Health Consultation

Health Outcome Data Evaluation, 1996-2005

BORIT SITE

AMBLER, MONTGOMERY COUNTY, PENNSYLVANIA

EPA FACILITY ID: PAD981034887

JANUARY 28, 2009

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

Health Consultation: A Note of Explanation

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

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

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Prepared By:

Pennsylvania Department of Health
Division of Environmental Health Epidemiology
under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Executive Summary

The Pennsylvania Department of Health (PADOH) prepared this Health Consultation (HC) Health Outcome Data Evaluation under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) to address community health concerns of perceived elevated rates of asbestos-related diseases possibly associated with the Borit site in addition to past industrial practices involving asbestos in the community. In response to these community concerns, historical site activities, and air sampling results, the PADOH analyzed and summarized available health outcome data for malignant mesothelioma and lung cancer in the Ambler, Blue Bell and Fort Washington communities for 1996-2005. This HC is one of two HCs that PADOH and ATSDR have prepared for the site. The first HC evaluated the EPA 2006-2007 air sampling data and is titled Borit Asbestos Air Sampling Results from 2006-2007.

This HC Health Outcome Data analysis evaluated the entire ZIP code of Ambler because it includes the Borit site. In addition, the Blue Bell and Fort Washington ZIP code areas were also selected because they are adjacent to the Borit site and since mesothelioma is a relatively rare cancer a large enough population base is required to reliably calculate a potential statistical difference in cancer incidence rates. Due to the long latency period of mesothelioma and cancer, this HC does not provide insight or conclusions on current environmental exposures or risk. Any elevated incidence rates detected by the analysis provide information on historical exposures potentially related to the site but do not reflect current site conditions or exposure levels. Based on an analysis of the available data and information, PADOH and ATSDR conclude:

1.) For the Ambler ZIP code, **a non-statistically significant increase in the incidence of mesothelioma was observed,** particularly more in the male population, compared to the expected number of cases in the Commonwealth of Pennsylvania as a whole.
2.) For the Blue Bell and Fort Washington ZIP codes respectively, observed mesothelioma incidence rates were not elevated above expected levels.
3.) Rates of bronchus and lung cancer in all three study ZIP code areas were lower significantly lower than the expected Commonwealth rates.
4.) In conclusion, **no statistically significant excess or increase in incidence rates for the cancers of interest** were observed in the study zip codes when compared to the overall expected Commonwealth rates.

PADOH also reviewed a Montgomery County Department of Health (MCHD) report of a separate health outcome data analysis. The MCHD evaluation showed that residents living within a 2-mile radius from six historic asbestos manufacturing and waste disposal sites in Montgomery County had a statistically significant higher mesothelioma incidence rate than those living outside these 2-mile zones. Both male and female mesothelioma incidence rates were elevated within the 2-mile radii, but were only statistically significant for the male population. Since mesothelioma has a long latency period (i.e., 30 years), elevated incidence rates detected by the MCHD provide information on historical exposures potentially related to the site and other exposure sources (i.e. occupational exposure) but do not reflect current site conditions or exposure levels. This study provides data on the overall trend of mesothelioma cases in Montgomery County adjacent to those six asbestos sites. However, since aggregate data from the six asbestos sites were used in the MCHD analysis, it is difficult for PADOH to draw conclusions regarding the Borit site based on these data. In considering

both the PADOH and MCHD analyses together, PADOH and ATSDR believe, overall, that residents living within a 2-mile radius of the six historical sites have a higher incidence rate of mesothelioma than those living outside a 2-mile zone. However, it is not possible, at this time, to differentiate occupational from non-occupational exposures in these communities. Lastly, this document includes a summary of community health concerns and self-reports of asbestos-related illnesses, as documented via a community petition drive effort, and information from approximately 30 community interviews conducted by an EPA graduate student intern.

Background and Statement of Issues

The Borit site consists of a waste pile, a bordering reservoir, the adjacent Whitpain Wissahickon Park, and the adjacent banks of the Wissahickon Creek, Rose Valley Creek and Tannery Run totaling approximately 32 acres. The Borit Site consists of three distinct asbestos-contaminated areas along Maple Street just west of Butler Pike in Ambler, PA (See Figure 1) at Latitude: 40.15047 Longitude: -75.227458. The areas were commonly referred to as the East Maple Street Pile (now called the Borit Asbestos Pile), the West Maple Street Pile (now a closed park known as the Whitpain Wissahickon Park), and a reservoir. These areas are located a few hundred yards northwest of the asbestos piles that became the Ambler Asbestos Piles NPL Site, which was remediated by U.S. Environmental Protection Agency (EPA) in 1993. Although the same companies disposed of asbestos-containing waste at both the Borit Site piles and the Ambler Asbestos Site piles across Butler Pike (a local major road) the Borit Site piles were not included as part of the NPL Site. A decision was made that the Borit Site piles would be monitored by the PADER (now PADEP – Pennsylvania Department of Environmental Protection), as the site had been covered with soil in the mid 1960s.

The Borit Asbestos Site exists as a result of waste disposal operations by the former Keasby and Mattison Company (K&M), Certainteed Corporation, and Nicolet Industries. The site was later owned by the British company Turner Newell Ltd. Former workers are most at risk for asbestos–related diseases due to higher exposure levels and durations of exposure. K&M, Certainteed Corporation and Nicolet Industries produced asbestos products including: paper, millboard, electrical insulation, brake linings, piping, conveyor belts, high pressure packings, roofing shingles, cement siding, asbestos cement pipe, automobile parts, laboratory table tops and other products. Asbestos manufacturing operations occurred on or near the site from approximately 1897 to the late 1980s.

The former East Maple Street Pile (now Borit Asbestos Pile) rises approximately 35 feet above the natural ground surface and is approximately 6 acres in size. The pile appears on a 1938 aerial photograph (earliest available) and K&M reportedly began disposing of waste there during the 1930s. Asbestos waste disposal appears to have continued until the 1960s. This area primarily received slurry of spent magnesium and calcium carbonate as well as waste products from the manufacturing of asbestos pipe, insulation, sound dampeners and ceiling/roof tile. The berms around the pile appear to have been constructed of asbestos shingles and soil. Based on aerial photographs, by 1965 the pile appears to be covered and vegetated. The property reportedly was first fenced in approximately 1986 and is currently partially fenced, on all sides, except those where water bodies lies adjacent. For short periods of time in the 1980s and 1990s, portions of the pile area were used as a trash transfer station or trash storage location and for fire department training (Gilmore & Associates, 2001). Currently, the pile is naturally vegetated although asbestos containing material (ACM) is visible on the surface in various locations.

The former West Maple Street pile (now the closed and fenced Whitpain Wissahickon Park) reportedly received out-of-spec asbestos manufacturing products and other solid wastes. It is not clear when disposal first took place but, based on historic aerial photos, it was occurring as early as 1937 (EPA Aerial Photo Collection, 1937-1985). Two rows of what appear to be factory worker homes are on the property from 1938 to 1959 but are removed by 1964. Aerial photos indicate that the pile was covered after the homes were removed, sometime during the 1965 to 1970 period. The current park is triangular and rises a few feet above the surrounding street level and is roughly 500 feet at its widest point and approximately 1500 feet from end to end. A 1973 aerial photo shows a baseball diamond in the park. The park also is currently vegetated and has been officially closed for approximately twenty years. However, localized areas of asbestos waste appear at the ground surface. The local community and other interested parties would like to see the park reopened for resident use.

The reservoir between the East Maple Street Pile and Whitpain Wissahickon Park was used to provide process water for facility operations. The reservoir appears in the 1937 aerial photo and likely was in place prior to this date. It is approximately 14 acres in size. The berm around the reservoir was made of asbestos shingles, millboard and soil. Asbestos product waste, particularly water pipe and tiles, are suspected to lie on portions of the reservoir bottom. Currently, the Wissahickon Valley Watershed Association (WVWA), a local conservation group, has plans to convert the reservoir to a waterfowl preserve with a bird watching platform on the northern side (EPA 2008a and EPA 2008b).

Public Health Involvement

Pennsylvania Department of Health (PADOH) and the U.S. Agency for Toxic Substances and Disease Registry (ATSDR) and its predecessor group at the Centers for Disease Control and Prevention (CDC) have provided health opinions and/or health outcome data reviews at various times for the Ambler Asbestos NPL and Borit sites, including a Public Health Advisory focusing on the Ambler Asbestos NPL Site area in 1983.

The following provides a historical summary of language specific to Wissahickon Park. In an October 29, 1984 memorandum, CDC reviewed two asbestos samples collected by the EPA from Wissahickon Park. CDC recommended that (1) every effort should be made to prevent human exposure to the asbestos identified on site, and that it was particularly desirable to prevent the possible re-suspension of the fibers as a result of play activities at the park; (2) a series of samples for asbestos should be collected from the yards abutting the site; and (3) consideration should be given to providing temporary covering for the obvious asbestos outcroppings observed at the site

In a November 8, 1984 memorandum, CDC reviewed information for the Borit tailings pile and the Wissahickon Park/Whitpain Township Park. CDC concluded that the presence of exposed friable asbestos-containing material to be a public health risk and a potential chronic public health hazard to persons near the site. The memo notes that the suspension of asbestos fibers would be partially restricted by vegetative ground cover but complete prevention could not be expected.

In January 18, 1985 and February 5, 1985 memoranda, CDC reviewed bulk soil sampling results from the Wissahickon/Whitpain Township Park taken after the park was closed to the public. CDC stated that any sampling strategy also needed to include soil samples from adjacent residential yards, and that the site required sufficient containment of asbestos materials to prevent resuspension of fibers and to prevent offsite migration. CDC recommended that a plan be developed and implemented to ensure against further disturbance of the ground cover at this site.

A June 26, 1985 CDC memo reiterated the need to sufficiently contain waste materials at Wissahickon Park before reopening of the park could be reconsidered. CDC recommended that the fence be maintained and that the area remain closed to the public until adequate containment could be achieved.

In December 2006, ATSDR Region 3 prepared an ATSDR Record of Activity (AROA) Health Consultation (HC) which detailed the extensive investigation and mitigation activities that have occurred on both the Ambler Asbestos and Borit sites since the early 1970's. The air sampling data collected, prior to the 2006/2007 sampling event, provides a confusing picture of the health implications of asbestos contamination at the Borit site because of confounding factors such as the lack of detailed sampling information and data inconsistencies resulting from the several types of air sampling techniques and analytical methods used over the years. Furthermore, the historical information does not

distinguish mineralogy of the fibers, and does not show if total Transmission Electron Microscopy (TEM) fibers were counted or if Phase Contrast Microscopy Equivalent (PCMe) data could be calculated from the counts, which makes drawing any health conclusions from the data extremely difficult. Samples were collected in April 2006, over one 24 hour period within the site perimeter, a time duration insufficient to make projections about continuing airborne asbestos levels given the numerous factors that might affect the release of fibers to the air; e.g. vegetative cover, onsite activities and ground surface disturbance, wind speed and direction, precipitation and ground moisture. Finally, four of the six air samples were found to be overloaded with dust and particles making the analytical data, as presented, unreliable for a determination of health risks or comparison to health-based standards or guidelines. The AROA HC concluded, due to the large piles of on-site ACM and air sampling data uncertainties that under certain conditions local levels of airborne asbestos may be of concern and further investigation and examination is warranted [1]

At the request of PA Department of Environmental Resources (now PADEP) and community concerns of perceived elevated rates of mesothelioma related to the Ambler Asbestos Pile, PADOH (Bureau of Program Evaluation) in 1975 conducted a health data outcome analysis. Based on death certificates and 1970 census data, the study analyzed the patterns of mortality from 1968 to 1976 for the Borough of Ambler and surrounding communities including Lower Gwynedd, Upper Dublin, Whitpain, Whitemarsh, and Springfield. Due to the fact, that at the time of analysis, the population in Ambler was small (7800 residents in 1970), mortality rates for 15 different groups of diseases (including malignant neoplasms of the buccal cavity, pharynx, digestive organs, genitals, urinary, as well as cardiovascular diseases) were computed rather than a single cause of death. The study did not single out mesothelioma and included all malignant neoplasms of the respiratory system, due to the small population size of Ambler and because mesothelioma was not coded specifically as a cause of death at the time of analysis. The number of observed deaths for Ambler was compared to the expected number of cases, based on the overall Commonwealth of Pennsylvania data. Next, utilizing a Poisson distribution, a statistical significance test was computed for the ratio of observed to the expected cases. For malignant neoplams of the respiratory system, an annual average death rate of 3.83 per 100,000 was calculated for Ambler, compared to an expected rate of 2.81. The ratio of observed to expected cases was 1.35. The study did not find that mortality due to mesothelioma was significantly higher in Ambler, or the surrounding communities, than the expected Commonwealth rate. Overall, the results of the mortality analysis indicate that although the crude death rate for Ambler was higher than expected rate, this difference was not significant. [2]

Contaminant Evaluation

Asbestos

Asbestos is a group of six different fibrous minerals (amosite, chrysotile, crocidolite, and the fibrous varieties of tremolite, actinolite, and anthophyllite) that occur naturally in the environment. Chrysotile, also known as white asbestos, is the predominant commercial form of asbestos; amphiboles are of minor commercial importance. Asbestos minerals have separable long fibers that are strong and flexible enough to be spun and woven and are heat resistant. Because of these characteristics, asbestos has been long used (mainly chrysotile) for a wide range of manufactured goods, mostly in building materials, heat-resistant fabrics, packaging, brakes, building materials, and coatings. Currently only the long fibers are considered a health threat, but the risk from shorter fibers is being investigated. Asbestos fibers may break into shorter pieces or separate into a larger number of individual fibers as a result of physical processes. [3]

Asbestos containing material (ACM) is considered "friable" when it can be easily crushed by hand. Friable asbestos can release fibers into the air, creating a potential health hazard. When asbestos fibers are intact, such as in an asbestos-containing cement pipe, they are considered "non-friable." This means that the individual fibers are contained and are not readily released into the surrounding air. From a public health and regulatory standpoint, "friable" asbestos is the much greater health concern.

