of Health (NDDoH) and the North Dakota Geological Survey initiated an investigation of naturally-occurring erionite deposits located in rural areas near the Killdeer Mountains, Chalky Buttes and Little Badlands mountain areas in Dunn, Slope and Stark counties. The investigation was started because these areas have been used for gravel sources for rural county roads and other areas for several decades.

Erionite is a fibrous mineral with some properties similar to asbestos. It is not regulated as a form of asbestos fiber. Like asbestos, erionite may pose health risks to those who breathe in the fibers. Exposure appears to be associated with increased risk of fibrogenic lung disease (a condition in which mineral dusts cause thickening or scarring of lung tissue), lung cancer and mesothelioma (a rare type of respiratory cancer usually related to asbestos exposure). According to the World Health Organization, International Agency for Research on

Cancer, erionite is a known human carcinogen and has been associated with respiratory health effects in Turkey. NDDoH requested the U.S. Environmental Protection Agency's (EPA) assistance to investigate the situation and evaluate the possibility that erionite in the gravels may pose a health threat to residents in these areas.

This informational sheet provides an update of the investigation and information on a focused medical study.

## **Medical Study**

The medical study will focus on a volunteer target audience designed to determine the prevalence of chest X-ray and chest CT scan changes in a population of workers potentially exposed to erionite contained in road gravel used in portions of western North Dakota. The target audience will be individuals who have the highest potential of exposure such as persons who have worked in gravel pits or road crews and possibly others exposed to these erionite containing gravels for an extended period. The study will consist of an occupational and medical

pulmonary questionnaire, chest X-rays and CT scans of voluntary applicants that meet specific criteria related to employment history, job responsibilities, exposure time, and other variables.

This study is not meant to provide medical assistance based on one's results but to provide clinical evidence that will assist North Dakota officials and EPA in deciding if there are potential health concerns with individuals with the highest exposure risk. Results from this study may determine whether or not additional study is needed. The individual results of the medical study will be shared with the individuals who participate, but it will be their responsibility to further discuss the results and any future medical needs with their primary health care provider, if necessary. The State of North Dakota intends to distribute the initial Screening Questionnaire for the medical study in spring, 2009.

### **Erionite Investigation Update**

The current investigation of the gravels and potential exposures focuses in the Killdeer area of Dunn County. In October, 2006 EPA conducted a sampling program to evaluate the erionite mineralogy and to determine if gravels contained erionite fibers that could become airborne and available for inhalation. EPA met with the County Commissioners and county

road maintenance supervisors and hosted a public meeting in Killdeer in April, 2008 to present the preliminary information and concerns.

EPA conducted additional sampling in June, 2008 that evaluated more exposure scenarios to better understand potential exposure to people in the area. The results showed that erionite fibers can become airborne when disturbed, such as with driving, and that the fibers are of a size that can be easily inhaled. There have been no observed health-related impacts from erionite exposure in North Dakota to date. Nonetheless the EPA and the NDDoH plan to implement a focused medical study to get a better understanding of potential health impacts related to erionite exposure in western North Dakota.

For more information or questions regarding erionite, please contact one of the following:

Mark Dihle  
North Dakota Department of Health  
Air Quality Division  
(701) 328-5188  
email: [mdihle@nd.gov](mailto:mdihle@nd.gov)

Libby Faulk  
US EPA, Region 8  
Community Inv. Coordinator  
1-800-227-8917, ext. 6083  
email: [faulk.libby@epa.gov](mailto:faulk.libby@epa.gov)

