

Health Consultation

BRIGHAM CITY SAND AND GRAVEL PITS
BRIGHAM CITY, BOX ELDER COUNTY, UTAH
EPA FACILITY ID: UTXCRA07W000

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
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HEALTH CONSULTATION

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Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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SUMMARY

Three sand, gravel, and asphalt operations are located near residential areas in Brigham City, Box Elder County, Utah. Residents of Brigham City have expressed concern about health effects related to dust and asphalt odors from the sand and gravel pits since 1997. In September 2003, the Utah Department of Health received a petition letter from the Brigham City Council requesting that the Utah Department of Health conduct a public health assessment aimed at evaluating the possible health effects associated with the sand, gravel and asphalt operations located in Brigham City.

In response to citizen complaints, the Utah Department of Environmental Quality's (UDEQ) Division of Air Quality (DAQ) performed air sampling in 1997, 1998 and 1999. In response to the petition letter from the Brigham City Council, the Division of Air Quality again performed air sampling during the summer of 2004.

Since citizen complaints were primarily directed towards dust exposure, sampling was limited to particulate matter (PM₁₀) and total suspended particulates (TSP). PM₁₀, refers to particulate matter with an aerodynamic diameter of 10 microns or less. These respirable particulates are of health concern since they can evade the body's natural defenses (nose, mouth, trachea) and accumulate in the lungs causing respiratory problems. Total suspended particulates (TSP) or fugitive dust, refers to the particulate concentration of particles of all sizes. The larger particles are filtered out by the body's respiratory system before they can enter the lungs. These particulates are a nuisance, but do not pose the health concern as the previously discussed smaller sized particles such as PM₁₀.

Sampling performed for PM₁₀ was compared to EPA standards and the total respirable dust (PM₁₀) sample concentrations were well below the health-based EPA guidelines. None of the sampling conducted for PM₁₀ in Brigham City was in violation of EPA standards and there is no indication of a threat to public health.

Sampling by DAQ indicates that the dust emitted from the sand, gravel, and asphalt operations is principally TSP of larger particle size. The EPA no longer regulates TSP; so former TSP standards were used as a comparison. Although a small number of samples exceeded the former standards, these particulates are more of a nuisance and do not pose a health concern.

Based on data available, the concentrations of TSP and respirable dust (PM₁₀) detected in ambient air samples from Brigham City pose no apparent public health hazard to the general population.

Utah's Indicator Based Information System for Public Health (IBIS-PH) was used to evaluate the occurrence of respiratory illness in Brigham City. The query was performed for the smallest area available, Brigham City. However, due to the small area and numbers, no rates could be calculated; therefore, there is no indication of high rates of respiratory illness in Brigham City.

Cancer rates were evaluated in Brigham City to assess if cancer rates are higher in Brigham City compared to the state of Utah. Data for this investigation were obtained from the Utah Cancer Registry using the IBIS-PH. None of the cancers evaluated in Brigham City were significantly elevated when compared to the state of Utah.

The Utah Department of Health's Environmental Epidemiology Program (EEP) recommends additional air sampling for air pollutants associated with asphalt production and diesel exhaust be conducted in Brigham City in residential areas near the asphalt production facilities during the summer months. The EEP recommends that sampling at this time be limited to particulates (PM_{2.5}, PM₁₀ and TSP), VOCs and semi-volatiles. Since previous sampling was conducted at a height of 10 feet, additional sampling for particulates should be conducted at a low height closer to the breathing zone of children and adults. In addition, since no analysis of the dust for crystalline silica was conducted, the EEP also recommends that an analysis for crystalline silica (total and respirable) in the dust be performed.

PURPOSE AND HEALTH ISSUES

The purpose of this health consultation is to determine if residents of Brigham City, Box Elder County, Utah, are being exposed to fugitive and respirable dust at levels of public health concern. The Brigham City community is adjacent to three sand, gravel and asphalt production sites.

Since 1997, many residents of the Brigham City community have expressed concern over dust and asphalt odors in their community. In September of 2003, the Brigham City Council requested that the Utah Department of Health's (UDOH) Environmental Epidemiology Program (EEP) investigate the possible health risks as a result of dust exposure from these sand, gravel and asphalt operations. The discussion of possible health effects will be limited to those that may result from exposure to particulate matter (dust) for which the Environmental Protection Agency (EPA) and the DAQ have regulations. No sampling was conducted for airborne silica, volatile organic compounds (VOCs) or polycyclic aromatic hydrocarbons (PAHs), air contaminants that are also found at asphalt production sites.

BACKGROUND

The UDOH has a cooperative agreement with ATSDR to address environmental health issues related to exposure from hazardous waste sites and other facilities in Utah. In an effort to respond to a petition letter resulting from growing number of air quality complaints from residents living adjacent to sand, gravel, and asphalt production facilities in Brigham City, the UDOH began a health assessment on the area in October of 2003 (Appendix A).

In September 2003, UDOH received a petition letter from the Brigham City Council expressing concerns about health affects associated with sand, gravel, and asphalt operations located in residential areas of Brigham City, Box Elder County, Utah. Residents in the community issued twenty-eight complaints against the two main operating pits that same summer, compared to eleven complaints received during the previous four years (1998 – 2002). Residents complained of dust, noise, and odor emanating from the nearby gravel pits, asphalt burners, and trucks. In

addition, residents reported health concerns including asthma, allergies, respiratory illness, eye & nose irritation, and a perceived increase in cancers. No specific cancer types were reported by the residents.

Brigham City is a small community located in Box Elder County, Utah with approximately 5,838 homes and approximately 17,411 people. Nonresidential buildings located near the sand and gravel pits include an elementary school, a junior high school, and two church houses. In addition, near the sand and gravel pits are a community golf course and a community park. Developers are actively constructing new homes along the border of the sand and gravel pits. The areas that are currently being developed for housing are along the north side of the largest pit and have had longstanding designations as residential properties. The community is bound by mountains of the Cache National Forest to the east and by active agricultural fields to the north, south, and west.