People can be exposed to asbestos by swallowing contaminated water containing ACM, or by breathing fibers in the air. Asbestos fibers are poorly absorbed through the skin. [4] Exposure to asbestos usually occurs by breathing contaminated air in workplaces that make or use asbestos. Asbestos exposure can cause serious lung problems and cancer. Low level concentrations of asbestos are present in the ambient air. These levels range from 0.00001 to 0.0001 f/cc of air and are usually highest in cities and industrial areas. People working in industries that make or use asbestos products or who are involved in asbestos mining may be exposed to high levels of asbestos. [5]

Asbestos fibers can enter the air or water from the breakdown of natural deposits and manufactured asbestos products. Asbestos fibers are generally not broken down to other compounds and will remain virtually unchanged over long periods. People living near these industries may be exposed to asbestos in air. Asbestos fibers may be released into the air by the disturbance of asbestos-containing material during product use, demolition work, building or home maintenance, repair, and remodeling. In general, exposure may occur only when the asbestos-containing material is disturbed in some way to release particles and fibers into the air. [6] The mammalian lung responds to exposures from inert materials, such as asbestos, whether fibrous or particulate. Once an inert material deposits in the lung beyond the conductive airways, it will either dissolve or be engulfed and cleared by alveolar macrophages; if the dose exceeds the lungs' capacity to clear the material, natural defense mechanisms may act, leading to fibrosis [7]

The mammalian lung responds to exposures from inert materials whether fibrous or particulate. Once an inert material deposits in the lung beyond the conductive airways, it will either dissolve or be engulfed and cleared by alveolar macrophages; if the dose exceeds the lungs' capacity to clear the material (exposures of approximately 5-10 mg/m^3 of chrysotile), natural defense mechanisms may act, leading to fibrosis. Chrysotile fibers were predominantly detected in EPA's 2006-2007 air samples from the Borit site. In studies, long chrysotile fibers were observed to break apart into small particles and smaller fibers in the lung. Toxicologically, chrysotile (which rapidly falls apart in the lung) behaves more like non-fibrous mineral dusts while response to amphibole asbestos reflects its insoluble fibrous structure. [8]

Health Effects

The Department of Health and Human Services (DHHS), World Health Organization (WHO), and EPA have determined that asbestos is a human carcinogen. The time between diagnosis of mesothelioma and the time of initial exposure to asbestos commonly has been 15-30 years or more (i.e., long latency period). Occupational exposure to asbestos is involved in 70-80% of all malignant pleural mesothelioma cases. The toxicity of asbestos is dependent on exposure intensity and duration as well as the physical/chemical properties of the asbestos fibers. Fiber length plays an important role in clearance and toxicity. In addition, asbestos exposure and cigarette smoking act synergistically to produce dramatic increases in lung cancer compared with those from exposure to either agent alone.

Cancer: Malignant Mesothelioma

Malignant Mesothelioma (MM) is a rare form of cancer in which cancerous cells are found in the mesothelium, a protective sac that covers most of the body's internal organs. It is composed of two layers of cells: One layer immediately surrounds the organ; the other forms a sac around it. The mesothelium produces a lubricating fluid that is released between these layers, allowing moving organs (such as the beating heart and the expanding and contracting lungs) to glide easily against adjacent structures. Cancer cells can also metastasize, or spread, from their original site to other parts of the body. Most cases of mesothelioma begin in the pleura or peritoneum. Although reported incidence rates have increased in the past 20 years, mesothelioma is still a relatively rare cancer. About 2,000 new cases of mesothelioma are diagnosed in the United States each year. Mesothelioma occurs more often in men than in women and risk increases with age, but this disease can appear in either men or women at any age.

Working with asbestos is the major risk factor for MM. A history of asbestos exposure at work is reported in about 70 percent to 80 percent of all cases. However, MM has been reported in some individuals without any known occupational exposure to asbestos. The risk of asbestos-related disease increases with exposure duration and concentration, and a very long latency period (>30 years) exists between exposure and disease onset. Not all workers who are heavily exposed develop asbestos-related diseases. Smoking does not appear to increase the risk of mesothelioma. However, the combination of smoking and asbestos exposure significantly increases a person's risk of developing cancer of the air passageways in the lung. Many scientists believe that amphibole asbestos fibers have potency for causing mesothelioma at rates 100 times greater than exposure to chrysotile fibers, mainly because of increased persistence of amphiboles in the lungs. Diagnosing mesothelioma is often difficult, because the symptoms are similar to those of a number of other conditions. [9]

Other Cancers:

Lung cancer, a malignant tumor that invades and obstructs the lung's air passages, is a leading cause of cancer death in the United States. Lung cancer related to asbestos exposure appears to be histologically the same as lung cancer caused by radiation, cigarette smoking, or other carcinogens. The exact mechanism relating asbestos exposure with lung cancer is not completely understood. The magnitude of risk appears to be influenced by several factors, the most important of which are: (1) the level and the duration of exposure; (2) the time since exposure occurred; (3) the age at which exposure occurred; (4) the tobacco-smoking history of the exposed person; and (5) the type and size distribution of the asbestos fibers. Smoking has shown to significantly increase the risk of lung cancer in persons exposed to asbestos. In 2006, the Institute of Medicine found sufficient evidence of an association between laryngeal cancer (voice box) and asbestos exposure.

Some studies of workers suggest that inhalation of asbestos fibers can increase the likelihood of developing cancer in other parts of the body (e.g. stomach, intestines, esophagus, pancreas, and kidneys). However, these findings have not been consistently replicated in other occupational studies. Ingestion of asbestos has been suspected to be associated with the development of gastrointestinal cancers in humans, however, the findings are inconsistent in both human and animal studies. It is important to note that for this HC the air pathway is considered the greatest or most pertinent potential exposure pathway. [10]

Non Cancer Health Effects:

Asbestosis

High level asbestos exposure is also associated with non-cancerous lung disease such as asbestosis. Asbestosis is a restrictive lung disease caused by asbestos fibers scarring the lung and results in pleural plaques (localized areas of thickening of the pleura); diffuse pleural thickening (generalized thickening of the pleura); pleural calcification (calcium deposition on pleural areas thickened from chronic inflammation and scarring); and pleural effusions (fluid buildup in the pleural space between the lungs and chest cavity). Loss of lung function or other clinical signs may or may not be associated with these noncancerous effects. Currently, asbestosis is not a reportable condition in the Commonwealth of Pennsylvania and the incidence of asbestosis was not able to be evaluated or determined in this HC.

Other Non-Cancer Health Effects

Ingestion of asbestos causes little or no risk of noncancerous effects. ATSDR's toxicological profile for asbestos reviewed the published literature about possible immunological effects, such as rheumatoid arthritis, lupus, or fibromyalgia, due to asbestos exposure. Not enough evidence exists to say whether asbestos exposure or resulting asbestos-related disease could increase a person's likelihood of experiencing autoimmune disease (ATSDR 2001). However, the associations that have been discovered between immunological changes and asbestos exposure indicate that this question deserves further research.

Health Outcome Data Analysis

Sources of Data

The Commonwealth of Pennsylvania maintains health outcome databases including vital statistics and cancer registries [11]. For this HC, The Pennsylvania Cancer Registry (PCR) provided PADOH Bureau of Epidemiology, Division of Community Epidemiology with cancer incidence data for a ten-year period (1996-2005) for all reportable cancer sites [exception: polycythemia vera only became reportable in 2001, thus 2001-2005 incidence rates only were utilized]. Since mesothelioma has a long latency period (i.e. 30 years), any elevated incidence rates detected by the analysis provide information on historical exposures potentially related to the site but do not reflect current site conditions or exposure levels. A previous HC document, which reviewed asbestos air sampling data collected by EPA from 2006 to 2007, did not detect off-site asbestos at levels of public health concern. Due to data accuracy and availability reasons, a ten-year study period was selected. The health outcome analysis centers the population data around the available U.S. Census data, which occurs every ten years with the most recent Census occurring in 2000. In addition, this data set is the most recent and thus the most relevant to the current site and community conditions.

Often times, in statistical analysis, in order to detect increases in cancer risk for a relatively rare cancer, large study populations are required. Therefore, the population of a ZIP Code needs to be large enough to reliably calculate and compare the relevant cancer incidence rates, and to rule out fluctuations in cancer rates due to chance variation. Mesothelioma is a rare cancer and has an expected Commonwealth incidence rate of 1.7 per 10,000 individuals, compared to an expected incidence rate of 88 and 616 per 10,000 individuals for bronchus/lung and all cancers in the Commonwealth, respectively. For this reason, the entire population of the Ambler ZIP code (30,746 according to the 2000 Census) and not just a narrow radius, such as 1/4-mile, from the site was selected for the analysis. Multiple-year data are

generally used in analyses because cases collected in a single year are subject to a large amount of chance variation from year-to-year.

The 2000 U.S. census was the source of basic population data; however, the census does not provide useable ZIP Code area population estimates. [12] To address this issue, PA DOH uses more reliable ZIP Code area population estimates from a vendor, Claritas Inc.[13]. The "observed cases" (or study area) for the Ambler ZIP code (19002), Blue Bell ZIP code (19422) and Fort Washington ZIP code (19034) represent the number of cancers reported for those respective ZIP codes (Figure 2). The "expected cases" (or comparison area) represent the number of expected cases if the study area had experienced rates of cancer similar to the rest of Pennsylvania during the same study period.

The PCR relies on coding sites and histology using International Classification of Disease (ICD) system specifically using the ICD Oncology Code, 3rd edition (ICD0-3). This data is submitted to the PADOH Bureau of Health Statistics and Research.[14] The Registry receives monthly reports from all acute care hospitals and pathology laboratory electronically and represents cancer incidence rates. The Registry also incorporates cancer mortality, using ICD 10th revision codes (ICD-10) when the underlying cause of death is determined to be cancer. For this HC, the number of cancers refers to the number of primary sites reported, not the number of people. Although some individuals may have more than one cancer during the period of interest, in general the number of primary sites is expected to be relatively similar to the number of persons with cancer.

Methods

A statistical analysis was conducted for all cancers combined and for 26 specific cancer sites for males, females, and total (males & females combined) where appropriate for 1996-2005, and for polycythemia for 2001-2005, in the Ambler, Blue Bell and Fort Washington communities. The Ambler, Blue Bell and Fort Washington ZIP codes were chosen because they are the closest areas in proximity to the Borit site. The main focus of this HC is mesothelioma and lung cancer incidence rates, because those are the cancer outcomes most closely related to or associated with inhaled asbestos exposure. To determine whether there is an excess of cancer in the community, the observed number of cases for the study ZIP codes was compared to an "expected" number of cases, based on PA statewide data. The information was further standardized to eliminate possible effects due to differences in race, gender, and age between the study area and the rest of the Commonwealth. Statewide sex, gender, and site-specific incidence rates were multiplied by age-groups (0-4, 5-14, 15- 24, …, 85+ years) by County and ZIP Code area populations to calculate the expected number of cases that would have occurred if a given study area had state-wide incidence rates. The statistical significance of the indirectly age-adjusted incidence rates was calculated in accordance with the methodology recommended by Selven, et. al [15]

A Standardized Incidence Ratio (SIR), or the observed cases divided by the expected cases, was used to evaluate the differences. A ratio of 1.0 indicates that the number of cases observed in the population is the same as the expected or Commonwealth rate. A ratio greater than 1.0 indicates that more cases occurred than expected; and a ratio less than 1.0 indicates that fewer cases occurred than expected. Accordingly, a ratio of 1.5 is interpreted as 50% more cases than expected; and a ratio of 0.9 indicates 10% fewer cases than would be expected. When conducting cancer risk screening evaluations, a SIR ratio of 2.0 or greater is generally regarded as noteworthy; however, to help interpret the statistical significance between the observed and expected values a statistical z-score was computed for all reportable cancers. Z-scores are utilized to help rule out the possibility that the results are due to chance variation. A z-score of 1.96 equates to a 95% level of statistical significance, or a 1 in 20 chance that the results are due to random variation alone ($p<0.05$). In other words, if the z-score is greater than 1.96, the

difference between the observed and expected values is probably due to some other set of factors and unlikely a result of chance variation.

Results

PADOH and ATSDR reviewed the health outcome data analysis for the Ambler, Blue Bell and Fort Washington communities, for all reportable cancers from 1996-2005 (Tables 1 -3). The cancers most likely related to or associated with asbestos exposure are mesothelioma and lung cancer. The observed incidence of mesothelioma was elevated in the Ambler community (11 observed cases, compared to 5.39 expected cases based on the Commonwealth of Pennsylvania rates as a whole); however this incidence rate for Ambler had a z-score of 1.61 and was, therefore, not statistically significantly elevated. There were 9 males and 2 females reported with mesothelioma in Ambler during the study period, compared to 4.33 expected male and 1.05 expected female cases, respectively. Neither the male nor female mesothelioma incidence rates in Ambler are statistically significantly elevated. The observed number of mesothelioma cases in the Blue Bell ZIP code (3 observed cases) was similar to the expected number (3.27 expected cases). During the study period, there were 3 observed male cases and no female cases in the Blue Bell community, compared to 2.68 expected male and 0.59 expected female cases based on statewide rates as a whole, respectively. Lastly, there were no reported cases of mesothelioma in the Fort Washington ZIP code during the study period, whereas 2.79 would have been expected.

The observed rates of bronchus and lung cancer in the three study areas were less than expected compared to the Commonwealth rates. In Ambler, there were 198 observed cases verses 270 expected cases. These low bronchus and lung cancer incidence rates are statistically significant, with a z-score of -4.86. The individual male and female incidence rates for Ambler were both statistically significant with Z-scores of -3.45 and -3.44, respectively. The same overall trend is present in Blue Bell, with 132 total observed cases and 163 expected cases. The resulting z-score of 2.53 indicates the observed rates are statistically significantly less than the expected rates. The male and female rates within the Blue Bell community contained 66 observed cases (95.58 expected cases) for males and 66 observed cases (67.47 expected cases) for females. The corresponding Z-score for the male population was -3.27 and the Z-Score for the female population was -0.18; only the male rate is statistically significantly lower. For the Fort Washington ZIP code, the overall total incidence rate of bronchus and lung cancer was 35 cases, versus the 47.76 expected cases. The resulting Z-score of -2.28 is statistically significantly lower then the expected Commonwealth rate. The male and female incidence rates alone were lower than expected, with 20 observed (28.28 expected cases) and 15 observed cases (19.51 expected cases), respectively. Although the total incidence rate for Fort Washington was statistically significant, the separate male Z-Score of -1.92 and the female Z-Score of -1.27 were not individually statistically significant.

In reviewing the additional reportable cancers, a statistically significantly elevated rate of non-Hodgkin's lymphoma (NHL) was observed in Ambler for the male population, with a z-score of + 2.00. Also, a statistically significant higher rate of breast cancer, in the Blue Bell community, occurred with a z-score of +1.99. However, according to published scientific literature, NHL and breast cancer are not associated with asbestos exposure and not considered relevant to the current HC. In Fort Washington, there were no statistically significantly elevated rates for the other cancers types in the reported data.

In summary, the data review did not demonstrate statistically significant excess cancer incidence rates in the study ZIP codes for 1996-2005 compared to the overall expected rates. All the rates are within or below the expected range, at the 95% confidence interval. Asbestos-related non-cancer diseases (e.g., asbestosis) are not reportable diseases and cannot be assessed. PADOH's ability to evaluate the rate of asbestosis or other asbestos-related diseases in this community is limited.