# North Dakota Erionite Initial Screening Questionnaire



NORTH DAKOTA  
DEPARTMENT of HEALTH

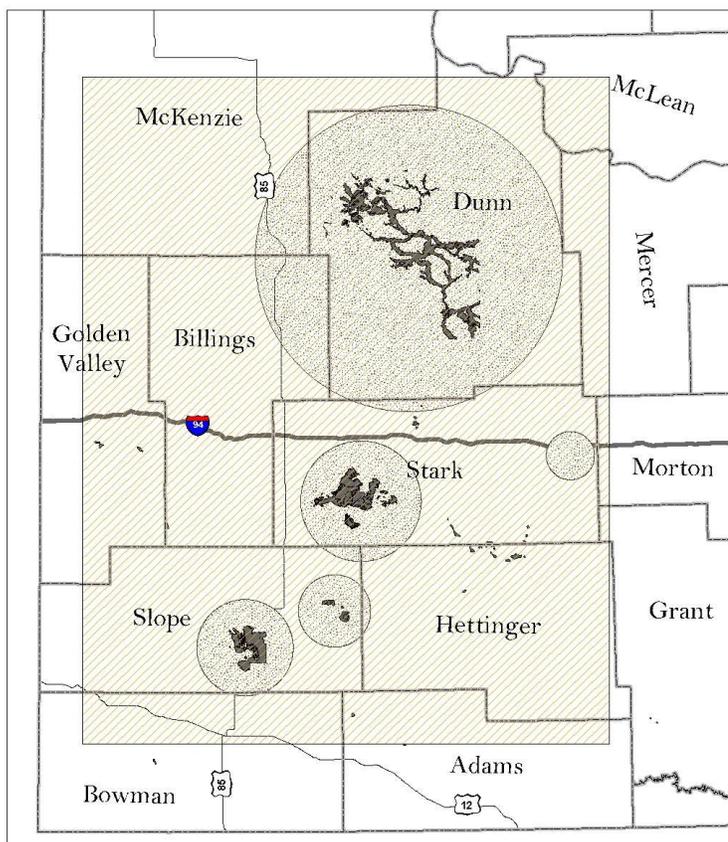
The U.S. Environmental Protection Agency (EPA) and the North Dakota Department of Health (NDDoH) are seeking participants for a medical study to determine if erionite in road gravel could increase health risks to exposed individuals. Medical faculty from the University of Cincinnati will conduct the study on behalf of EPA and NDDoH. While no health-related impacts from erionite exposure in North Dakota have been observed, the study will provide a more thorough evaluation of potential health effects in persons with likely exposure.

**Objective:** The objective of this initial screening questionnaire is to identify individuals who have been potentially occupationally exposed to erionite in road gravel in western North Dakota, and to determine their eligibility for potential participation in the subsequent medical study. The objective of the subsequent medical study is to determine the prevalence of chest X-ray and chest CT scan changes in a population of workers potentially exposed to erionite contained in road gravel used in portions of western North Dakota.

**Study Process:** The first step in the study is to identify people potentially exposed to erionite in road gravel. The persons who are considered to have the highest potential exposure are persons who have worked in the gravel pits, processed gravel, worked on road crews, or those who drove as a major part of their job (mail carriers, bus drivers, truck drivers, law enforcement officers, etc.). If you have held one of these identified jobs, you could be included in the study. **Please fill out and submit the attached initial screening questionnaire to indicate your interest in being considered for inclusion in the subsequent medical study.** Submitting this questionnaire does not commit you to participating in the subsequent medical study. Completed questionnaires will be reviewed by EPA, NDDoH, Agency for Toxic Substances and Disease Registry

(ATSDR) and University of Cincinnati representatives to identify medical study participants. Individuals with the highest potential exposures will be requested to participate in the medical study, which includes a more comprehensive questionnaire, chest x-ray and chest CT scan. Individuals who are not selected for inclusion in the medical study will be notified. Participants in the medical study will receive interpretation of their results including copies of the medical tests. Information on this Initial Screening Questionnaire and medical study results will be kept confidential and anonymous.

**Background:** Erionite is naturally occurring in the ore that is used for road surface material in western North Dakota. Some properties of erionite are similar to the properties of asbestos; however, erionite is not currently regulated by EPA. Like asbestos, erionite may pose increased risks of fibrogenic lung disease, lung cancer and mesothelioma (a rare type of respiratory cancer usually related to asbestos exposure) to those who breathe in the fibers. The possible health effects of environmental exposure to erionite in North Dakota have not been studied.