Mining of sand and gravel in Brigham City began in the late 1800's to early 1900's. At that time the population of Brigham City consisted of 4,000 people. Currently, the community of Brigham City has expanded around the gravel pits and many homes border the fence lines of the pits. In addition, the main access routes for the gravel pits run through residential areas. Zoning regulations on these residential areas were made at a time when the sand and gravel pit operations were smaller and less intensive than they currently are.

Mining of sand and gravel in Brigham City began in the late 1800's. Currently, there are three sand, gravel, and asphalt operations in Brigham City. The largest pit belongs to the Staker Parsons Company and is located at 33 south and 900 east along the eastern edge of Brigham City. Staker Parsons purchased the land in 1959 and now produces rock products, ready mix concrete, asphalt, and paving products on site. A neighboring pit belongs to Brigham City Sand and Gravel and is located on the east extremity of the Staker-Parsons pit. And a third pit, Fife Rock Products, is located just south of these at approximately 600 east and 500 south. Fife Rock Products has been in operation for 59 years and also produces rock products, ready mix concrete, and has an asphalt facility that has not been in use for several years.

The largest and most extensively sampled pit, Staker Parsons, is approximately 400 feet from the closest dwellings in the residential area. The nearest residential home from the Fife Rock Products location is approximately 500-600 feet. The gravel pits are bound by the mountains of the Cache National Forest to the east and are surrounded by residential areas of Brigham City to the north, south and west. Highway 90 divides the Staker Parsons and Brigham City Sand and Gravel Pits from the Fife Rock Products pit.

The Staker Parsons aggregate plant runs 2 million tons/year with an increase in production rate to 1200 tons/hr. The actual amount of aggregate produced in 2004 was 1,562,094 tons. The air quality permit restricts crushing to 6am – 10pm, however maintenance and hauling do occur at night. The Staker Parsons asphalt operation is permitted 200,000 tons/year and produces 100-200 tons of asphalt per hour (tph) during a 16 hour per day limit without specific start/stop times to accommodate schedules mandated by the Utah Department of Transportation. In 2004, the actual amount of asphalt produced by Staker Parsons was 104,133 tons. The asphalt-operating

season is approximately from April through November, weather permitting. In addition, Staker Parsons will also have a concrete plant included in their permit for the first time. The plant will be permitted 180,000 cubic yards per year with an hourly limitation similar to the asphalt plant. The concrete plant has voluntarily included a bag house, which will eliminate the grandfathered status of the plant. This new permit will go to public comment prior to issuance.

At the Fife Rock Products site, sand, and gravel is extracted onsite and trucked to Ogden. The pit has a crusher onsite as well as a ready-mix batch concrete plant. They also have an asphalt plant, but it is rarely used. The land owned by Fife Rock Products is 110 acres, but only a small area is mined and much of the area is comprised of offices and shops. Fife is permitted to operate between 5 am – 9 pm, but usually run 8-10 hours a day for five days a week seasonally.

All the sand and gravel pits use wet suppression methods (water sprays and water truck) to control fugitive dust emissions and the Staker-Parsons pit has installed a bag house to control asphalt plant emissions. In addition, berms were constructed along the fence lines.

METHODS

Environmental Sample Collection

Individual citizens of Brigham City contacted DAQ in 1997, 1998, and 1999. Each year DAQ responded by conducting air sampling at requested locations. Because the complaints DAQ received were directly against the fugitive dust generated by the sand and gravel operations, sampling was conducted to measure both fine and coarse particulates (PM₁₀ and TSPs). No samples were found to be in violation of national ambient air standards. In response to a petition letter from the Brigham City Council and further complaints by residents, DAQ conducted additional particulate sampling during the summer of 2004.

Sampling for additional air pollutants, such as those associated with asphalt production and diesel exhaust, (VOCs, PAHs, semi-volatiles, carbon monoxide, nitrogen oxides, sulfur dioxides) has not been conducted. Also, analysis of the crystalline silica (total and respirable) in the dust has not been determined.

Limited sampling was performed and samples were analyzed for: (1) TSPs and (2) respirable particulates (PM₁₀). The airborne particulates were collected using Minivol portable samplers. Each sampler was hung from a support structure at a height of 10 feet from the ground. Samplers were equipped with a pump, programmable timer to start and stop the pump, an elapsed timer to track how much time the sampler operated, a 12-volt rechargeable battery, and a filter assembly containing a pre-weighed filter. The pump draws air through a tube connected to the specific collection device. The total suspended particulates were collected directly on the pre-weighed filter. A pre-weighed filter also collects the “respirable” particles and particulate measurements were made by weighing the filters (NIOSH¹ 0500). Analytical results were compared to health and safety guidelines. Sampling information and results are summarized in Table 1.

¹NIOSH: The National Institute for Occupational Safety and Health is the federal agency responsible for conducting research and making recommendations for the prevention of work-related disease and injury.

Respiratory Illness Evaluation

Utah's Indicator Based Information System for Public Health (IBIS-PH) was used to evaluate the occurrence of respiratory illness in Brigham City. IBIS-PH is public health data resource maintained by UDOH's Center for Health Data. This tool provides health status information on Utahans, the status of the health care system, and Utah Public Health activities.

To examine respiratory illness rates in Brigham City, custom queries were performed using International Classification of Disease (ICD-9) codes relevant to respiratory illness possible from exposure to airborne contaminants related to sand, gravel and asphalt operations. The ICD-9 codes used included asthma, and lung diseases due to external agents and pertinent acute respiratory infections. A list of the ICD-9 codes used are listed below:

460 – Acute nasopharyngitis	476 – Chronic laryngitis and laryngotracheitis
461 – Acute sinusitis	477 – Allergic rhinitis
462 – Acute pharyngitis	493 - Asthma
464 – Acute laryngitis	495 – Extrinsic Allergic Alveolitis
466 – Acute bronchitis and bronchiolitis	502 – Pneumoconiosis due to silica or silicates
472 – Chronic pharyngitis/nasopharyngitis	503 – Pneumoconiosis due to other inorganic dust
473 – Chronic sinusitis	504 – Pneumonopathy due to other dust
465 – Acute upper respiratory infections of multiple of unspecified sites	
508 – Respiratory conditions due to other and unspecified external agents	

The query was conducted for the smallest area available, Brigham City. However, due to the small area and numbers, no rates could be calculated for the illnesses and diseases listed above.