Discussion

Health outcome data evaluations are measures of disease occurrence in a defined population. Such evaluations can help to provide an overall picture of community health, and can potentially identify or confirm excess disease in a community. However, elevated rates of a particular disease may not necessarily be caused by hazardous substances in the environment. Other factors, such as socioeconomic status, occupation, and lifestyle, also may influence the development of disease. In contrast, a contaminant can contribute to illness or disease without being reflected in the available health outcome data. Certain cases may not appear in the disease registry, due to under reporting or difficulty in diagnosing the condition. In addition, since mesothelioma has a long latency period (i.e. 30 years), any elevated incidence rates detected by the analysis provide information on historical exposures potentially related to the site but do not reflect current site conditions or exposure levels. A previous HC document, which reviewed asbestos air sampling data collected by EPA from 2006 to 2007, did not detect off-site asbestos at levels of public health concern.

There are many limitations, like any statistical analysis, to using the existing data to examine the relationship between environmental exposures and chronic diseases such as cancer. First, the quality of the information is directly related to the accuracy of the reporting system, and under reporting of cases is possible. However, in general Pennsylvania is considered to have a highly reliable cancer registry. Second, this HC can only determine whether there is an increased rate of cancer in the study area. Cause and effect relationships cannot be established because other factors that may contribute to the observation, such as heredity, lifestyle, environmental exposures from other sources, and occupational exposures are unable to be accounted for. Third, the cancer registry uses only the residence of the individual at the time he or she was diagnosed with the disease. Information on previous residence and length of residency are not included in the cancer registry. Population mobility and changes in population could affect the results of this analysis. For example, a life-long Ambler resident who moves from the area and is later diagnosed with mesothelioma elsewhere would not be detected in the analysis. Fourth, since mesothelioma and lung cancer have a very long latency period (>30 years), the current health outcome data reflect past exposures and do not correspond to current site conditions. Most of these limitations would make it less likely (as opposed to more likely) that this health outcome data analysis would identify any potentially elevated rates of asbestos-related cancers in the communities living near the Borit site.

In order to know whether the study areas had high cancer incidence rates, the observed number of cancers was compared to the Commonwealth of Pennsylvania. The cancer rate for the Commonwealth as a whole was used to calculate an expected number of cancer rates that would have hypothetically occurred in the study ZIP codes over the same period of time. The "observed cases", theoretically, should not vary significantly from the Commonwealth as a whole. The evaluation of cancer incidence was performed using the Standard Incidence Ratio (SIR), or the ratio of the observed number of cancer incidence divided by the expected number (O:E). The interpretation of the SIR has inherent limitations. Any conclusions drawn from the ratios depend on both the ratio value and the total number of observed and expected cases. Two ratios can have the same value but be interpreted differently. For example, a ratio of 1.5 based on 2 expected cases and 3 observed cases indicates a 50% excess in cancer, but the excess is actually only a single case. However, a ratio of 1.5 based on 200 expected cases and 300 observed cases represents the same 50% excess in cancer, but because it is based upon a greater number of cases, the estimate is less likely to be attributable to chance.

Rates based on rare events over a specified period of time or sparsely populated geographic area are inherently unstable. For cancer types with a small number of cases (<5 observed cases), statistical results

can be difficult to interpret. Statistical evaluations are more stable with a larger sample population (i.e. observed and expected cases) and over multiple years of study. In order to detect increases in cancer risk for a relatively rare cancer, large study populations are required. Therefore, the population of a ZIP Code needs to be large enough to reliably calculate the relevant cancer incidence rates, and to rule out any fluctuations in cancer rates due to chance variation. Mesothelioma is a relatively rare cancer and selecting a narrow study area would not be useful in detecting changes in cancer incidence rates. Chance variation is expected when looking at the occurrence of different health conditions in communities, and statisticians have developed methods to take this into account. One method is to calculate a 95% confidence interval (CI) for the SIR. The 95% CI is the range of estimated ratio values that has a 95% probability of including the true ratio for the population and is a statistical measure of precision. "Statistically significant" means there is less than 5% chance that the observed difference is merely the result of random fluctuation. The z-score, a tool used to determine statistical significance, indicates how far, and in what direction, the observed rates deviate from the mean, expressed in units of standard deviation. If a confidence interval z-score is above + 1.96, it implies there is a statistically significantly higher rate than would be expected. Similarly, if the confidence interval z-score is below -1.96, then the number of cases is statistically significantly lower than expected. [16]

Health Outcome Data Analysis – Montgomery County

The Montgomery County Health Department (MCHD) performed an analysis of health outcome data (Appendix A) for mesothelioma cases from 1996-2004. PADOH and ATSDR reviewed the health outcome data analysis performed by MCHD. The MCHD analysis was not limited to the Borit site or the communities adjacent to the site. The MCHD analysis focused on six historical asbestos sites in Montgomery County, including: Nicolet/CertainTeed Ambler Asbestos Piles/Borit sites in Ambler; American Asbestos Textile Corporation in Norristown Municipality; Nicolet Industries in Norristown Municipality; Lavino Refractory Brick Plant in Plymouth Township; Brick Refractory in Upper Merion Township; and Ehret Magnesia Company in Upper Merion Township. Incidence rates of mesothelioma within a 2-mile radius of each site were aggregated and calculated. The 2-mile reference was selected and modeled after several other ATSDR health outcome data studies on asbestos. The first study was a health outcome data study of residents living with 2.5 miles of the center of Libby, Montana. [17] The second study was conducted in Utah, and analyzed a 2-mile radius from an asbestos processing site. [18]

Important distinctions and differences between the PADOH analysis and the MCHD analysis are presented in Table 4. The PADOH study analyzed the data based on ZIP code and compared the study area to the Commonwealth rate. In contrast, MCHD calculated the incidence rate based on distance (radii) from the sites and compared the observed cases to the overall Montgomery County rate outside the 2-mile radii. MCHD determined the incidence rate, from the Cancer Registry, for cases located within a 2-mile radius of the six asbestos sites, which served as the ‘observed’ cases. MCHD aggregated the data for the six sites, with no delineation between specific sites. The age-specific incidence rates were determined for the county population located outside the 2-mile zones, and represent the ‘expected’ number of mesothelioma cases for the study period. For the MCHD analysis, the Standardized Incidence Ratio (SIR) and confidence intervals (CI) were computed using chi-square and Poisson distributions. A SIR ratio of 1.0 indicates the observed population experienced similar rates as the rest of the county

A summary of the results of the MCHD analysis for total mesothelioma incidence rates, for both male and female cases, is shown in Table 5. A total of 158 cases of mesothelioma were diagnosed in Montgomery County in 1996-2004. Of the 158 cases, 120 cases were outside the 2-mile radii and 38

cases were located within the radii with 27 male and 11 female cases. Utilizing the county-level incidence data, 22.89 mesothelioma cases were expected within the 2-mile radii of all six sites combined. The SIR was 1.66 (95% CI of 1.17 - 2.28), which is statistically significant indicating that the 1996-2004 mesothelioma incidence rate within the 2-mile Radii of all sites combined was elevated, compared to Montgomery County as a whole. A higher than expected number of cases, or an elevated SIR, was found in the age categories 50 through 85+ years but these age-specific rates were not individually statistically significant.

Table 5 – PADOH summary of MCHD analysis of mesothelioma incidence rates

Outside the 2-mile Radii					Within the 2-mile Radii				
Age Group	**Pop†**	**Cases**	**Rate***	**95% CI**	**Pop†**	**Expected Cases**	**Observed Cases**	**SIR**	**95% CI**
35-39	54321	1	1.84	-1.77, 5.45	9152	0.17	0	0	N/A
40-44	55663	1	1.80	-1.72, 5.32	8810	0.16	0	0	N/A
45-49	49164	2	4.07	-1.57, 9.71	7774	0.32	0	0	N/A
50-54	42860	6	14.00	2.8, 25.2	**6937**	**0.97**	**1**	**1.03**	**-0.99. 3.05**
55-59	32787	5	15.25	1.88, 28.62	**5642**	**0.86**	**2**	**2.32**	**-0.9, 5.55**
60-64	25189	4	15.88	0.32, 31.44	**4829**	**0.77**	**1**	**1.3**	**-1.25, 3.86**
65-69	23173	13	56.10	25.6, 86.6	**4607**	**2.58**	**3**	**1.16**	**-0.15, 2.47**
70-74	23011	26	112.99	69.56, 156.42	**4771**	**5.39**	**7**	**1.3**	**0.34, 2.26**
75-79	20514	32	155.99	101.94,210.04	**4201**	**6.55**	**12**	**1.83**	**0.8, 2.87**
80-84	14316	20	139.70	78.48, 200.93	**2487**	**3.47**	**9**	**2.59**	**0.9, 4.28**
85+	12634	10	79.15	30.09, 128.21	**2083**	**1.65**	**3**	**1.82**	**-0.24, 3.88**
Total	638162	120	18.80	15.44, 22.17	**111935**	**22.89**	**38**	**1.66**	**1.17, 2.28**

† Total population for all age groups (from 0-85+ years)
* Rate per 100,000 persons
Bolded fields have higher than expected cases
Highlighted fields are statistically significant

For the MCHD analysis, the SIR for mesothelioma in the male population was 1.59 (95% CI of 1.05 - 2.32). This value was statistically significant, indicating that the male mesothelioma incidence rate within the 2-mile radii was statistically significantly higher than the male mesothelioma incidence rate outside the radii. The expected female incidence rate outside the 2-mile radii was 5.55, and the observed number of cases was 11. The resulting SIR for female mesothelioma incidence was 1.99 (95% CI of 0.99 - 3.55), which is not statistically significant. A linear regression method was used to determine the yearly trend for mesothelioma incidence for 1996-2004. The yearly trend showed no statistically significant increases or decreases in rates. Population changes were not taken into consideration due to the difficulties of estimating population data at the level of this analysis over the years.

The MCHD calculated the age-specific incidence rates and percentages for cases located inside and outside the 2-mile radii (Appendix 1: Table 6 MCHD report). The MCHD findings were summarized by PADOH for this HC document by combining the age categories and the total percentages into three age groups; 35 to 49, 50 to 69 and 70 to 85+ age range (Table 6). The highest number of cases occurred in the 70 – 85+ age range, representing 73.3% (88 cases of 120 total cases) for outside the 2-mile radii and 81.6 % (31 cases of 38 total cases) within the radii. In the 50 to 69 age category there were 23.3%

(28 cases) and 7.9% (3) for outside and within the 2-mile radii, respectively. For the 35-49 age range, 3.3% (4 cases) occurred outside the radii. No cases were reported for the 35-49 age categories within the 2-mile radii. The percentage of reported cases was also summarized by gender. For cases located outside the 2-mile radii, males represented 75.8% of the reported cases and females 24.2%. A similar trend is present in the area within in the 2-mile radii, with 71.1% male cases and 28.9% female cases. The age distribution analysis shows that the majority of cases, both outside and within the 2-mile radii, are in the older populations, which represents the long-latency period of mesothelioma.

Table 6- PADOH summary of MCHD age distribution analysis of mesothelioma incidence based on percentages

Age range	Outside 2-mile radii			Within 2-mile radii		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**
35-49	1.7% (2)	1.7% (2)	3.3% (4)	0.0% (0)	0.0% (0)	0.0% (0)
50-69	19.2% (23)	4.2% (5)	23.3% (28)	18.4% (7)	0.0% (0)	18.4% (7)
70-85+	55.0% (66)	18.3% (22)	73.3% (88)	52.6% (20)	28.9% (11)	81.6% (31)
Total	75.8% (91)	24.2% (29)	100% (120)	71.1% (27)	28.9% (11)	100.0% (38)

In summary, the MCHD analysis showed that residents living within a 2-mile radius from the six historic asbestos manufacturing and waste disposal sites in Montgomery County had a statistically significant higher mesothelioma incidence rate than those living outside the study area. Both male and female mesothelioma incidence rates were elevated within the 2-mile radii, but were only statistically significant for the male population, potentially indicating a historical occupational exposure. Since mesothelioma has a long latency period (i.e. 30 years), any elevated incidence rates detected by the MCHD provides information on historical exposures potentially related to the site but do not reflect current site conditions or exposure levels. This analysis provides data on the overall trend of mesothelioma cases in Montgomery County adjacent to asbestos sites. However, since aggregate data from the six asbestos sites were used in this analysis, it is difficult to draw conclusions for any specific site, including Borit. In addition, MCHD compared the study areas with the expected county rates, while PADOH evaluated the rates against the Commonwealth rates, thus making inter–study comparisons inappropriate. These different approaches illustrate that it is possible to evaluate these kinds of health outcome data sets in a variety of ways.

Community Health Concerns

The Borit Community Advisory Group (CAG) and other community members have expressed concern, particularly regarding health effects potentially associated with the site. The following is a summary of the CAG's concerns:

Concern: The CAG expressed concern that the Borit site is potentially responsible for the observed adverse asbestos-related health conditions, particularly mesothelioma, experienced by some local residents.

Response: In this HC, ATSDR and PADOH have attempted to address these concerns by analyzing the health outcome data for incidence of mesothelioma. PADOH evaluated the cancer incidence data for Ambler and neighboring Blue Bell and Fort Washington. The data show that although the level of mesothelioma was elevated in the Ambler community compared to the Commonwealth as a whole, this elevation was not statistically significant. In other words, the results may be due to chance variation. It should also be noted that the elevated mesothelioma rates were more pronounced in the male population than the female population, and could indicate a possible historical occupational exposure. Unfortunately, the cancer registry data do not contain sufficient information on possible sources of exposure. Asbestos-related non-cancer diseases (e.g., asbestosis) were not studied in this HC, because they are not currently reportable diseases in Pennsylvania. Therefore, PADOH's ability to evaluate the rate of asbestosis or other non-cancerous asbestos-related diseases in the community is very limited.

Concern: Community members indicated there are cases of asbestos-related disease in the Ambler community with no known occupational exposure. Since the current Commonwealth reporting data do not contain sufficient information to determine the source of exposure, concerned residents collected self-reported information on asbestos-related illnesses, particularly of non-occupational exposure.

Response: PADOH and ATSDR reviewed the health-related information collected by concerned residents, during a petition drive to support the listing of the Borit site on EPA's National Priorities List. The goal of this review was to evaluate whether any information was available that would indicate cases of asbestos-related disease in the Ambler area with no known occupational origin. Occupational origin would include both direct employment history with exposure to asbestos, sharing a household with such a worker, and/or having contact with such a worker's asbestos-contaminated clothing.

The table below summarizes the self-reported health-related comments provided to PADOH and ATSDR, and information collected by an EPA graduate student summer intern during approximately 30 community interviews conducted during the summer of 2008. The information documents the deep sentiments and thorough awareness of asbestos-related diseases in this community. Unfortunately, in most cases the information is not specific enough to identify whether the reports of asbestos-related disease are related to exposures from the Borit site. In some cases the Ambler, PA area is specified, but the information generally does not indicate whether there was an occupational link to the illnesses reported. There are several exceptions to this, such as two individuals who ran or worked in businesses in Ambler. PADOH and ATSDR attempted to obtain additional information for these cases, but were not successful. One possibility is that these businessmen may have been exposed via asbestos fibers brought in to their places of business from Ambler factory workers, on their clothes.