- Formations That Are Likely to Contain Erionite
- Gravel Mining Areas of Concern
- Gravel Road Areas of Concern

**Appendix 2 - Attachment F:  
Initial Screening Questionnaire**

# North Dakota Erionite Initial Screening Questionnaire



**NORTH DAKOTA**  
DEPARTMENT of HEALTH

## CONTACT INFORMATION

Name: \_\_\_\_\_ Age: \_\_\_\_\_ Gender (circle one): Male Female  
First Name Middle Name Last Name

Home Phone Number: (\_\_\_\_) \_\_\_\_\_ - \_\_\_\_\_ Cell Phone Number: (\_\_\_\_) \_\_\_\_\_ - \_\_\_\_\_

Work Phone Number: (\_\_\_\_) \_\_\_\_\_ - \_\_\_\_\_ E-mail address: \_\_\_\_\_

Street Address: \_\_\_\_\_

City, State, Zip: \_\_\_\_\_ County: \_\_\_\_\_

Mailing Address (if different): \_\_\_\_\_

City, State, Zip: \_\_\_\_\_

How long have you lived in western North Dakota (see map of area of concern)? \_\_\_\_\_

## EMPLOYMENT HISTORY

Have you ever been employed in western North Dakota (see map of area of concern) as any of the following (check all that apply). Indicate counties where employment occurred, ranking them A, B, C, or D, with A being the county where you worked in the job the most.

_____ Gravel Pit Worker Dunn____ Slope____ Stark____ Other ____	From (Month/Year) _____ To (Month/year) _____ Average number of months per year _____ Total number years _____
_____ Road Maintenance Worker Dunn____ Slope____ Stark____ Other ____	From (Month/Year) _____ To (Month/year) _____ Average number of months per year _____ Total number years _____
_____ Mail carrier Dunn____ Slope____ Stark____ Other ____	From (Month/Year) _____ To (Month/year) _____ Average number of months per year _____ Total number years _____
_____ School Bus Driver Dunn____ Slope____ Stark____ Other ____	From (Month/Year) _____ To (Month/year) _____ Average number of months per year _____ Total number years _____
_____ Truck Driver (delivery, local hauler) Dunn____ Slope____ Stark____ Other ____	From (Month/Year) _____ To (Month/year) _____ Average number of months per year _____ Total number years _____
_____ Law Enforcement Officer Dunn____ Slope____ Stark____ Other ____	From (Month/Year) _____ To (Month/year) _____ Average number of months per year _____ Total number years _____

# North Dakota Erionite Initial Screening Questionnaire



**NORTH DAKOTA**  
DEPARTMENT *of* HEALTH

## EMPLOYMENT HISTORY (continued)

Have you had any job(s) not included in the employment history above where you think you may have been exposed to gravel dust from the area of concern (see map). Indicate counties where employment occurred, ranking them A, B, C, or D, with A being the county where you worked in the job the most.

Job duties: \_\_\_\_\_

Month/Year started: \_\_\_\_\_ Month/Year ended: \_\_\_\_\_ Number of Months per year: \_\_\_\_\_

Dunn\_\_\_\_ Slope\_\_\_\_ Stark\_\_\_\_ Other \_\_\_\_\_

Job duties: \_\_\_\_\_

Month/Year started: \_\_\_\_\_ Month/Year ended: \_\_\_\_\_ Number of Months per year: \_\_\_\_\_