Cancer Rates

Cancer rates were evaluated in Brigham City to assess if cancer rates are higher in Brigham City compared to the state of Utah rates. Data for this investigation were obtained from the Utah Cancer Registry using IBIS-PH. The Utah Cancer Registry receives reports on each newly diagnosed case of cancer in Utah from hospitals, radiation therapy facilities, pathology laboratories, nursing homes, and physicians. Each newly diagnosed case is assigned to the census tract of residence at the time of diagnosis. The data for the study area (2000 census tract 9607.02) and the state of Utah was categorized by cancer site/type, sex, age group, and year of diagnosis, and covered the years from 1992 – 2001. The year 2001 was the most recent year for which complete data were available from the Utah Cancer Registry. The 2000 census tract 9607.02 was selected for this study by the correspondence of the tract boundaries to the area of concern surrounding the gravel pits.

The population demographics for the study area (2000 census tract 9607.02) and the state of Utah were obtained from the 1990, and 2000 U.S. Census Data, provided electronically by Geolytics CensusCD products. The intercensal populations were estimated linearly on the basis of the 1990 and 2000 populations. The populations were estimated on the basis of a constant rate of growth.

A comparison population was selected in order to evaluate whether the observed cases in the study population is statistically different from that which would be expected if the population had not been at any special risk. The state of Utah was used as the comparison population for this investigation. For the purpose of analysis, from this point after census tracts 9607.02 will be referred to as *Brigham City* and the state of Utah will be referred to as *Utah*, unless otherwise specified. Brigham City has similar demographic characteristics to Utah. In the 2000 U.S. Census, the median age of Brigham City is 28.8 years; Utah's median age is 27.1 years. Brigham City's population was 91.3% White in 2000; the state of Utah was 89.2% White.

Standardized Incidence Ratios (SIR) was used for the quantitative analysis of cancer incidence in the area under evaluation (Kelsey, et al 1986, Aldrich and Griffith 1993). A SIR was calculated for each period and used to determine if there is a greater risk or a lower risk of developing cancer as compared to the comparison population. The SIR was calculated by dividing the crude observed count by the expected count. The ratio of observed to expected was then used to determine if there was a greater risk or a lower risk of developing cancer as compared to the comparison population. The expected count was calculated by multiplying the age-specific comparison rate (Utah) by the age-specific population of the study population (Brigham City), and summing the results. A SIR of one (1.0) indicates rates are equal and there is no increased risk. A SIR greater than one (1.0) indicates an increased risk for the study group, while a SIR less than one (1.0) indicates a decreased risk for the study group. Random fluctuations may account for some SIR deviations from 1.0. A more detailed description of the standardization of the data is presented in Appendix B.

The statistical significance of deviations from a SIR of 1.0 was evaluated using a 95 percent confidence interval. The confidence interval for the SIR is the range within which the true SIR value has a specified probability of being included. The specified probability is called the confidence level, and the endpoints of the confidence interval are called the confidence limits. The confidence limits were calculated using the method of Frumkin and Kantrowitz (Frumkin and Kantrowitz 1987). By assessing the confidence interval, information about the variability of the data and the statistical significance of the SIR was obtained. The differences between the observed versus the expected (or SIR) were considered significant (not a random occurrence or due to chance alone) if the confidence interval applied to the SIRs did not include one (1.0). Important note: statistical significance does *not* mean causally associated. It does mean that the recognized association has stability and may need further evaluation. A more detailed description of the confidence interval calculation is presented in Appendix B.

The variation of the incidence of cancer overtime was evaluated. Rates, SIRs, and confidence intervals were calculated for iterative 5-year periods incremented one year at a time for each cancer covering a period of 10-years (1992 – 2001). The iterative 5-year period calculations were computed beginning with period 1992 – 1996 and ending with period 1997 – 2001. Therefore, a total of six overlapping five-year periods were evaluated. For comparison purposes, five-year running incidence rates were also calculated for Utah.

Age-Adjusted Rates

Age-adjusted rates of morbidity (per 100,000 person-years) were calculated through direct standardization and adjusted to the 2000 U.S. Standard Population. This adjustment provides a basis for comparison across populations by reducing the effects of differences in the age distributions of the population being compared. It is computed by using the weighted age-specific rates in the population of interest and the proportions of the persons in the corresponding age groups within a standard population.

Cancers Evaluated

The Agency for Toxic Substances and Disease Registry (ATSDR) recommends against performing statistical analysis whenever there are fewer than three cases of the same type of cancer in a population (ATSDR, 1993). Only those cancers occurring three or more times in at least one of the time periods evaluated in the study area between 1992 and 2001 were included in this analysis. The cancer sites that occurred three or more times are as follows:

<i>All sites</i>	<i>Urinary bladder</i>
<i>Prostate</i>	<i>Lung and bronchus</i>
<i>Colon excluding rectum</i>	<i>Female breast</i>

DISCUSSION

Exposure Pathway Analysis

To determine whether nearby residents are being exposed to high levels of PM₁₀ and fugitive dust at this site, EEP and ATSDR evaluate the environmental and human components that make up a human exposure pathway. An exposure pathway consists of five elements (ATSDR 1992b):

- (1) a source of contamination;
- (2) transport through an environmental medium;
- (3) a point of exposure
- (4) a route of human exposure; and
- (5) a receptor population.

ATSDR categorizes an exposure pathway as either *completed*, *potential* or *eliminated*. In *completed* exposure pathways, all five elements exist to indicate that exposure to a contaminant has occurred in the past, is occurring, or will occur in the future. In *potential* exposure pathways, at least one of the five elements has not been confirmed, but may exist. Exposure to a contaminant could have occurred in the past, could be occurring, or could occur in the future. An exposure pathway can be *eliminated* if at least one of the five elements is missing and will never be present (ATSDR 2005).