In summary, the community-collected information substantiates the degree to which asbestos-related diseases have affected the Ambler area. However, PADOH and ATSDR cannot make any conclusions

from this information regarding non-occupational, solely environmental exposures producing asbestos-related disease in this community. The deeply intertwined populations of workers and community members may make a differentiation of solely environmentally exposed individuals in this community impossible.

Community member's current city, state (if noted)	Occupational or environmental exposure?	Health-related comments from community members
Ambler, PA	Environmental	My husband was exposed to Ambler asbestos as a child. He died at age 53.
Ambler, PA	Unspecified	Asbestos has affected our family. My husband has mesothelioma.
Ambler, PA	Unspecified	I have mesothelioma at the age of 35.
Ambler, PA	Occupational	I have mesothelioma…. An American company Johnsmansville caused my cancer, cost me my mom, my uncle, and my hearing.
Ambler, PA	Unspecified	We live in Ambler and have had relatives die due to the asbestos.
Ambler, PA	Unspecified	I have experienced the lost of a loved one to the cancer caused by asbestos exposure.
Ambler, PA	Unspecified	Six households on one block report a family member dying from asbestos-related disease. I have lost 5 members to asbestos-related disease.
Ambler, PA	Unspecified, both?	Asbestos fibers were found in the garage (located directly in front of the reservoir) of this household. A member of this family died from asbestos-related disease.
Ambler, PA	Unspecified	A resident of the Ambler area for 70 years provided the names of 20 people he knew personally died of asbestos-related disease.
Ambler, PA	Unspecified	My neighbor's husband died in 1999 from mesothelioma.
Ambler, PA	Environmental, take home?	An aunt reported that her nephew ran a business on Main Street for 30 years. He never worked in a factory and neither did any of his relatives. He was just diagnosed with mesothelioma.
Ambler, PA	Environmental, take home?	A businessman was reported to have died of lung cancer (he worked at his business for 35 years on Butler Pike). His wife was never told if his illnesses was asbestos-related or not, but she always thought so.

Ambler, PA	Both	I work with a woman whose mother and grandmother died from mesothelioma. The grandfather worked in the factory and she told me that her mom played on the piles for all of her childhood. The family lived on Spring Garden Street. Her mother died at 48 years of age. I was fortunate to meet her grandfather, who vivaciously has been spared from the disease. He is the man who told me about the doctor located at the corner of Bethlehem Pike and Tennis who reportedly falsified many of the files so that asbestos-related disease was not noted on the records. He was the factory doctor. Several of the old men in this neighborhood tell me they have lost 2-3 friends who worked at the factory. All of the old timers say that a lot of them were never really tested for the disease, they just knew they had it. I have a few acquaintances in the neighborhood that send me an e-mail every now and then to include a neighbor who is very ill now (and probably or properly? Diagnosed with asbestos-related disease) onto the list of the sick and dying. I met a man last year, who told me he was diagnosed with mesothelioma just a few months prior, and that he only worked in the factory for a few years, but he lived in this town for over 30 years.
Abington, PA	Unspecified	My father is stricken with this awful cancer.
Alburtis, PA	Unspecified	My father dies from peritoneal mesothelioma.
Ardmore, PA	Unspecified	My husband has mesothelioma.
Blue Bell, PA	Unspecified	There have been health concerns and even death in my family due to asbestos.
Bothell, WA	Unspecified	Several generations of my family grew up in Ambler, and sadly we've lost some members to that pile of pollution.
Conshohocken, PA	Unspecified	I teach in the school district of Upper Dublin. In the Fort Washington community, there have been an alarmingly large number of cancer cases. I'm feeling like this may be connected to the asbestos site.

Glenside, PA	Both	Many people I knew died that grew up playing on the asbestos mountains. My grandfather died when I was 3 months old and he worked directly with the asbestos in that area.
Huntingdon Valley, PA	Both	I grew up hearing stories of many people having cancer due to the asbestos factory and the mound by the creek.
Huntingdon, PA	Unspecified	I know of 2 people affected by asbestos waste.
King of Prussia, PA	Unspecified	My mom has mesothelioma caused by asbestos.
Macungie, PA	Both?	My husband who grew up near and worked in Ambler in his younger years developed mesothelioma and died in 2005.
Meadowbrook, PA	Unspecified	My husband died of mesothelioma two years ago.
Montclair, NJ	Unspecified	Wife died of malignant peritoneal mesothelioma one year ago. We lived in North Wales, PA.
Not specified	Unspecified	A retired thoracic surgeon from Chestnut Hill hospital related that he personally saw hundreds of cases of asbestos-related disease in that hospital coming from Ambler.
Oreland, PA	Unspecified	Mesothelioma has had a direct effect on our family.
Palmyra, PA	Unspecified	I lost my husband (at age 52) to mesothelioma.
Penllyn, PA	Unspecified	I was diagnosed with mesothelioma 16 months ago. I'm only 52 years old.
Philadelphia, PA	Unspecified	My father died last year at the age of 60 from mesothelioma. His exposure to Ambler, PA asbestos led to his premature and painful death.
Phoenixville, PA	Environmental	Because I have mesothelioma, and I never worked around asbestos.
Royersford, PA	Unspecified	Know friends affected by this.
Royersford, PA	Unspecified	My mother died of mesothelioma.
West Chester, PA	Unspecified	My brother in law passed away last month from mesothelioma.

Wynnewood, PA	Unspecified	My friend's mother was diagnosed with lung cancer due to asbestos, and others could be too.
Not specified	Unspecified	A local physician reported that it is well known that if a patient lives in Ambler, to look for asbestos disease.
Not specified	Both	A woman reported her brother died at the age of 41, reportedly from mesothelioma. She said her brother used to play in the contaminated areas and swim in the reservoir. With permission, ATSDR followed up with this person. The brother was not diagnosed specifically with an asbestos-related illness, but rather with lung cancer. As an adult, his principal profession was as a mechanic (HVAC systems), and he was a smoker.
Not specified	Both	92 individuals were listed as having an asbestos-related illness and/or death in their household or family (some overlap with above individual reports). Many families in Ambler reported that their daughter, wife, uncle, brother, father, mother, etc. died from asbestos-related disease. Many worked in the factory or are directly related to someone who worked in the factory here. Some were exposed just doing the laundry of the men that worked in the factory. Some were exposed just by having the dust in their homes, most likely trucked there from the clothing and shoes of factory workers. But there are some that did not work in the factory. USEPA cleaned many homes in Ambler during the investigation in the late 1980s. Many homes tested positive for high fiber counts. Six families on Spring Garden Street described having their houses cleaned out by the USEPA, and they had to move out for a few weeks while it was being done.
Ambler, PA	Both	Women reported husband died of Asbestosis. Four sons died of cancer - lung cancer (smoker in his 40's), esophageal, throat and stomach cancer
Ambler, PA	Occupational	Husband and father-in-law died of mesothelioma
Ambler, PA	Both	Brother died of leukemia at age 45
Ambler, PA	Unspecified	Several friends died of cancer, believed to be from asbestos exposure

Conclusions

PADOH/ATSDR Health Outcome Data Analysis:

PADOH and ATSDR reviewed the available pertinent health outcome data for the Ambler, Blue Bell and Fort Washington ZIP codes. An elevated mesothelioma incidence rate was observed in the Ambler community compared to the state rate for the same study period, and was higher for male population. However, this rate was not statistically significant. No elevated rates of mesothelioma were observed in the Blue Bell and Fort Washington communities. The cancer incidence rates for lung or bronchial cancer in the Ambler, Blue Bell, and Fort Washington communities were significantly lower than the expected values. Based on the statistical analysis results and the current reporting data, the available health outcome data do not show a statistically significant number of cases of lung cancer or mesothelioma in the surrounding community. Based on the current reporting system (i.e., lack of information regarding exposure history) and the deeply intertwined populations of workers and community members, making a differentiation of solely environmentally exposed individuals in this community unlikely. In addition, since mesothelioma has a long latency period (i.e., 30 years), incidence rates evaluated in this HC provide information on historical exposures potentially potentially associated with the Borit site but does not reflect current site conditions or community exposure levels. A previous HC, which reviewed the asbestos air sampling data collected by EPA in 2006 to 2007, did not show off-site levels of asbestos at levels of public health concern.

MCHD Health Outcome Data Analysis:

In this HC, PADOH and ATSDR reviewed the health outcome data analysis performed by the MCHD. This analysis showed that residents living within 2-mile radii from six historic asbestos sites located in Montgomery County had a statistically significant higher mesothelioma incidence rate than those living outside the study area. Only the male incidence rates were statistically significant, potentially indicating a historical occupational exposure. The majority of the mesothelioma cases occurred in the older population (70- 85+ years), reflecting the long-latency period of mesothelioma and a possible historical exposure. Since mesothelioma has a long latency period (i.e., 30 years), elevated incidence rates detected by the MCHD analysis provides information on historical exposures potentially related to the historical asbestos sites but does not reflect current site conditions or community exposure levels. This analysis provides data on the overall trend of mesothelioma cases in Montgomery County adjacent to asbestos sites. However, since aggregate data from the six asbestos sites were used in this analysis, it is difficult for PADOH to draw conclusions from the MCHD analysis specific to the Borit site.

When considering both the PADOH and MCHD evaluations together, PADOH and ATSDR believe, overall, that residents living within a 2-mile radius of the six historical sites have a higher incidence rate of mesothelioma than those living outside a 2-mile zone. However, it is impossible, at this time, to determine occupational from non-occupational exposures in these communities.

Recommendations

1. PADOH and ATSDR will make this health consultation available to residents and will be available to answer the residents' health questions. ATSDR and PADOH will continue to work with the community to answer questions and address ongoing concerns as appropriate and indicated. PADOH, ATSDR, and Montgomery County will present this information to the Borit Community Advisory Group and the group's physician-led Health, Environment, Risk, and Safety workgroup.

2. PADOH will explore the feasibility of updating PADOH's health outcome data for subsequent years in Ambler and the surrounding communities as appropriate and indicated.

3. ATSDR and PADOH remain interested in learning if any cases of non-occupationally exposed asbestos-related disease have been identified in the community, and in potentially utilizing and evaluating such data or information.

4. PADOH and ATSDR encourage residents, who you are concerned about their potential exposure to asbestos or are symptomatic to take the following steps:

    a. Visit their physician for more information on asbestos-related diseases
    b. Quit smoking because asbestos exposure combined with smoking greatly increases a persons risk of developing lung cancer
    c. Consult with a health care provider about getting a flu shot, to help reduce the chance of lung infections

Public Health Action Plan

In light of the uncertainties related to quantitative risk and the weight of the evidence regarding health effects associated with some asbestos exposures, ATSDR and PADOH recommend several precautionary actions to reduce potential exposures and increase public awareness of potential hazards.

1. Outreach to community and local health professionals
    a. In response to community concerns, explore the feasibility of updating cancer health outcome data for Ambler and the surrounding communities.
    b. Continue working with the community to answer questions and address ongoing asbestos-related concerns.
    c. Continue to explore, if feasible and appropriate, the connection between confirmed mesothelioma cases and occupational exposure, for Ambler and the adjacent communities.

2. Community precautions:
    a. Implement mitigation efforts to cover exposed areas of the Borit site that can result in the migration of asbestos fibers into ambient air
    b. Continue to restrict access to the site until mitigation work is completed

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Certification

This health consultation for the Borit site was prepared by the PADOH under a cooperative agreement with the ATSDR. It is in accordance with approved methodology and procedures existing at the time the health consultation were initiated. Editorial review was completed by the cooperative agreement partner.

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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

for Alan W. Yarbrough, MS

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Tables

Table 1 – Cancer incidence for Ambler zip code (19002)

	Population Size	Observed Cases	Expected Cases	SIR	ST Rate	CR Rate	Adjusted Rate	Z-Score	
All CANCER SITES									
MALE	14550	793	956.05	.83	614.80	545.02	509.95	-5.42	-
FEMALE	16196	853	937.84	.91	543.69	526.67	494.51	-2.73	-
TOTAL	30746	1646	1893.89	.87	578.03	535.35	502.37	-5.73	-
BUCCAL CAVITY AND PHARYNX									
MALE	14550	18	25.11	.72	16.01	12.37	11.48	-1.55	
FEMALE	16196	14	12.13	1.15	7.04	8.64	8.13	.47	
TOTAL	30746	32	37.23	.86	11.37	10.41	9.77	-.87	
ESOPHAGUS									
MALE	14550	9	15.64	.58	9.99	6.19	5.75	-2.06	-
FEMALE	16196	4	4.90	.82	2.79	2.47	2.27	-.41	
TOTAL	30746	13	20.54	.63	6.26	4.23	3.96	-1.96	-
STOMACH									
MALE	14550	10	17.96	.56	11.50	6.87	6.40	-2.35	-
FEMALE	16196	9	12.16	.74	6.80	5.56	5.03	-.95	
TOTAL	30746	19	30.12	.63	9.07	6.18	5.72	-2.36	-
COLON AND RECTUM									
MALE	14550	94	114.81	.82	73.57	64.60	60.24	-2.00	-
FEMALE	16196	86	123.28	.70	69.89	53.10	48.76	-3.69	-
TOTAL	30746	180	238.09	.76	71.67	58.54	54.18	-4.01	-
LIVER/INTRAHEPATIC BILE DUCT									
MALE	14550	10	12.68	.79	8.09	6.87	6.38	-.79	
FEMALE	16196	4	5.77	.69	3.32	2.47	2.30	-.82	
TOTAL	30746	14	18.45	.76	5.62	4.55	4.27	-1.11	
PANCREAS									
MALE	14550	21	21.45	.98	13.73	14.43	13.44	-.09	
FEMALE	16196	25	23.54	1.06	13.37	15.44	14.20	.27	
TOTAL	30746	46	44.98	1.02	13.55	14.96	13.85	.14	
LARYNX									
MALE	14550	8	13.68	.58	8.73	5.50	5.10	-1.86	
FEMALE	16196	2	3.74	.53	2.21	1.23	1.18	-1.18	
TOTAL	30746	10	17.42	.57	5.36	3.25	3.07	-2.22	-
BRONCHUS AND LUNG									
MALE	14550	113	152.01	.74	97.59	77.66	72.55	-3.43	-
FEMALE	16196	85	118.27	.72	69.66	52.48	50.07	-3.44	-
TOTAL	30746	198	270.28	.73	83.15	64.40	60.91	-4.86	-
MELANOMA OF THE SKIN									
MALE	14550	34	30.54	1.11	19.76	23.37	21.99	.56	
FEMALE	16196	16	23.85	.67	14.15	9.88	9.49	-1.89	
TOTAL	30746	50	54.40	.92	16.86	16.26	15.49	-.59	
BREAST									
MALE	14550	1	2.47	.40	1.58	.69	.64	-1.37	
FEMALE	16196	267	266.61	1.00	154.75	164.86	154.97	.02	
TOTAL	30746	268	269.09	1.00	80.79	87.17	80.47	-.06	
CERVIX UTERI									
FEMALE	16196	15	15.80	.95	9.38	9.26	8.91	-.20	
CORPUS/UTERUS, NOS									
FEMALE	16196	59	61.72	.96	36.08	36.43	34.49	-.33	