Dunn\_\_\_\_ Slope\_\_\_\_ Stark\_\_\_\_ Other \_\_\_\_\_

## CONSENT

I have read the included information for the North Dakota Erionite Medical Study and would like to be considered for participation in the study. By submitting this questionnaire my potential exposure to erionite in road gravel will be evaluated by representatives of the U.S. Environmental Protection Agency, the North Dakota Department of Health, Agency for Toxic Substances and Disease Registry (ATSDR), and representatives of the University of Cincinnati who will be overseeing the study. Completion of the questionnaire does not mean that I will be automatically included in the group of people who are included in the subsequent medical study and who undergo medical testing. Furthermore, by submitting this questionnaire I am not committing to participate in the subsequent medical study and I may withdraw from participating at any time. Information on this Initial Screening Questionnaire and subsequent medical study results will be kept confidential and anonymous.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Thank you for your interest in this study and for completing the questionnaire. Please forward your completed questionnaire to Mark Dihle of the North Dakota Department of Health at the address below. If you know anyone who had any of the listed jobs and may have been exposed to gravel dust, please let them know about this planned study.

Additional information and Initial Screening Questionnaires are available from:

Mark Dihle  
North Dakota Department of Health / Air Quality  
918 E. Divide, 2nd Floor  
Bismarck, ND 58501

Phone: (701) 328-5188  
e-mail: mdihle@nd.gov  
website: <http://www.ndhealth.gov/EHS/Erionite/>

**Appendix 3:**  
**Occupational and Pulmonary Medical History Questionnaire**



Draft

# North Dakota Erionite Medical Screening Study Occupational and Pulmonary Medical History Questionnaire

ID:

Date:   /   /

## A. Demographic Information

1. What is your name?

First Name

MI

Last Name

2. What is your date of birth?

/   /

Month

Day

Year

3. Gender?

Male

Female

4. What is your weight?

lbs

5. What is your height?

ft

in

6. What is your telephone number?

(    ) -    -

Home Number

(    ) -    -

Work Number

(    ) -    -

Cell Number



Draft

7. What is your current address?

Street

City

County

State

Zip

Date Moved In (Month / Year)

8. Keeping in mind that people move, we would like to get information to help us locate you in the future. Could we have the addresses and phone numbers of two people who live outside your household and who would always know how to find you?

a.

First Name

MI

Last Name

Relationship

Street

City

County

State

Zip

(    ) -    -

Home Number

b.

First Name

MI

Last Name

Relationship

Street

City

County

State

Zip

(    ) -    -

Home Number



Draft

ID:

Date:   /   /

### B. Occupational History

9. Have you ever worked in a gravel pit including summer jobs, part-time jobs, and full-time jobs?

Yes                      No

If "No", Skip to Question 10.

If "Yes", Please complete the questions below

Starting with your most recent job working in a gravel pit and working backwards; lets assume your most recent job is gravel pit #1.

Gravel Pit #   ...(Complete as many times as necessary)

Name of Employer

Name of Gravel Pit

Township/County of Gravel Pit

Address of Employer

City

County

State

Zip

Main Job Duties / Job Activities

Start Date (month/year)

End Date (month/year)

Total Number of Months



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10. Have you ever worked as a school bus driver including summer jobs, part-time jobs, and full-time jobs?

Yes                      No

If "No", Skip to Question 11.

If "Yes", Please complete the questions below.

Starting with your most recent job working as a school bus driver and working backward; Lets assume your most recent job is School Bus Driver #1.

School Bus Driver Job #  ...(Complete as many times as necessary)

Name of Employer

Address of Employer

City

County

State

Zip

Main Job Duties / Job Activities

Start Date (month/year)

End Date (month/year)

Total Number of Months

You have been provided with 4 county maps top guide you. The maps are labeled Dunn County, Slope County, Stark County I and Stark County II. Which of these maps reflect areas that you drove in?

Dunn     Stark I

Slope     Stark II

If "Yes", Please list the county and the average number of times / week that you drove on the highlighted roads as part of your job.

County & Highlighted Roads	Average miles per day	times per week	weeks per year
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>



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11. Have you ever worked as a mail carrier including summer jobs, part-time jobs, and full-time jobs?

Yes No

If "No", Skip to Question 12.

If "Yes", Please complete the questions below.