There is one completed exposure pathway for residents living near the Brigham City Sand and Gravel pits sites: respirable dust inhalation. Elements of the completed exposure pathway are

described below.

Completed Exposure Pathway: respirable dust inhalation

Exposure element

- 1) a source of contamination.....dust released from sand and gravel pit operations
- 2) transport through environmental medium.....airborne dust
- 3) a point of exposure.....contact with airborne dust
- 4) a route of human exposure.....inhalation
- 5) a receptor population.....residents of Brigham City

A completed pathway of exposure to airborne respirable dust is found due to the proximity of residential homes to the sand, gravel and asphalt operations in Brigham City. Air Monitoring data indicates low levels of airborne respirable dust (PM₁₀) and moderate levels of TSP in the residential areas near the sand and gravel pits of Brigham City. Examples of this exposure pathway include children playing outside or a resident working in their yard. The dust inhalation pathway existed in the past and because the site is residential and the since the sand and gravel operations plan to continue for the foreseeable future, it is also a current and future exposure pathway.

Respirable Particulates (PM₁₀)

Respirable particulates or PM₁₀, refers to particulate matter with an aerodynamic diameter of 10 microns or less. These respirable particulates are of health concern since they can evade the body's natural defenses (nose, mouth, trachea) and accumulate in the lungs causing respiratory problems. Health effects shown by epidemiology studies to be statistically related to ambient PM₁₀ exposures include increased mortality (especially for the elderly and those with preexisting cardiopulmonary conditions), increased hospital admissions, respiratory symptom rates and decrements in lung function [Harris, 2000]. Possible health effects in humans and animals related to PM₁₀ include respiratory symptoms, inflammation, changes in mucociliary clearance of particles, decrement in lung function, and morphologic changes in lung tissue. These effects could contribute to pulmonary or cardiopulmonary events that could result in PM₁₀ associated mortality [Rom, 1998].

Ambient (outdoor) levels of PM₁₀ are regulated by the EPA. The 24-hour ambient air standard is 150 micrograms per cubic meter of air sampled (150 µg/m³) and the annual standard is set at 50 µg/m³. Sampling for respirable particulates was done in 1997, 1998, 1999, and recently in 2004.

In 1997, air monitors were set up for sampling of PM₁₀ at two sites in the vicinity of the sand and gravel pits. The sites were selected based upon citizen complaints and proximity to the main haul roads. A total of eight PM₁₀ samples were collected from July 26th to August 6th. The average 24-hour concentration of these samples was 14 ug/m³, which is less than one-tenth of the EPA ambient standards of 150 µg/m³. The highest recorded 24-hour sample of PM₁₀ in 1997 was 21 µg/m³.

In 1998 sampling for PM₁₀ was performed at a single site located near Box Elder Junior High School. Thirteen PM₁₀ samples were collected September 4th through November 4th, with an average 24-hour concentration of 14 µg/m³ and a highest 24-hour recorded sample of 32 µg/m³. None of the samples taken violated EPA standards or appeared to pose a threat to public health.

In 1999 three sites were chosen for PM₁₀ sampling. Again these sites were selected due to citizen complaints on locations of heavy fugitive dust and proximity to the major truck haul roads. A total of 28 PM₁₀ samples were collected during September 21st through October 23rd of 1999. The average 24-hour concentration was 32 µg/m³ and the highest recorded 24-hour sample was 63 µg/m³. Sampling did not violate EPA standards or appear to pose a threat to public health.

The most recent sampling was conducted in the summer of 2004 in response to a petition letter from the Brigham City Council. Sampling for PM₁₀ was conducted at a single site located at 765 Eliason Ave. (50 north) from July 7th to September 29th. This site was located to measure representative dust exposures of citizens living near the Staker Parson and Brigham City pits. A total of 16 PM₁₀ samples were collected. The average 24-hour concentration was 27 µg/m³ and a highest recorded 24-hour sample was 68 µg/m³. None of the samples showed concentrations in violation of federal ambient air standards. The gravel pits did not appear to emit high enough levels of inhalable particulates to pose a threat to general public health in the area. Complete sampling results are summarized in Appendix C, Tables 1-5.

Monitoring and sampling data showed that average and high concentrations of PM₁₀ were well below EPA's 24-hour average ambient air standard of 150 µg/m³. However, this guideline may not completely protect sensitive populations such as those with asthma or bronchitis from exposures to short-term peak levels that could cause respiratory difficulty.

The total respirable dust concentrations are below the health-based EPA guidelines. None of the samples collected for PM₁₀ in Brigham City were in violation of EPA standards and there is no indication of a threat to public health.

Total Suspended Particulates (TSP)

Total suspended particulates (TSP) or fugitive dust, refers to the particulate concentration of particles of all sizes, but generally consists of particles whose average aerodynamic diameter is about 40 microns. These larger particles are filtered out by the body's respiratory system before they can enter the lungs. These particulates are a nuisance, but do not pose the health concern as the previously discussed smaller sized particles such as PM₁₀. Until 1987, EPA had regulations for TSP of 260 µg/m³ for 24-hour averages and 75 µg/m³ for annual averages. In 1987, the EPA developed more specific guidelines based on PM₁₀. Due to the more protective regulation of PM₁₀, TSP is no longer regulated by the EPA and the former standards to regulate TSP are no longer enforceable. However, for this assessment, the former EPA standard of 260 µg/m³ is used as a comparison and guideline in evaluating TSP monitoring results. Similar to the PM₁₀, sampling for TSP was conducted in 1997, 1998, 1999, and 2004.

In 1997 sampling for TSP was done at three different sites in the vicinity of the sand and gravel pits. Locations were specifically chosen due to citizen complaints and proximity to truck haul roads. A total of 33 TSP samples were collected from August 8th to October 1st. The average 24-hour concentration of these samples was 56 $\mu\text{g}/\text{m}^3$ and the highest 24-hour recorded sample was 349 $\mu\text{g}/\text{m}^3$. Moderate to high levels of TSP were observed in a few of the samples collected. One TSP exceedance of the former TSP benchmark was observed.