OVARY								
FEMALE	16196	22	30.34	.73	17.65	13.58	12.80	-1.67
PROSTATE								
MALE	14550	234	273.67	.86	175.34	160.82	149.92	-2.42 -
TESTIS								
MALE	14550	7	8.15	.86	5.94	4.81	5.11	-.46
URINARY BLADDER								
MALE	14550	38	70.59	.54	45.26	26.12	24.37	-4.93 -
FEMALE	16196	18	26.80	.67	15.33	11.11	10.30	-1.92
TOTAL	30746	56	97.38	.58	29.78	18.21	17.13	-5.20 -
KIDNEY AND RENAL PELVIS								
MALE	14550	26	31.04	.84	19.86	17.87	16.64	-.92
FEMALE	16196	18	20.93	.86	12.23	11.11	10.51	-.65
TOTAL	30746	44	51.97	.85	15.91	14.31	13.47	-1.13
BRAIN/OTHER NERVOUS SYSTEM								
MALE	14550	16	12.74	1.26	8.36	11.00	10.49	.78
FEMALE	16196	7	11.12	.63	6.62	4.32	4.17	-1.50
TOTAL	30746	23	23.86	.96	7.46	7.48	7.19	-.17
THYROID								
MALE	14550	4	7.90	.51	5.17	2.75	2.62	-1.86
FEMALE	16196	35	26.73	1.31	16.17	21.61	21.17	1.37
TOTAL	30746	39	34.64	1.13	10.86	12.68	12.23	.67
NON-HODGKIN LYMPHOMA								
MALE	14550	54	38.38	1.41	24.79	37.11	34.88	2.00 +
FEMALE	16196	42	37.41	1.12	21.69	25.93	24.35	.67
TOTAL	30746	96	75.79	1.27	23.19	31.22	29.37	1.94
HODGKIN LYMPHOMA								
MALE	14550	5	5.41	.93	3.81	3.44	3.53	-.19
FEMALE	16196	5	4.64	1.08	2.99	3.09	3.22	.17
TOTAL	30746	10	10.04	1.00	3.39	3.25	3.37	-.01
MULTIPLE MYELOMA								
MALE	14550	12	10.47	1.15	6.71	8.25	7.69	.41
FEMALE	16196	12	10.38	1.16	5.99	7.41	6.93	.44
TOTAL	30746	24	20.85	1.15	6.34	7.81	7.30	.60
LEUKEMIAS								
MALE	14550	21	24.84	.85	16.11	14.43	13.62	-.79
FEMALE	16196	24	20.64	1.16	11.86	14.82	13.79	.64
TOTAL	30746	45	45.48	.99	13.91	14.64	13.76	-.07
MESOTHELIOMIA								
MALE	14550	9	4.33	2.08	2.79	6.19	5.79	1.46
FEMALE	16196	2	1.05	1.90	.62	1.23	1.18	.64
TOTAL	30746	11	5.39	2.04	1.67	3.58	3.41	1.61
KAPOSIS SARCOMA								
MALE	14550	0	1.12	.00	.76	.00	.00	-1.05
FEMALE	16196	0	.19	.00	.11	.00	.00	-.42
TOTAL	30746	0	1.31	.00	.42	.00	.00	-1.14
Polycythemia vera (2001-2005)								
Male	14550	0	1.48	.00	1.92	.00	.00	-1.18
Female	16196	0	1.14	.00	1.27	.00	.00	-1.01
Total	30746	0	2.62	.00	1.58	.00	.00	-1.56
ALL OTHER SITES								
MALE	14550	49	59.49	.82	38.35	33.68	31.59	-1.41
FEMALE	16196	81	75.25	1.08	42.61	50.01	45.86	.59
TOTAL	30746	130	134.74	.96	40.55	42.28	39.13	-.38

Table 2- Cancer incidence for Blue Bell (19422)

	Population Size	Observed Cases	Expected Cases	SIR	ST Rate	CR Rate	Adjusted Rate	Z-Score
All CANCER SITES								
MALE	8793	568	599.99	.95	614.80	645.97	582.03	-1.21
FEMALE	9540	526	537.28	.98	543.69	551.36	532.28	-.47
TOTAL	18333	1094	1137.27	.96	578.03	596.74	556.04	-1.22
BUCCAL CAVITY AND PHARYNX								
MALE	8793	15	15.99	.94	16.01	17.06	15.02	-.23
FEMALE	9540	7	6.98	1.00	7.04	7.34	7.06	.01
TOTAL	18333	22	22.98	.96	11.37	12.00	10.89	-.19
ESOPHAGUS								
MALE	8793	8	9.88	.81	9.99	9.10	8.09	-.59
FEMALE	9540	4	2.72	1.47	2.79	4.19	4.10	.63
TOTAL	18333	12	12.60	.95	6.26	6.55	5.97	-.16
STOMACH								
MALE	8793	10	11.20	.89	11.50	11.37	10.27	-.34
FEMALE	9540	5	6.58	.76	6.80	5.24	5.17	-.70
TOTAL	18333	15	17.78	.84	9.07	8.18	7.65	-.67
COLON AND RECTUM								
MALE	8793	45	71.60	.63	73.57	51.18	46.24	-3.58-
FEMALE	9540	54	67.65	.80	69.89	56.60	55.79	-1.83
TOTAL	18333	99	139.25	.71	71.67	54.00	50.96	-3.82-
LIVER/INTRAHEPATIC BILE DUCT								
MALE	8793	9	8.01	1.12	8.09	10.24	9.10	.29
FEMALE	9540	2	3.22	.62	3.32	2.10	2.06	-.85
TOTAL	18333	11	11.22	.98	5.62	6.00	5.51	-.06
PANCREAS								
MAL	8793	13	13.47	.96	13.73	14.78	13.25	-.12
FEMALE	9540	14	12.93	1.08	13.37	14.68	14.48	.28
TOTAL	18333	27	26.40	1.02	13.55	14.73	13.85	.11
LARYNX								
MALE	8793	11	8.73	1.26	8.73	12.51	11.00	.60
FEMALE	9540	2	2.22	.90	2.21	2.10	1.99	-.14
TOTAL	18333	13	10.94	1.19	5.36	7.09	6.36	.51
BRONCHUS AND LUNG								
MALE	8793	66	95.58	.69	97.59	75.06	67.39	-3.27-
FEMALE	9540	66	67.47	.98	69.66	69.18	68.14	-.18
TOTAL	8333	132	163.05	.81	83.15	72.00	67.31	-2.53-
MELANOMA OF THE SKIN								
MALE	8793	26	19.14	1.36	19.76	29.57	26.84	1.22
FEMALE	9540	17	14.04	1.21	14.15	17.82	17.13	.69
TOTAL	18333	43	33.18	1.30	16.86	23.45	21.84	1.39
BREAST								
MALE	8793	3	1.55	1.93	1.58	3.41	3.05	.75
FEMALE	9540	184	156.47	1.18	154.75	192.87	181.97	1.91
TOTAL	18333	187	158.03	1.18	80.79	102.00	95.60	1.99+
CERVIX UTERI								
FEMALE	9540	3	9.51	.32	9.38	3.14	2.96	-3.54-
CORPUS/UTERUS, NOS								
FEMALE	9540	31	36.62	.85	36.08	32.49	30.54	-.95

OVARY								
FEMALE	9540	16	17.68	.90	17.65	16.77	15.97	-.40
PROSTATE								
MALE	8793	198	173.20	1.14	175.34	225.18	200.45	1.57
TESTIS								
MALE	8793	8	4.84	1.65	5.94	9.10	9.82	1.20
URINARY BLADDER								
MALE	8793	46	43.95	1.05	45.26	52.31	47.38	.27
FEMALE	9540	13	14.83	.88	15.33	13.63	13.44	-.50
TOTAL	18333	59	58.78	1.00	29.78	32.18	29.89	.03
KIDNEY AND RENAL PELVIS								
MALE	8793	17	19.63	.87	19.86	19.33	17.20	-.57
FEMALE	9540	7	12.01	.58	12.23	7.34	7.13	-1.84
TOTAL	18333	24	31.64	.76	15.91	13.09	12.07	-1.44
BRAIN/OTHER NERVOUS SYSTEM								
MALE	8793	5	7.92	.63	8.36	5.69	5.28	-1.21
FEMALE	9540	3	6.44	.47	6.62	3.14	3.09	-1.95
TOTAL	18333	8	14.35	.56	7.46	4.36	4.16	-2.14-
THYROID								
MALE	8793	12	4.97	2.41	5.17	13.65	12.49	1.86
FEMALE	9540	21	16.19	1.30	16.17	22.01	20.97	1.00
TOTAL	18333	33	21.16	1.56	10.86	18.00	16.93	1.94
NON-HODGKIN LYMPHOMA								
MALE	8793	20	23.98	.83	24.79	22.75	20.67	-.81
FEMALE	9540	14	21.11	.66	21.69	14.68	14.39	-1.86
TOTAL	18333	34	45.09	.75	23.19	18.55	17.48	-1.79
HODGKIN LYMPHOMA								
MALE	8793	1	3.28	.31	3.81	1.14	1.16	-2.33-
FEMALE	9540	2	2.71	.74	2.99	2.10	2.21	-.53
TOTAL	18333	3	5.98	.50	3.39	1.64	1.70	-1.79
MULTIPLE MYELOMA								
MALE	8793	5	6.55	.76	6.71	5.69	5.12	-.62
FEMALE	9540	7	5.78	1.21	5.99	7.34	7.26	.46
TOTAL	18333	12	12.32	.97	6.34	6.55	6.17	-.09
LEUKEMIAS								
MALE	8793	15	15.36	.98	16.11	17.06	15.73	-.09
FEMALE	9540	13	11.53	1.13	11.86	13.63	13.37	.40
TOTAL	18333	28	26.89	1.04	13.91	15.27	14.49	.20
MESOTHELIOMIA								
MALE	8793	3	2.68	1.12	2.79	3.41	3.13	.17
FEMALE	9540	0	.59	.00	.62	.00	.00	-.77
TOTAL	18333	3	3.27	.92	1.67	1.64	1.53	-.14
KAPOSIS SARCOMA								
MALE	8793	0	.67	.00	.76	.00	.00	-.82
FEMALE	9540	0	.10	.00	.11	.00	.00	-.32
TOTAL	18333	0	.78	.00	.42	.00	.00	-.88
Polycythemia vera, 2001-2005								
Male	8793	0	.93	.00	1.92	.00	.00	-.92
Female	9540	0	.63	.00	1.27	.00	.00	-.78
Total	18333	0	1.56	.00	1.58	.00	.00	-1.21
ALL OTHER SITES								
MALE	8793	32	36.83	.87	38.35	36.39	33.32	-.78
FEMALE	9540	41	41.60	.99	42.61	42.98	41.99	-.09
TOTAL	18333	73	78.44	.93	40.55	39.82	37.74	-.60

Table 3- Cancer incidence for Fort Washington (19034)

	Population Size	Observed Cases	Expected Cases	SIR	ST Rate	CR Rate	Adjusted Rate	Z-Score	
All CANCER SITES									
MALE	3010	164	179.75	.91	614.80	544.85	560.92	-1.27	
FEMALE	3064	159	160.41	.99	543.69	518.93	538.90	-.12	
TOTAL	6074	323	340.17	.95	578.03	531.77	548.86	-.99	
BUCCAL CAVITY AND PHARYNX									
MALE	3010	2	5.09	.39	16.01	6.64	6.29	-2.07	-
FEMALE	3064	1	2.10	.48	7.04	3.26	3.35	-1.13	
TOTAL	6074	3	7.20	.42	11.37	4.94	4.74	-2.33	-
ESOPHAGUS									
MALE	3010	4	3.00	1.33	9.99	13.29	13.30	.50	
FEMALE	3064	1	.78	1.28	2.79	3.26	3.56	.24	
TOTAL	6074	5	3.79	1.32	6.26	8.23	8.27	.55	
STOMACH									
MALE	3010	0	3.31	.00	11.50	.00	.00	-1.86	
FEMALE	3064	1	1.86	.54	6.80	3.26	3.66	-.96	
TOTAL	6074	1	5.16	.19	9.07	1.65	1.76	-4.44	-
COLON AND RECTUM									
MALE	3010	16	21.10	.76	73.57	53.16	55.80	-1.34	
FEMALE	3064	16	19.24	.83	69.89	52.22	58.14	-.90	
TOTAL	6074	32	40.33	.79	71.67	52.68	56.86	-1.59	
LIVER/INTRAHEPATIC BILE DUCT									
MALE	3010	1	2.51	.40	8.09	3.32	3.23	-1.47	
FEMALE	3064	1	.93	1.08	3.32	3.26	3.58	.08	
TOTAL	6074	2	3.44	.58	5.62	3.29	3.27	-1.01	
PANCREAS									
MALE	3010	6	4.02	1.49	13.73	19.93	20.51	.83	
FEMALE	3064	5	3.66	1.37	13.37	16.32	18.27	.67	
TOTAL	6074	11	7.68	1.43	13.55	18.11	19.41	1.07	
LARYNX									
MALE	3010	4	2.69	1.49	8.73	13.29	12.99	.64	
FEMALE	3064	0	.67	.00	2.21	.00	.00	-.82	
TOTAL	6074	4	3.36	1.19	5.36	6.59	6.37	.31	
BRONCHUS AND LUNG									
MALE	3010	20	28.25	.71	97.59	66.45	69.09	-1.92	
FEMALE	3064	15	19.51	.77	69.66	48.96	53.55	-1.27	
TOTAL	6074	35	47.76	.73	83.15	57.62	60.93	-2.28	-
MELANOMA OF THE SKIN									
MALE	3010	5	5.96	.84	19.76	16.61	16.57	-.43	
FEMALE	3064	6	4.38	1.37	14.15	19.58	19.39	.66	
TOTAL	6074	11	10.34	1.06	16.86	18.11	17.93	.20	
BREAST									
MALE	3010	1	.47	2.13	1.58	3.32	3.36	.54	
FEMALE	3064	59	48.19	1.22	154.75	192.56	189.46	1.38	
TOTAL	6074	60	48.66	1.23	80.79	98.78	99.62	1.48	
CERVIX UTERI									