Starting with your most recent job working as a mail carrier and working backward; Lets assume your most recent job is Mail Carrier #1.

Mail Carrier Job #  ...(Complete as many times as necessary)

Name of Employer

Address of Employer

City

County

State

Zip

Main Job Duties / Job Activities

Start Date (month/year)

End Date (month/year)

Total Number of Months

You have been provided with 4 county maps top guide you. The maps are labeled Dunn County, Slope County, Stark County I and Stark County II. Which of these maps reflect areas that you drove in?

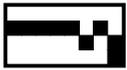
Dunn  Stark I

Slope  Stark II

If "Yes", Please list the county and the average number of times / week that you drove on the highlighted roads as part of your job.

County & Highlighted Roads	Average miles per day	times per week	weeks per year
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>





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ID:

Date:   /   /

13. Have you ever worked as a delivery truck driver?

Yes                      No

If "No", Skip to Question 14.

If "Yes", Please complete the questions below.

Starting with your most recent job working as a delivery truck driver and working backward; Lets assume your most recent job is delivery truck driver #1.

Delivery Truck Driver Job #   ...(Complete as many times as necessary)

Name of Employer

Address of Employer

City

County

State

Zip

Main Job Duties / Job Activities

Start Date (month/year)

End Date (month/year)

Total Number of Months

You have been provided with 4 county maps to guide you. The maps are labeled Dunn County, Slope County, Stark County I and Stark County II. Which of these maps reflect areas that you drove in?

Dunn     Stark I

Slope     Stark II

If "Yes", Please list the county and the average number of times / week that you drove or worked on the highlighted roads as part of your job.

County & Highlighted Roads	Average miles per day	times per week	weeks per year
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

ID: Date:  /  / 

14. Have you ever worked as a road maintenance worker?

Yes      No

If "No", Skip to Question 15.

If "Yes", Please complete the questions below.

Starting with your most recent job working as a road maintenance worker and working backward;

Let's assume your most recent job is road maintenance worker #1.

Road Maintenance Worker Job #  ... (Complete as many times as necessary)

Name of Employer

Address of Employer

City

County

State

Zip

Main Job Duties / Job Activities

Start Date (month/year)

End Date (month/year)

Total Number of Months

You have been provided with 4 county maps to guide you. The maps are labeled Dunn County, Slope County, Stark County I and Stark County II. Which of these maps reflect areas that you drove in?

 Dunn     Stark I Slope     Stark II

If "Yes", Please list the county and the average number of times / week that you drove and worked on the highlighted roads as part of your job.

County & Highlighted Roads	Average miles per day	times per week	weeks per year
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>



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14a. While working in this job as a road maintenance worker, did you work in the road maintenance work shop?

Yes                  No

If "Yes":

14b. On average, how many months per year did you work in the road maintenance shop?

Months per year

14c. Did you work with or change brake pads on vehicles?

Yes                  No

If "Yes":

14d. On average, how many days per month did you work on changing brakes?

Days per month

14e. Did you work with or change clutch pads on vehicles?

Yes                  No

If "Yes":

14f. On average, how many days per month did you work on changing clutch pads?

Days per month

ID: Date:  /  / 

15. Have you ever worked in another job where you think you may have been exposed to gravel or gravel dust?? (eg. Rancher, Farmer)

Yes                      No

If "No", Skip to Question 16.

If "Yes", Please complete the questions below.

Starting with your most recent job working as a other job and working backward; Lets assume your most recent job is other job #1.

Other Job #  ... (Complete as many times as necessary)

Name of Employer

Address of Employer

City

County

State

Zip

Main Job Duties / Job Activities




Start Date (month/year)

End Date (month/year)

Total Number of Months

You have been provided with 4 county maps top guide you. The maps are labeled Dunn County, Slope County, Stark County I and Stark County II. Which of these maps reflect areas that you drove in?

Dunn     Stark I

Slope     Stark II

If "Yes", Please list the county and the average number of times / week that you drove or worked on the highlighted roads as part of your job.