In 1998 four sites were chosen for TSP sampling. These sites were chosen to show levels of fugitive dust exposure of those nearest to the source and to sample levels along major truck haul routes. A total of 48 samples were collected from September 4th to November 4th. The average 24-hour TSP concentration was 65 $\mu\text{g}/\text{m}^3$ and the highest 24-hour recorded sample was 232 $\mu\text{g}/\text{m}^3$. Moderate levels of TSP were found near the truck access to the Parson pit, but lower levels were observed at the other sites. There were no exceedances of the former TSP benchmark in 1998.

In 1999 three sites were selected for TSP sampling. City officials assisted DAQ in selecting sampling sites of heavy truck traffic and locations of heavy fugitive dust. A total of 44 samples were collected in August 17th through November 19th. The average 24-hour TSP concentration was 105 $\mu\text{g}/\text{m}^3$ and the highest 24-hour sample was recorded at 238 $\mu\text{g}/\text{m}^3$. Sampling indicated moderate to high levels of TSP near the entrance to the Parson pit and low to moderate levels along routes of truck hauling sand and gravel. There were no exceedances to the previous EPA standards.

In response to further complaints by the residents of Brigham City and a petition from the Brigham City Council, further TSP sampling was conducted during the summer of 2004. Five sites, including one indoor site, were selected based upon complaints of heavy dust and proximity to the sand and gravel operations. A total of 108 samples were collected from May 18th through September 29th. The average 24-hour TSP concentration was 64 $\mu\text{g}/\text{m}^3$ and the highest 24-hour recorded sample was 329 $\mu\text{g}/\text{m}^3$. Two exceedances of the TSP benchmark standards were observed.

Sampling by DAQ indicates that the dust emitted from the sand, gravel, and asphalt operations is principally TSP (as determined by comparing TSP and PM_{10} results). The potential for high TSP remains due to occasional strong winds characteristic of the area. Although TSP should pose no health risk to the general population, sensitive populations such as those with preexisting respiratory disease may be affected. The analytical results are presented in Appendix C, Graph 1.

Sampling results show that fugitive dust poses more of a problem in Brigham City than finer particulates. Rarely did the sampling for TSP rise above former EPA standards, however the potential for high TSP exposure to residents exists due to high winds (>20 mph). More testing is needed to determine if respirable silica (i.e., quartz, cristobalite, tridymite) is at safe levels.

Sensitive Groups

Although there does not appear to be a threat to the general population, certain populations may be more sensitive to PM₁₀ and TSP levels. These sensitive groups include the elderly, individuals with cardiopulmonary diseases such as asthma and children [Harris, 2000]. However, the Clean Air Act and National Ambient Air Quality Standards (NAAQS) requires consideration of sensitive population groups, in this case citizens with bronchial asthma or emphysema who are exposed to the ambient environment through daily activity [Rom, 1998]. So the EPA standards set for PM₁₀ are set to be protective of those sensitive populations as well as the general public.

Respiratory Illness Evaluation

Utah's IBIS-PH was used to evaluate the occurrence of respiratory illness in Brigham City. The query was performed for the smallest area available, Brigham City. However, due to the small area and numbers, no rates could be calculated; therefore, there is no indication of high rates of respiratory illness in Brigham City.

Cancer Rates

None of the cancers evaluated in Brigham City were significantly elevated when compared to the state of Utah. Standardized incidence ratios and incidence rates for the cancers evaluated are presented in Appendix D.

Cancer Risk Factors

Cancer is a name applied to many diseases with many different causes. Cancers are very common. Nearly half of all men and one-third of all women in the U.S. population will develop cancer at some point in their lives and 22 percent of the population will eventually die of cancer (ACS 2004). Statistically, it is normal for cancer rates to fluctuate in smaller communities. Some years the rates are higher, other years lower, eventually the rates tend to balance out over time.

When a subset of the population is found to have an increased rate of cancer, there are no definitive tests to determine which of the cancer cases are due to the unique risk factors present in that population and which cases are due to the background risk factors or genetic factors present in the general population. Therefore, if the expected rate of a particular cancer in the general population is 100 cases and a particular occupational group is found to have 120 cases, no test currently can determine which 20 individuals developed the disease due to the specific risks associated with their profession (or environmental exposures) and which 100 would have occurred anyway. Characterizing types of cancers, cancer rates, and determining causal relationships to environmental exposures without exposure measurements or data is difficult because people live and work in many environments and are exposed to complex mixtures of toxic pollutants at home, at work, and in the ambient environment.

Lung & Bronchial

Smoking is by far the leading risk factor of lung cancer. Passive smoking is also a risk factor. Exposure to radon and asbestos are factors leading to lung cancer, however, smoking in addition to these exposures greatly increases the cancer causing effects of asbestos and radon. Cancers of the lung are elevated after radiotherapy for Hodgkin's disease. Excess lung cancers of all types have been reported from military exposures to atomic and thermonuclear weapons. Smoking and radiation exposure also appear to have an additive effect on lung cancer. Occupational lung cancer may result from exposure to inorganic arsenic compounds (insecticides, pesticides, smelter workers, tin miners). The risk of lung cancer, mesothelioma, and asbestosis is increased in various asbestos industries, including mining, milling, textile, gas mask, friction products, insulation, shipyard, and cement workers. A high risk of lung cancer was reported in workers exposed to bis(chloromethyl)ether (BCME). Risk appears to decrease following cessation of exposure, suggesting that the chemical may affect late as well as early stages of carcinogenesis (Schottenfeld & Fraumeni, 1996). An excess of lung cancer has been reported among persons with high dietary intake of foods rich in fat and cholesterol. Other risk factors implicated in lung and bronchus cancer are exposure to asbestos, coal gas, nickel, polycyclic hydrocarbons, chromium, arsenic (Schottenfeld and Fraumeni 1996), chlormethyl ethers (Gowers et al 1993), radon (Archer et al 1973), miners (arsenic, asbestos and coal) (Ames et al 1983, McDonald and McDonald 1987, Taylor et al 1989) and uranium (UCR 2000). Risk increases when exposure to these contaminants occurs in conjunction with cigarette smoking. Tuberculosis has also been identified as a risk factor for lung and bronchus cancer (Zheng et al 1987). Lung cancer may also be connected with breathing vinyl chloride over long periods (ATSDR 1997). In a study of workers exposed to dry cleaning solvents (carbon tetrachloride, TCE, and PCE) an excess of lung cancer was observed (Blair et al 1979). Some studies have suggested a possible association between respiratory cancer with TCDD exposures (NTP 2001).