FEMALE	3064	1	3.03	.33	9.38	3.26	3.09	-1.93
CORPUS/UTERUS, NOS								
FEMALE	3064	9	11.31	.80	36.08	29.37	28.71	-.75
OVARY								
FEMALE	3064	5	5.40	.93	17.65	16.32	16.33	-.18
PROSTATE								
MALE	3010	51	51.49	.99	175.34	169.44	173.66	-.07
TESTIS								
MALE	3010	2	1.61	1.24	5.94	6.64	7.39	.31
URINARY BLADDER								
MALE	3010	14	12.80	1.09	45.26	46.51	49.49	.34
FEMALE	3064	2	4.23	.47	15.33	6.53	7.25	-1.75
TOTAL	6074	16	17.03	.94	29.78	26.34	27.98	-.27
KIDNEY AND RENAL PELVIS								
MALE	3010	5	6.06	.82	19.86	16.61	16.38	-.47
FEMALE	3064	3	3.54	.85	12.23	9.79	10.35	-.33
TOTAL	6074	8	9.61	.83	15.91	13.17	13.25	-.57
BRAIN/OTHER NERVOUS SYSTEM								
MALE	3010	2	2.53	.79	8.36	6.64	6.62	-.37
FEMALE	3064	3	1.95	1.54	6.62	9.79	10.20	.63
TOTAL	6074	5	4.47	1.12	7.46	8.23	8.34	.24
THYROID								
MALE	3010	2	1.62	1.24	5.17	6.64	6.40	.26
FEMALE	3064	1	5.24	.19	16.17	3.26	3.09	-4.01 -
TOTAL	6074	3	6.86	.44	10.86	4.94	4.75	-2.14 -
NON-HODGKIN LYMPHOMA								
MALE	3010	10	7.30	1.37	24.79	33.22	33.97	.87
FEMALE	3064	9	6.16	1.46	21.69	29.37	31.68	1.02
TOTAL	6074	19	13.46	1.41	23.19	31.28	32.73	1.33
HODGKIN LYMPHOMA								
MALE	3010	2	1.08	1.86	3.81	6.64	7.09	.70
FEMALE	3064	2	.86	2.33	2.99	6.53	6.95	.86
TOTAL	6074	4	1.94	2.07	3.39	6.59	7.00	1.10
MULTIPLE MYELOMA								
MALE	3010	2	1.94	1.03	6.71	6.64	6.93	.05
FEMALE	3064	3	1.64	1.83	5.99	9.79	10.96	.88
TOTAL	6074	5	3.58	1.40	6.34	8.23	8.86	.68
LEUKEMIAS								
MALE	3010	5	4.67	1.07	16.11	16.61	17.26	.16
FEMALE	3064	1	3.38	.30	11.86	3.26	3.51	-2.56 -
TOTAL	6074	6	8.04	.75	13.91	9.88	10.38	-.88
MESOTHELIOMA								
MALE	3010	0	.76	.00	2.79	.00	.00	-.92
FEMALE	3064	0	.16	.00	.62	.00	.00	-.44
TOTAL	6074	0	.92	.00	1.67	.00	.00	-1.01
KAPOSIS SARCOMA								
MALE	3010	0	.21	.00	.76	.00	.00	-.48
FEMALE	3064	0	.03	.00	.11	.00	.00	-.18
TOTAL	6074	0	.24	.00	.42	.00	.00	-.51

POLYCYTHEMIA VERA								
MALE	3010	0	.29	.00	1.92	.00	.00	-.54
FEMALE	3064	0	.18	.00	1.27	.00	.00	-.44
TOTAL	6074	0	.47	.00	1.58	.00	.00	-.69
ALL OTHER SITES								
MALE	3010	10	11.01	.91	38.35	33.22	34.85	-.33
FEMALE	3064	14	12.10	1.16	42.61	45.69	49.32	.55
TOTAL	6074	24	23.10	1.04	40.55	39.51	42.13	.20

Notes:

+ A higher cancer incidence rate than expected, and is statistically significant (Z-Score greater than or equal to 1.96)

- A lower cancer incidence rate than expected, and is statistically significant (Z-Score less than or equal to -1.96)

Population size = 2000 Census Population.

Observed Cases = Number of newly diagnosed cases during the 1996-2005.

Expected Cases = Number of expected cases if study area had experienced average PA state rates during 1996-2005.

SIR = Standard Incidence Ratio (observed/expected cases).

ST Rate = Average annual age-adjusted State rate per 100,000 population during reporting period.

CR Rate = Average annual crude rate per 100,000 population for study area during reporting period.

Adjusted Rate = Average annual age-adjusted per 100,000 population for study area during reporting

Z-Score = Statistical significance of study area compared to state during reporting

period (a z-score of 1.96 equates to a 95 % level of statistical significance or a 1 in 20 chance that the results are due to random variation).

Table 4 – Comparison of PADOH analysis and MCHD analysis

Study Parameter	PADOH Analysis	MCHD Analysis
Study years	1996-2005	1996-2004
Asbestos sites investigated	One site: Borit	Six historical sites in Montgomery Co.
Study area, "observed" population	Ambler, Blue Bell and Fort Washington ZIP Codes	2-mile radii from the six sites
Comparison area, "expected" population	Commonwealth of PA	Montgomery County, outside the 2-mile radii
Statistical Analysis performed (Confidence Interval testing)	Z-test	Chi-square/Poisson distributions
Census/Mapping data	Census Zip Code data, Claritas	Census block data, DataFerrett

Figures

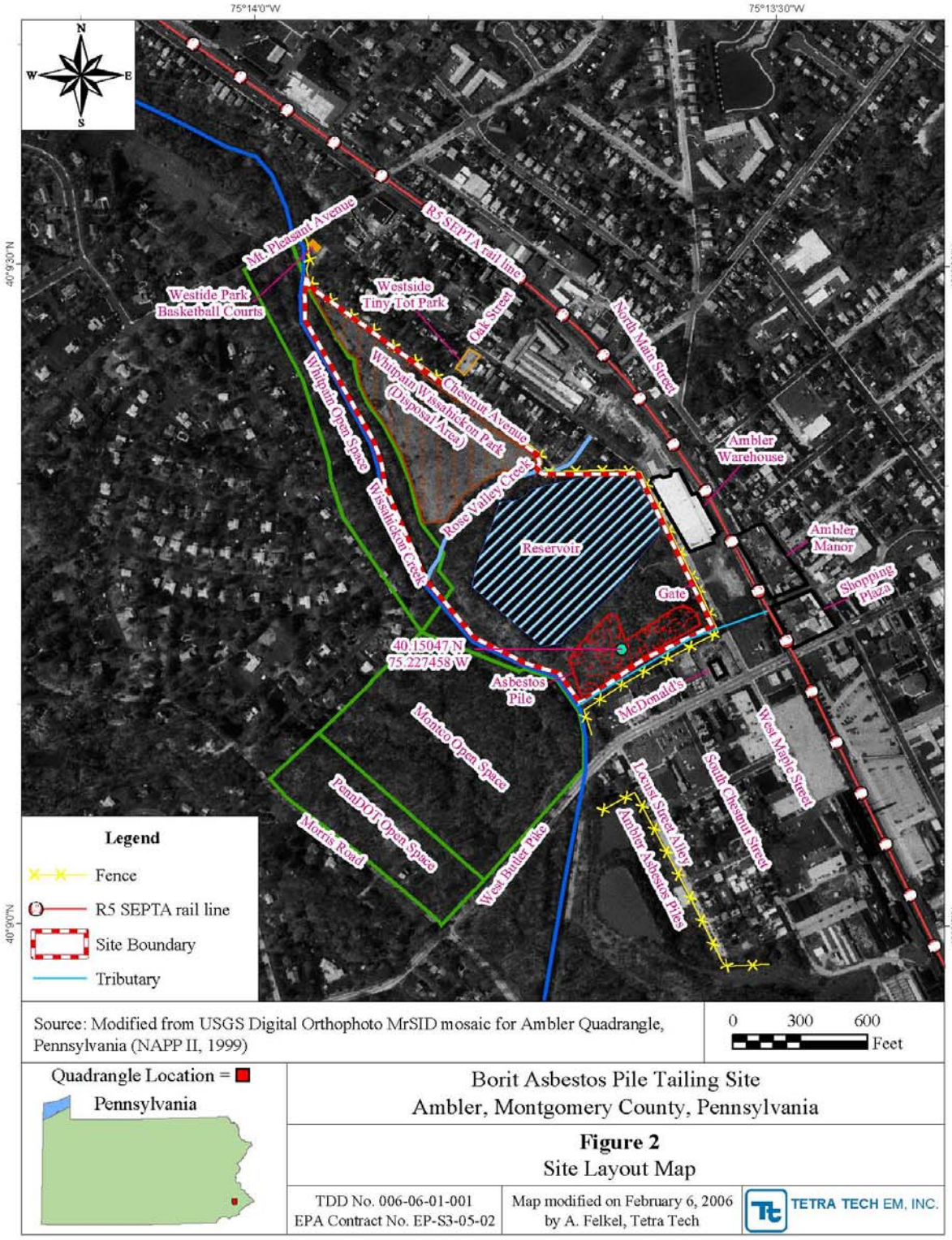

Figure 1- Borit site layout

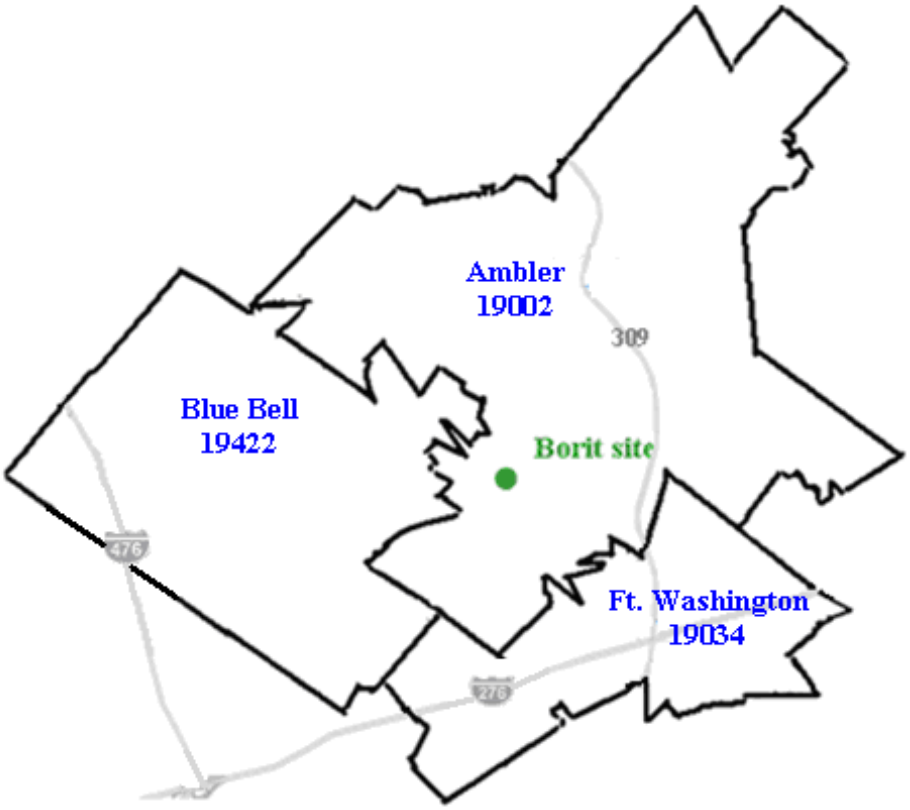

Figure 2 – Zip code map of study area, around the Borit site (Ambler, Blue Bell and Fort Washington)

Appendix A:

Montgomery County –

Health Outcome Data Analysis Report

Analysis of Mesothelioma Incidence around Known Asbestos Sites in Montgomery County, Pennsylvania, 1996 – 2004 using ArcGIS

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Abstract

Background: Asbestos is known to cause mesothelioma in humans and is classified as a known human carcinogen by the United States Department of Health and Human Services, the Environmental Protection Agency and the International Agency for Research on Cancer. [1-3] Mesothelioma risk analysis is usually done by analyzing data available from a cancer registry, using postal code or municipality designations to delineate a geographic area of interest. A 2005 study has shown that living near naturally occurring asbestos sources in California increases mesothelioma risk.[4] Six historic asbestos manufacturing and waste disposal sites have been identified in Montgomery County, PA (see Appendix A).

Method: Use ArcGIS to geocode address information for Montgomery County, PA 1996 – 2004 mesothelioma cases and the six known historic asbestos manufacturing and waste disposal sites. Draw 2-mile radii from the asbestos sites. Compare the mesothelioma incidences Within the 2-mile Radii and Outside the 2-mile Radii.

Results: For the time period 1996-2004, residents living Within the 2-mile Radii from the historic asbestos manufacturing and waste disposal sites had a statistically significant higher mesothelioma incidence than those living Outside the 2-mile Radii. Further analysis showed both male and female mesothelioma incidences were higher Within the 2-mile Radii than

1-3
4

Outside the 2-mile Radii, but were not significantly elevated for females. There were no increasing mesothelioma incidence trends for 1996 – 2004 for males or females, either Within or Outside the 2-mile Radii.

Conclusion: For the period 1996 -2004, residents living Within the 2-mile Radii had a higher mesothelioma incidence than those living Outside the 2-mile Radii from the six known historic asbestos manufacturing and waste disposal sites. Occupational history and other exposure-related information would be needed for further analysis.

Background

Asbestos is known to cause mesothelioma in humans. There were a number of facilities in Montgomery County, PA where asbestos-containing products such as heat-resistant bricks, pipe and boiler insulation, roofing materials, and specialty textiles were manufactured. These facilities also created disposal areas with asbestos-containing waste.

The Pennsylvania Cancer Registry (PCR) data only provide postal code, municipality and other limited geographic information in the data format. Traditionally, cancer cluster analyses are based on defined geographic areas such as postal code or municipality. Due to their irregular geo-shapes (see Chart 1) information categorized by these base areas may not be relevant to specific exposure sites. People residing within the same postal code or municipality as these historic asbestos sites do not necessarily have closer proximities to the sites than those who live outside the same postal code or municipality. Using ArcGIS and a radius-based approach to evaluate populations' proximities to these sites will provide more precision in these kinds of analyses.

Study Design

This analysis was conducted using cancer registry data from the PCR, which is maintained by the Pennsylvania Department of Health (PADOH). Montgomery County Health Department (MCHD) receives the PCR data for Montgomery County on an annual basis. The Pennsylvania Public Health Code requires that all hospitals, clinical laboratories and health care facilities where cancer is diagnosed or treated must report each newly-diagnosed case to the PCR within 180 days. [5] Reported

[5]

cases of cancer are housed in the PCR database at the PADOH. MCHD stores the files and analyzes the data upon request.