County & Highlighted Roads	Average miles per day	times per week	weeks per year
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>



ID:

Date:  /  /

### C. Exposure to Asbestos or Other Fibers

16. Have you had any of the following jobs? (Please check all that apply)

- Pipe or steam fitter
- Welder
- Plumber
- Brake repair person
- Insulator
- Dry wall finisher
- Heating / Ventilation work
- Carpenter
- Roofer
- Electrician
- Shipbuilding / Ship repair
- Asbestos processing
- Other job where you think you may have been exposed to asbestos (please specify)

If "No" to all of the above, skip to Question 17.

If "Yes", Please provide details about each job below.

Job #1 (Repeat as necessary)

Main Job Duties / Job Activities

Start Date (month/year)

End Date (month/year)

Total Number of Months

Comment





ID: [ ][ ][ ]

Date: [ ][ ] / [ ][ ] / [ ][ ][ ][ ]

Job # [ ][ ] (Repeat as necessary) [ ]

[ ]

Main Job Duties / Job Activities

[ ]

[ ]

[ ]

Start Date (month/year)

End Date (month/year)

Total Number of Months

[ ]

Comment

Job # [ ][ ] (Repeat as necessary) [ ]

[ ]

Main Job Duties / Job Activities

[ ]

[ ]

[ ]

Start Date (month/year)

End Date (month/year)

Total Number of Months

[ ]

Comment



Draft

ID:

Date:   /   /

17. Have you ever worked with the Robinson Insulation Vermiculite Plant in Minot, North Dakota?

Yes            No

If "Yes":

Main Job Duties / Job Activities

Start Date (month/year)    End Date (month/year)

18. Are you aware of any asbestos in any of the homes you have lived in?

Yes   No   Don't Know

If "Yes":

Dates lived in the home

Type of asbestos            Start Date (month/year)    End Date (month/year)

Comments

19. Have you ever installed or physically handled vermiculite insulation?

Yes            No

20. Were you ever in a military service?

Yes            No

If "Yes":

20a. In the military, did you ever work on any kind of ship?

Yes            No

If "Yes", please describe your duties:



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20b. Are you aware of any exposure to asbestos during your military service?

Yes                      No

If "Yes", please describe how you may have been exposed:

21. Did you ever live with someone performing one of the jobs listed in questions 16 or 17 above?

Yes                      No

If "Yes", please list below:

If "No", please skip to question 22.

**Jobs listed in questions 16 and 17:**

Pipe or steam fitter, Welder, Plumber, Brake repair person, Insulator, Dry wall finisher, Heating / Ventilation work, Carpenter, Roofer, Electrician, Shipbuilding / Ship repair, Asbestos processing, Other job where they may have been exposed to asbestos, or any job at the Robinson Insulation Vermiculite Plant in Minot, North Dakota.

Dates Worked

Job

Relation

1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

**D. Tobacco Use**

22. Have you ever smoked cigarettes? This means at least 400 cigarettes or 20 packs during your whole life?

Yes                      No

If "No", please skip to question 28.

23. Do you now smoke cigarettes (as of one month ago)?

Yes                      No



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24. How old were you when you first started smoking regularly?

Age in years

25. If you have stopped smoking completely, how old were you when you stopped?

Age in years

26. How many cigarettes do you now smoke per day?

Cigarettes/day (Put '0' if quit)

27. On average over the entire time you smoked, how many cigarettes did you smoke per day??

Cigarettes/day

**E. Pulmonary Medical History**

28. Do you have a regular doctor or clinic that you go to?

Yes                  No

If "Yes", what is the name and address of the doctor or clinic?

Doctor's Name

Doctor's Address

City

County

State

Zip

**COUGH**

29. Do you usually have a cough?

Yes                  No

(Count a cough with first smoke or on first going out-of-doors. Exclude clearing of the throat.)

If "No" Skip to 35.