More than 2 percent of the population in Utah will be affected with lung and bronchial cancer in their lifetime (UCR 1996).

Urinary Bladder

Bladder cancer has been associated with lifestyle factors, medical procedures, and occupational exposures. Cigarette smoking is well established as a cause of bladder cancer. Overall, smokers appear to have two to three times the risk of nonsmokers.

Ionizing radiation causes bladder cancer. Women receiving pelvic radiation and radioactive iodine experienced a higher risk of bladder cancer. Consumption of chlorinated drinking water is also associated with increased risk for bladder cancer compared to drinking non-chlorinated ground water (Schottenfeld & Fraumeni, 1996).

Occupational risk factors for bladder cancer have been associated with dyestuffs workers, dye users, aromatic amine manufacturing workers, rubber workers, leather workers, painters, truck drivers, aluminum workers, and increased risk has also been reported for many other

occupational groups. Dye workers and aromatic amine manufacturing workers are exposed to 2-naphthalamine and benzidine. A positive trend in bladder cancer mortality was seen with increasing duration of employment. Rubber workers are also exposed to 2-naphthalamine either during manufacturing or as a product of metabolization of phenyl-B-naphthalamine. Specific exposures to leather workers and truck drivers were not identified. Painters may be exposed to benzidine, polychlorinated biphenyls, formaldehyde, asbestos, benzene, dioxin, and methylene chloride. Coal tar-pitch volatiles emitted from the anodes in the Soderberg electrolytic reduction process may be responsible for the observed bladder cancer excess (Schottenfeld & Fraumeni, 1996).

Colorectal Cancer

The factors involved in the etiology of colorectal cancer are genetics (familial history), polyps in the colon, ulcerative colitis, a history of inflammatory bowel disease and a diet high in fat and low in fiber has been considered the most important environmental risk factors (ACS, 1991). Rates are consistently higher in males than in females, for unknown reasons. Currently more than 3 percent of Utahns will be affected in their lifetime (UCR, 1996).

Prostate

In examining prostate cancer, we find that age is a major risk factor. This form of cancer is frequent among older men and its occurrence increases with age. The highest rates in prostate cancer have been recorded among the black population in the United States. Only in Utah do rates for this largely white population exceed those for a U.S. black population; reasons are unknown (Shottenfeld and Fraumeni, 1996). Prostate cancer is the most common cancer in Utah males. Currently nearly 6 percent will develop prostate cancer in their lifetimes. Other than age and race, the definitive etiology of prostate cancer remains elusive (UCR, 1996).

Breast Cancer

Breast cancer is the most common site of cancer among females (incidence and death) in the state of Utah. Currently more than 10 percent of Utah females will be affected in their lifetime (UCR, 1996). The most important demographic risk factor for female breast cancer is age. Hormones are also a factor in the female breast cancer etiology. Epidemiologic and experimental evidence suggests that estrogen makes an essential contribution to the development of breast cancer (Shottenfeld and Fraumeni, 1996). The risk of an American woman developing breast cancer during her lifetime is approximately 11%, with approximately 3-4% dying of the disease. Several factors appear to increase the risk of developing breast cancer, including family history, reproductive history, diet, hormone usage, and radiation exposure. Despite the recognition of these risk factors, approximately 70% of the women who develop breast carcinomas do not have any of these identifiable risk factors (Shottenfeld and Fraumeni, 1996, and Armstrong et al., 2000).

Breast cancer is presently the most common type of malignancy diagnosed among women in Utah and the United States. However, incidence rates for breast cancer among women in Utah

are approximately 10-15 percent lower than comparable nationwide rates (UCR 2000). It is also interesting to note that Utah women are less likely than women nationwide to have had a mammogram. In 1999, for example, approximately 67 percent of women 40 years of age and older reported ever having had a mammogram, compared with 74 percent of women nationwide (UCR 2000).

Study Limitations

The main area of study and sampling was conducted around the largest sand and gravel pit, Staker Parsons. A second operation, Brigham Sand and Gravel, is located on the east extremity of Staker Parsons and may be included in the sampling. Air sampling for Fife Rock Products was limited. Also, composition of the particulate matter collected was not analyzed for crystalline silica or heavy metals. In addition, sampling for VOCs and PAHs were not conducted. VOCs and PAHs can be released from asphalt production facilities and may lead to adverse health effects. PM_{2.5} values were not measured; these “fine particles” can penetrate deeper into the lung and may lead to adverse health effects.

Utah’s IBIS-PH was used to evaluate the occurrence of respiratory illness in Brigham City. The query was performed for the smallest area available, Brigham City. However, due to the small area and numbers, no rates for respiratory illness could be calculated.

CHILDREN’S HEALTH CONSIDERATIONS

ATSDR and the EEP recognize the unique vulnerabilities of infants and children. Children are at greater risk than adults from some environmental hazards. Children are more likely to be exposed to contaminants because they play outdoors, often bring food into contaminated areas, and are more likely to come into contact with dust and soil. Also, because their bodies are still developing, children can sustain permanent damage if toxic exposures to some contaminants occur during critical growth stages. Children's health was considered as part of this health consultation.