The software programs ArcGIS 9.2, SPSS15, DataFerrett and Microsoft Excel were used to geocode patients' addresses, calculate age-category populations, determine centroid points for all Census blocks in Montgomery County PA, obtain 2000 Census block populations and calculate age-adjusted rates. The age-specific incidence rates were calculated for the County population Outside the 2-mile Radii as the basis to project the expected number of mesothelioma cases for the County population Within the 2-mile Radii. The Standardized Incidence Ratio (SIR) and confidence intervals (CI) were calculated in Microsoft Excel using the formula that relates the chi-square and Poisson distributions (Dobson et al., 1991) [6-7] The mesothelioma yearly trend charts, tables and related linear regression statistics were generated using Microsoft Excel.

Methods

PCR data for diagnosis years 1996 – 2004, the most current data available at the time of this analysis, were used. ArcGIS 9.2 was used to geocode all the addresses for mesothelioma cases. Of 158 mesothelioma cases, three could not be geocoded to the exact point due to insufficient address information. The remaining 155 cases were geocoded to the exact point with address match scores as shown:

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Score 57 – 80	Score 81 – 90	Score 100
7	20	128

The standard address file used to geocode was last updated in 2004. Some newer street numbers may not be in the file. This may explain why some of the streets match but not the street numbers. The three unmatched addresses were evaluated based on the municipality code and zip code in the cancer registry file, to determine if they fell Within or Outside the 2-mile Radii from the known asbestos sites.

The six asbestos sites' mailing addresses or the closest proximities were used as center points to draw the 2-mile radii. The Census block shape file was converted from polygons to centroids to determine if a block fell Within or Outside the 2-mile Radii. A Census block is the smallest geographic unit used by the Census Bureau for tabulation of 100-percent data (data collected from all houses, rather than a sample of houses). Census blocks are typically bounded by streets, roads or creeks, and Census block populations vary. There are 11,620 Census blocks in Montgomery County PA with a population range of 0- 3,681, with a mean of 65 and a median of 41. A block centroid is the geometric center point of a Census block polygon (see Chart 2).

Census block population data were obtained using DataFerrett from the 2000 U.S. Census, [9] then linked to the Census block shapefile using common variable "Summary File ID" (SFID).

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The SFID is a unique identifier that refers to one and only one Census unit, and contains all the information needed to find the location of that unit (e.g. a Census tract) in the United States. Each state and county in the United States is assigned a Federal Information Processing Standard (FIPS) code.

PCR data are coded based on the "International Classification of Diseases for Oncology, Third Edition" codes.[9] There were about 37,000 records in total for Montgomery County PA, for 1996-2004. Each of these 37,000 cases was grouped into one of the twenty-four categories based on the criteria used by the Surveillance, Epidemiology, and End Results (SEER) Program at the National Cancer Institute. Duplicate cases were eliminated by PADOH before MCHD received the PCR data. A duplicate is defined as multiple case entries of cancer at the same primary site for the same person. Patients with more than one case of cancer at different primary sites were counted as multiple cases. For example, a patient who was diagnosed with cervical cancer in 1998 and then with breast cancer as a separate primary cancer in 2001, is counted as one case of cervical cancer and one case of breast cancer. A mesothelioma case is defined as being one of any ICD-O-3 site with ICD-O-3 Histology code between 9050 and 9055. This definition will include all mesothelioma cases, benign or malignant.
Age-specific incidence rates (see Table 1) were calculated using the 2000 U.S. Census population. Age-specific rates were calculated for both genders and were not calculated for race or ethnicity due to small numbers.

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The SIR, defined as the ratio of the number of observed cases to the number of expected cases, was calculated for the County populations Within and Outside the 2-mile Radii. An SIR with a value greater than 1.0 indicates that more cases were observed than would be expected when compared to a similar population. SIR values less than 1.0 indicate that fewer cases were observed than would be expected. SIR was assessed for statistical significance by examining 95% confidence intervals using the technique described by Dobson et al. (1991). An SIR with confidence intervals that do not contain the null value (1.0) is considered to be statistically significant. The expected cases in this study were derived from the incidence rate for the County population Outside the 2-mile Radii.

A simple linear regression method was used to determine the yearly trend for mesothelioma incidences for 1996-2004. The yearly trend showed no statistically significant increases or decreases (see Table 4 and Table 5). Population changes were not taken into consideration due to the difficulties of estimating population data at Census block level over the years. Positive slope (m) indicates an increasing trend over the years; negative slope (m) indicates a decreasing trend over the years. T-tests were used to determine the significance between the actual yearly incidences and the projected incidences.

Results

A total of 158 cases of mesothelioma were diagnosed in Montgomery County PA for 1996- 2004. Of these 158 cases, 120 cases were Outside the 2-mile Radii and 38 were Within the 2-mile Radii. Forty

of the 158 cases were female, 118 were male**.** Four (2.5%) of the 158 cases were 35-50 years old, 35 (22.2%) were 51-70 years old, and 119 (75.3%) were >70 years old (see Table 6).

The SIR was calculated for the mesothelioma incidence. Based on the mesothelioma incidence for the County population Outside the 2-mile Radii, a total of 23 mesothelioma cases were expected for the County population Within the 2-mile Radii. There were a total of 38 mesothelioma cases diagnosed Within the 2-mile Radii. The resulting SIR for all mesothelioma cases was 1.66 with a 95% CI of 1.17 - 2.28, which is statistically significant, indicating that the 1996-2004 mesothelioma incidence rate Within the 2-mile Radii was significantly higher than the mesothelioma incidence rate Outside the 2-mile Radii.

The expected number of male mesothelioma cases based on the male population and male incidence rate Outside the 2-mile Radii was 16.97, and the observed cases were 27. The resulting SIR for male mesothelioma incidence was 1.59 with a CI of 1.05 - 2.32, which was statistically significant at a 95% confidence level, indicating that the male mesothelioma incidence rate Within the 2-mile Radii was significantly higher than the male mesothelioma incidence rate Outside the 2-mile Radii (see Table 2).

The expected number of female mesothelioma cases based on the female population and female incidence rate Outside the 2-mile Radii was 5.55, and the observed cases were 11. The resulting SIR for female mesothelioma incidence was 1.99 with a CI of 0.99 - 3.55, which is not statistically significant at a 95% confidence level, indicating that the higher female mesothelioma incidence rate Within the 2-mile Radii was not statistically significantly higher than the female mesothelioma incidence rate Outside the 2-mile Radii (see Table 3).

A simple linear regression method was used to determine mesothelioma incidence yearly trend. The mesothelioma incidence for Montgomery County PA as a whole and for the County population Outside the 2-mile Radii increased slightly over the years. The mesothelioma incidence Within the 2-mile Radii was decreasing for 1996-2004. However, none of the increasing or decreasing trends were statistically significant. T-test values were 0.285, 0.475 and 0.570 with t-critical value with 7 degrees of freedom and Alpha = 0.05 of 2.36. (See Table 4.)

The 1998 Montgomery County PA mesothelioma incidence in the PCR was significantly lower than for all the previous and subsequent years in the period 1996-2004 (see Table 4). The average yearly mesothelioma incidence for the period, excluding year 1998, for all Montgomery County residents is 19.1; Within the 2-mile Radii it is 4.6, and Outside the 2-mile Radii it is 14.5. The PCR shows only five Montgomery County mesothelioma cases in 1998. While such a decreased annual incidence could be due to a sharp incidence fluctuation, it may also be due to data entry errors or incomplete data. When the 1998 PCR Montgomery County mesothelioma incidence numbers for the populations Within and Outside the 2-mile Radii were substituted with averages derived from the previous 2 years (1996, 1997) and subsequent 2 years (1999, 2000), the yearly mesothelioma incidence indicated decreasing trends for Montgomery County as a whole, as well as Within the 2-mile Radii and Outside the 2-mile Radii (see Table 5). The total Montgomery County mesothelioma incidence for 1996-2004 with substituted 1998 incidence data indicates a statistically significant decreasing trend, with t-test value of 2.607 with t-critical value with 7 degrees of freedom and Alpha = 0.05 of 2.36. The yearly mesothelioma incidence trends Within and Outside the 2-mile Radii with substituted 1998 data were not statistically significant, with t-test value of 0.552 and 1.354.

Discussion

Based on the mesothelioma incidence data for the Montgomery County PA population Outside the 2-mile Radii, and the population data for the areas Within the 2-mile Radii, a total of 23 (17 male and 6 female) mesothelioma cases would be expected to be diagnosed in residents Within the 2-mile Radii for 1996-2004. There were 38 mesothelioma cases diagnosed Within the 2-mile Radii in that time span, which is 1.66 times more than expected. The SIR for all (male and female) mesothelioma was 1.66 with 95% CI of 1.17 - 2.28. The CI for this SIR does not contain 1.0, indicating that the value is statistically significant. There were 27 male mesothelioma cases diagnosed for 1996-2004 Within the 2-mile Radii. The SIR for male mesothelioma was 1.59 with CI of 1.05 - 2.32 indicating that the male mesothelioma incidence Within the 2-mile Radii was significantly higher than expected. There were 11 female mesothelioma cases diagnosed for 1996- 2004 Within the 2-mile Radii. The SIR for female mesothelioma was 1.98 with CI of 0.99 - 3.55. The CI for female SIR includes 1.0, indicating that the female mesothelioma incidence Within the 2-mile Radii was higher then expected but was not statistically significant.

Working with asbestos is the major risk factor for mesothelioma. Nationally, a history of asbestos exposure at work is reported in about 70-80 percent of all meothelioma cases (National Cancer Institute). [10] There is a long latency period for mesothelioma, generally 30 years or more from time of exposure. [10] However, mesothelioma has been reported in some individuals without any known exposure to asbestos. Asbestos has been widely used in many industrial products, including cement, brake linings, roof shingles, flooring products, textiles, and insulation. In addition to mesothelioma,

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exposure to asbestos increases the risk of asbestosis, lung cancer and other cancers, such as those of the larynx and kidney. [10] Those types of cancer were not analyzed in this study.

For the period 1996-2004, Montgomery County PA residents living Within the 2-mile Radii from the known asbestos sites had a higher mesothelioma incidence than residents living Outside the 2-mile Radii. It may be that a sizeable percentage of these people used to work in the asbestos sites near their home, and were exposed on the job, or exposed by living in proximity to the facilities when they were active. The statistically significant higher mesothelioma incidence Within the 2-mile Radii for males but not for females may indicate that the higher mesothelioma incidence Within the 2-mile Radii is due to past work- related exposure, based on the assumption that more men worked at these sites than women. Collecting work histories for the mesothelioma cases may provide further evidence of work-related exposure as an explanation.

A simple linear regression method indicated that the mesothelioma incidence Within the 2-mile Radii had a decreasing trend for 1996-2004. For Outside the 2-mile Radii there was a slight increase, but this is not statistically significant. When the substituted 1998 incidence numbers were used, mesothelioma incidences both Within and Outside the 2-mile Radii showed decreasing trends, but these are not statistically significant.

MCHD receives Cancer Registry data from the PADOH for Montgomery County only. Therefore, this analysis considered 2-mile Radius areas only and did not examine incrementally larger-radius areas, which would have partially fallen out of the county at the next increment. Results from an analysis including several stratified concentric zones would be more conclusive but could not be done due to this data limitation.

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Appendix A

List of Historic Asbestos Manufacturing and Waste Disposal Sites

Montgomery County, PA

Ambler Borough

• Nicolet/CertainTeed Ambler Asbestos Piles and Bo-Rit Disposal Site
(geocoded as one site)

Norristown Municipality

• American Asbestos Textile Corporation

• Nicolet Industries

Plymouth Township

• Lavino Refractory Brick Plant

Upper Merion Township

• Brick refractory

• Ehret Magnesia Company

Chart 1
Mesothelioma Cases in Montgomery County (1996-2004)

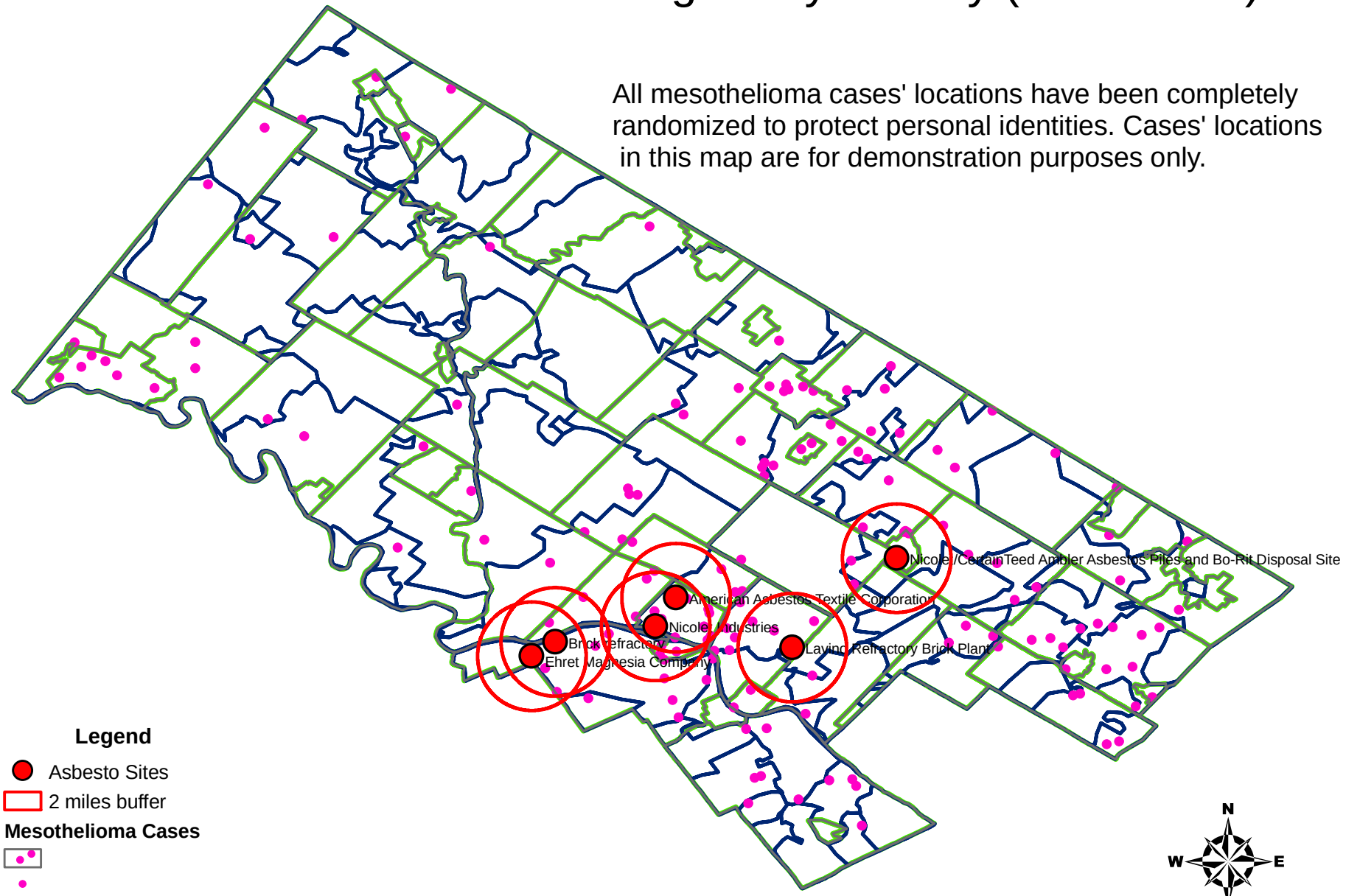

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Chart 2
Census Blocks and Block Centroids in Montgomery County, PA