30. Do you usually cough as much as 4 to 6 times a day?

Yes                  No

31. Do you usually cough like this 4 or more days out of the week?

Yes                  No



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32. Do you usually cough at all on getting up, or first thing in the morning?

Yes                      No

33. Do you usually cough at all during the rest of the day or night?

Yes                      No

If "Yes" to 29 to 33, answer the following:

34. Do you usually cough like this on most days for 3 consecutive months or more during the year?

Yes                      No

35. For how many years have you had this cough?

Years

#### PHLEGM

36. Have you ever coughed up phlegm (thick mucus) that was bloody?

Yes                      No

37. In the past year, have you ever coughed up phlegm that was bloody?

Yes                      No

38. Do you usually bring up phlegm from your chest?

Yes                      No

(Count phlegm with the first smoke or on first going out-of-doors. Exclude phlegm from the nose. Count swallowed phlegm.)

If "No", skip to 43.

39. Do you usually bring up phlegm like this as much as twice a day, 4 or more days out of the week?

Yes                      No

40. Do you usually bring up phlegm at all on getting up, or first thing in the morning?

Yes                      No

41. Do you usually bring up phlegm at all during the rest of the day or night?

Yes                      No

If "Yes" to any of 37-39, answer the following:

42. Do you usually bring up phlegm like this on most days for 3 consecutive months or more during the year?

Yes                      No

43. For how many years have you had trouble with phlegm?

Years



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EPISODES OF COUGH AND PHLEGM (for persons who usually have a cough AND phlegm)

44. Have you had periods or episodes of increased cough and phlegm lasting for 3 weeks or more each year?

Yes                  No

45. For how long have you had at least 1 such episode per year?

Years

OTHER MEDICAL/SYMPTOM HISTORY

46. Have you ever had tuberculosis?

Yes                  No

47. Have you ever been hospitalized for pneumonia or pleurisy?

Yes                  No

48. Have you ever had congestive heart failure or fluid on the lungs?

Yes                  No

49. Have you ever had any other chest illness?

Yes                  No

50. Have you ever had a significant chest injury?

Yes                  No

51. Have you ever had chest surgery (open heart or chest drainage tube)?

Yes                  No

52. Do you suffer from rheumatoid arthritis, scleroderma, or lupus?

Yes                  No

53. Have you ever had or do you now have any type of cancer?

Yes                  No

If "Yes", please specify the type of cancer:

AND Please specify the year of diagnosis:



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54. Have you ever had a chest x-ray?

Yes                  No                  Don't Know

If "Yes", What year did you have your most current chest x-ray?

Year

If "Yes", Where was this x-ray taken?

Clinic/Hospital

City

County

55. Have you ever been told by a doctor that you have any of the following lung diseases or conditions? Check all that apply.

	If "Yes", When were you told about it?	If "Yes", Who told you about the problem?
___ Asthma	<input type="text"/>	<input type="text"/>
___ COPD, emphysema	<input type="text"/>	<input type="text"/>
___ Pulmonary fibrosis	<input type="text"/>	<input type="text"/>
___ Other	<input type="text"/>	<input type="text"/>

56. Have you become hoarse or developed difficulty swallowing in the last year?

Yes                  No

57. In the past year, have you had periods of chest pain related to breathing?

Yes                  No

58. Have you lost more than 15 pounds without dieting over the past 6 months?

Yes                  No



59. Are you now troubled by shortness of breath when walking up a slight hill or when hurrying on level ground?

Yes                      No

60. Do you have to walk slower than people your own age because of shortness of breath?

Yes                      No                      Don't Know

61. Do you have to stop for breath when walking at your own pace on level ground?

Yes                      No                      Don't Know

62. Do you have to stop for breath when walking about 100 yards (or after walking several minutes) on level ground?

Yes                      No                      Don't Know

63. Are you too short of breath to leave the house, or are you short of breath while dressing or undressing?

Yes                      No                      Don't Know

64. Are there any comments you would like to add or any important information that you think we should know?

65. Interviewer comments?