Although vapors released from the production of asphalt were not analyzed, children living near the asphalt operations in Brigham City may be exposed to airborne contaminants released by the asphalt production plant. Children may be more sensitive to the development of adverse health outcomes from this exposure. Children are still in their development phase and may not have developed some of the protective physiological mechanisms present in adults and may be more sensitive to the toxic effects of some of the compounds. In addition, children, who are smaller and have a higher rate of respiration, will receive higher doses of airborne contaminants relative to their body weight as compared to an adult exposed to the same concentration.

CONCLUSIONS

Residents of Brigham City who live near the Brigham City Sand and Gravel operations sites are exposed to airborne dust emissions.

Based on the data available, concentrations of Total Suspended Particulates (TSP) and respirable dust (PM₁₀) detected in ambient air samples from Brigham City pose no apparent public health hazard to the general population.

None of the cancers evaluated in Brigham City were significantly elevated when compared to the state of Utah. Due to the small area and numbers of cases, no rates for respiratory illness could be calculated.

RECOMMENDATIONS

UDOH recommends additional air sampling be conducted in Brigham City in residential areas near the asphalt production facilities during the summer months at a low height closer to the breathing zone of children and adults. EEP recommends that sampling should be done for VOCs, PAHs, semi-volatiles, carbon monoxide, nitrogen oxides and sulfur dioxides in Brigham City. In addition, since no analysis of the dust for crystalline silica was conducted, the EEP also recommends that an analysis for crystalline silica (total and respirable) in the dust be performed.

PUBLIC HEALTH ACTION PLAN

The UDOH will collaborate with DAQ to identify and obtain available resources to conduct additional air sampling and analysis of the samples. UDOH will evaluate the public health implications of any additional air sampling data.

The UDOH will continue to monitor cancer rates in Brigham City to assess if rates are increasing in residents living near gravel and asphalt production sites.

The UDOH will provide copies of this health consultation to residents living near the sites, and will provide residents with results of any additional investigations conducted by the UDOH.

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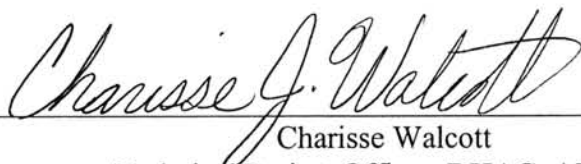
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CERTIFICATION

This Health Consultation, **Brigham City Sand and Gravel Pits, Brigham City, Box Elder County, Utah**, was prepared by the Utah Department of Health, Environmental Epidemiology Program under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by cooperative agreement partner.



Charisse Walcott
Technical Project Officer, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this Health Consultation and concurs with its findings.



Alan Yarbrough
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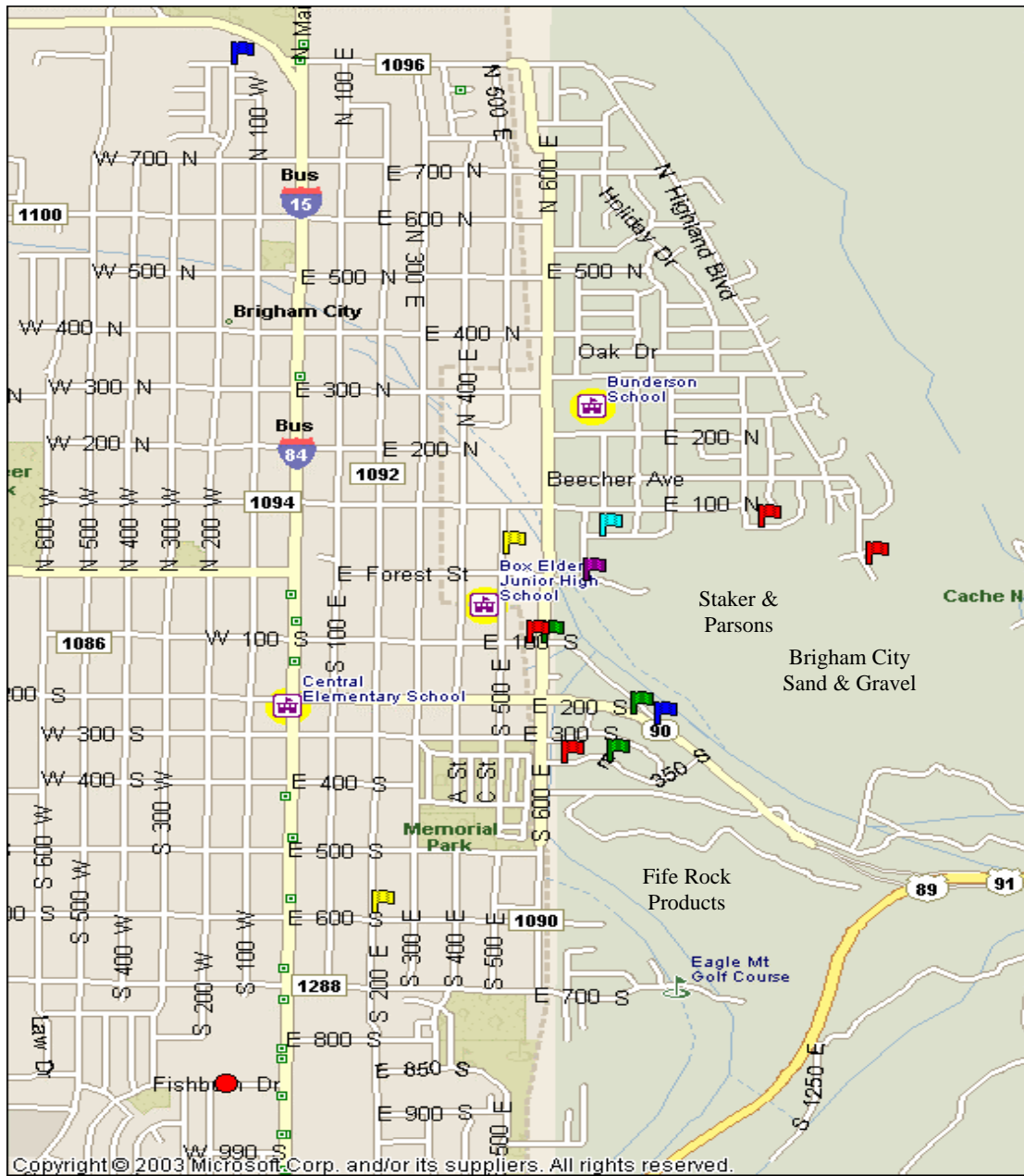
APPENDICES