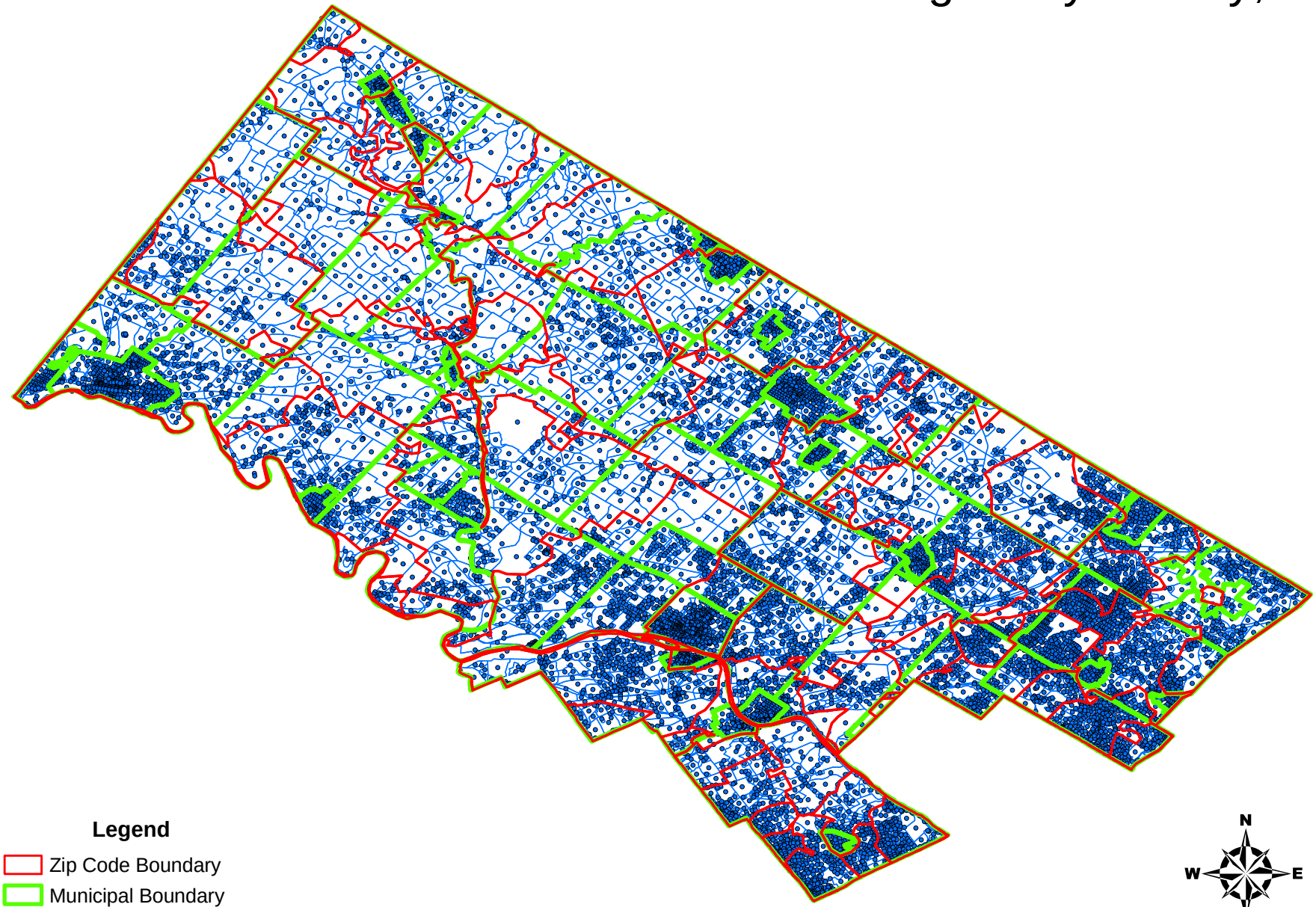

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Table 1: Mesothelioma Incidence Within and Outside the 2-mile Radii of Asbestos Sites in Montgomery County, PA, 1996-2004

	Outside the 2-mile Radii				Within the 2-mile Radii				
Age Group	Cases	Population	Rate	95%CI	Population	Expected Cases	Observed Cases	SIR	95%CI
under 5	0	40654	0.00	0, 0	6636	0.00	0	0.00	N/A
5-9	0	44310	0.00	0, 0	7031	0.00	0	0.00	N/A
10-14	0	46071	0.00	0, 0	6803	0.00	0	0.00	N/A
15-19	0	39740	0.00	0, 0	6019	0.00	0	0.00	N/A
20-24	0	30518	0.00	0, 0	6452	0.00	0	0.00	N/A
25-29	0	37274	0.00	0, 0	8542	0.00	0	0.00	N/A
30-34	0	45963	0.00	0, 0	9152	0.00	0	0.00	N/A
35-39	1	54321	1.84	-1.77, 5.45	9159	0.17	0	0.00	N/A
40-44	1	55663	1.80	-1.72, 5.32	8810	0.16	0	0.00	N/A
45-49	2	49164	4.07	-1.57, 9.71	7774	0.32	0	0.00	N/A
50-54	6	42860	14.00	2.8, 25.2	6937	0.97	1	1.03	-0.99, 3.05
55-59	5	32787	15.25	1.88, 28.62	5642	0.86	2	2.32	-0.9, 5.55
60-64	4	25189	15.88	0.32, 31.44	4829	0.77	1	1.30	-1.25, 3.86
65-69	13	23173	56.10	25.6, 86.6	4607	2.58	3	1.16	-0.15, 2.47
70-74	26	23011	112.99	69.56, 156.42	4771	5.39	7	1.30	0.34, 2.26
75-79	32	20514	155.99	101.94, 210.04	4201	6.55	12	1.83	0.8, 2.87
80-84	20	14316	139.70	78.48, 200.93	2487	3.47	9	2.59	0.9, 4.28
85 up	10	12634	79.15	30.09, 128.21	2083	1.65	3	1.82	-0.24, 3.88
Total	**120**	**638162**	**18.80**	**15.44, 22.17**	**111935**	**22.89**	**38**	**1.66**	**1.17 - 2.28**

Table 2: Male Mesothelioma Incidence Within and Outside the 2-mile Radii of Asbestos Sites in Montgomery County, PA, 1996-2004

	Outside the 2-mile Radii				Within 2-mile radius of Sites				
Age Group	Cases	Population	Rate	95%CI	Population	Expected Cases	Observed Cases	SIR	95%CI
Under 5	0	20761	0.00	0, 0	3330	0.00	0	0.00	N/A
5-9	0	22660	0.00	0, 0	3612	0.00	0	0.00	N/A
10-14	0	23836	0.00	0, 0	3494	0.00	0	0.00	N/A
15-19	0	20072	0.00	0, 0	3160	0.00	0	0.00	N/A
20-24	0	14917	0.00	0, 0	3283	0.00	0	0.00	N/A
25-29	0	18761	0.00	0, 0	4340	0.00	0	0.00	N/A
30-34	0	22665	0.00	0, 0	4681	0.00	0	0.00	N/A
35-39	0	26640	0.00	0, 0	4489	0.00	0	0.00	N/A
40-44	0	27508	0.00	0, 0	4349	0.00	0	0.00	N/A
45-49	2	24020	8.33	-3.21, 19.87	3746	0.31	0	0.00	N/A
50-54	5	21161	23.63	2.92, 44.34	3285	0.78	1	128.83	-123.68, 381.35
55-59	3	15834	18.95	-2.49, 40.39	2609	0.49	2	404.60	-156.15, 965.35
60-64	3	11911	25.19	-3.31, 53.69	2218	0.56	1	179.01	-171.84, 529.86
65-69	12	10669	112.48	48.84, 176.11	2070	2.33	3	128.85	-16.96, 274.66
70-74	22	10175	216.22	125.87, 306.57	2066	4.47	3	67.16	-8.84, 143.16
75-79	22	8397	262.00	152.52, 371.48	1691	4.43	8	180.57	55.44, 305.7
80-84	16	5283	302.86	154.46, 451.26	881	2.67	7	262.35	68, 456.7
85 & over	6	3436	174.62	34.9, 314.35	534	0.93	2	214.48	-82.77, 511.74
Total	**91**	**308706**	**29.48**	**23.42, 35.53**	**53838**	**16.97**	**27**	**1.59**	**1.05 - 2.32**

Table 3: Female Mesothelioma Incidence Within and Outside the 2-mile Radii of Asbestos Sites in Montgomery County, PA, 1996-2004

	Outside the 2-mile Radii					Within the 2-mile Radii				
Age Group	**Cases**	**Population**	**Rate**	**95%CI**		**Population**	**Expected Cases**	**Observed Cases**	**SIR**	**95%CI**
under 5	0	19893	0.00	0, 0		3306	0.00	0	0.00	**N/A**
5-9	0	21650	0.00	0, 0		3419	0.00	0	0.00	**N/A**
10-14	0	22235	0.00	0, 0		3309	0.00	0	0.00	**N/A**
15-19	0	19668	0.00	0, 0		2859	0.00	0	0.00	**N/A**
20-24	0	15601	0.00	0, 0		3169	0.00	0	0.00	**N/A**
25-29	0	18513	0.00	0, 0		4202	0.00	0	0.00	**N/A**
30-34	0	23298	0.00	0, 0		4471	0.00	0	0.00	**N/A**
35-39	1	27681	3.61	-3.47, 10.69		4670	0.17	0	0.00	**N/A**
40-44	1	28155	3.55	-3.41, 10.51		4461	0.16	0	0.00	**N/A**
45-49	0	25144	0.00	0, 0		4028	0.00	0	0.00	**N/A**
50-54	1	21699	4.61	-4.42, 13.64		3652	0.17	0	0.00	**N/A**
55-59	2	16953	11.80	-4.55, 28.15		3033	0.36	0	0.00	**N/A**
60-64	1	13278	7.53	-7.23, 22.29		2611	0.20	0	0.00	**N/A**
65-69	1	12504	8.00	-7.68, 23.67		2527	0.20	0	0.00	**N/A**
70-74	4	12836	31.16	0.62, 61.7		2705	0.84	4	474.53	**9.49, 939.57**
75-79	10	12117	82.53	31.38, 133.68		2510	2.07	4	193.10	**3.86, 382.34**
80-84	4	9033	44.28	0.89, 87.68		1606	0.71	2	281.23	**-108.53, 670.99**
85 up	4	9198	43.49	0.87, 86.11		1549	0.67	1	148.45	**-142.51, 439.41**
Total	**29**	**329456**	**8.80**	**5.6, 12.01**		**58087**	**5.55**	**11**	**1.98**	**0.99 - 3.55**

Table 4: Mesothelioma Cases By Year and Area, Montgomery County, PA 1996-2004

Area		Outside the 2-mile Radii	Within the 2-mile Radii	Total
Year	1996	13	6	19
	1997	16	6	22
	1998	4	1	5
	1999	16	4	20
	2000	16	4	20
	2001	15	4	19
	2002	11	8	19
	2003	14	2	16
	2004	15	3	18
Slope (m)		0.250	-0.167	0.083
SE for m		0.526	0.292	0.292
T-test		0.475	-0.570	0.285

Highlighted row indicates year with aberrant data

Table 5: Mesothelioma Cases with Data Adjustment By Year and Area, Montgomery County, PA 1996-2004

Area		Outside the 2-mile Radii	Within the 2-mile Radii	Total
Year	1996	13	6	19
	1997	16	6	22
	1998	15	5	20
	1999	16	4	20
	2000	16	4	20
	2001	15	4	19
	2002	11	8	19
	2003	14	2	16
	2004	15	3	18
Slope (m)		-0.125	-0.300	-0.425
SE for m		0.227	0.222	0.163
T-test		-0.552	-1.354	-2.607

Highlighted row indicates year with substituted data

Table 6: Mesothelioma Cases By Gender, Age Group and Area, Montgomery County, PA, 1996-2004

	Outside*		Within**		Total		Total	
Age Group	Male	Female	Male	Female	Male	Female	Outside	Within
35 to 39	0 (0%)	1 (3.4%)	0 (0%)	0 (0%)	0 (0%)	1 (2.5%)	1 (0.8%)	0 (0%)
40 to 44	0 (0%)	1 (3.4%)	0 (0%)	0 (0%)	0 (0%)	1 (2.5%)	1 (0.8%)	0 (0%)
45 to 49	2 (2.2%)	0 (0%)	0 (0%)	0 (0%)	2 (1.7%)	0 (0%)	2 (1.7%)	0 (0%)
50 to 54	5 (5.5%)	1 (3.4%)	1 (3.7%)	0 (0%)	6 (5.1%)	1 (2.5%)	6 (5%)	1 (2.6%)
55 to 59	3 (3.3%)	2 (6.9%)	2 (7.4%)	0 (0%)	5 (4.2%)	2 (5%)	5 (4.2%)	2 (5.3%)
60 to 64	3 (3.3%)	1 (3.4%)	1 (3.7%)	0 (0%)	4 (3.4%)	1 (2.5%)	4 (3.3%)	1 (2.6%)
65 to 69	12 (13.2%)	1 (3.4%)	3 (11.1%)	0 (0%)	15 (12.7%)	1 (2.5%)	13 (10.8%)	3 (7.9%)
70 to 74	22 (24.2%)	4 (13.8%)	3 (11.1%)	4 (36.4%)	25 (21.2%)	8 (20%)	26 (21.7%)	7 (18.4%)
75 to 79	22 (24.2%)	10 (34.5%)	8 (29.6%)	4 (36.4%)	30 (25.4%)	14 (35%)	32 (26.7%)	12 (31.6%)
80 to 84	16 (17.6%)	4 (13.8%)	7 (25.9%)	2 (18.2%)	23 (19.5%)	6 (15%)	20 (16.7%)	9 (23.7%)
85 & over	6 (6.6%)	4 (13.8%)	2 (7.4%)	1 (9.1%)	8 (6.8%)	5 (12.5%)	10 (8.3%)	3 (7.9%)
Total	91	29	27	11	118	40	120	38
Pearson's r	0.77		0.75		0.87		0.96	

***Outside the 2-mile Radii**

**** Within the 2-mile Radii**