Appendix A - Maps

Figure 1. Aerial view of Brigham City and Sand and Gravel Pits



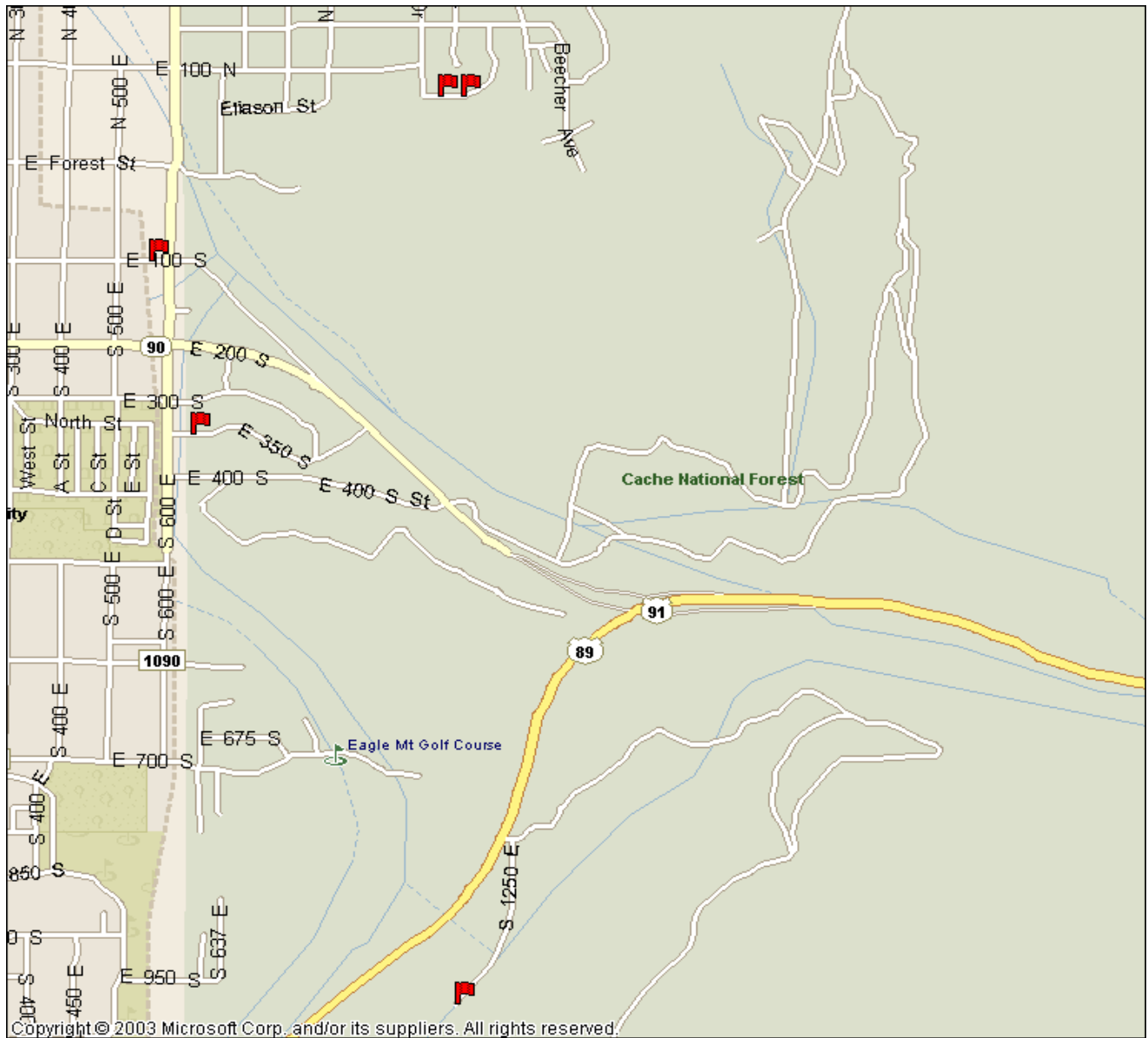
**Figure 2. Air Sampling Locations in Brigham City, Box Elder County, Utah.
1997, 1998, 1999 & 2004**



Sampling Site Locations

- Red flag = 2004 sampling site
- Dark Blue flag = 1999 sampling site
- Purple flag = 1998 & 1999 sampling sites
- Light blue flag = 1998 & 2004 sampling site
- Yellow flag = 1998 sampling site
- Green flag = 1997 sampling site
- Red dot = wind monitoring station

Locations of Air Monitoring Sites Brigham City, UT May – September, 2004



Red Flag = 2004 Sampling Site Locations

Appendix B - Statistical Calculations

STATISTICAL CALCULATIONS

Age-Adjustment Method (Standardized Incidence Ratios)

Standardized Incidence Ratios (SIR) were calculated using a statistical method applicable to both the direct and indirect age-adjustment or standardization methods. This method uses the age distribution of each population group and the age-specific rates for the standard population (state of Utah) to calculate the expected number of cancer cases if the rates of disease were constant as in the standard population. The observed number of incidences is then compared (divided) with the expected number of incidences in the study population (census tract 9607.02) and a ratio is derived, referred to as the SIR.

The formula for this ratio = $\frac{\sum p_{ia}n_{ia}}{\sum p_{is}n_{ia}}$

Where: a = area chosen as the study area (census tract 9607.02)

s = area chosen as a reference standard (state of Utah)

n_{ia} = number of individuals in ith class of study area

n_{is} = number of individuals in ith class of reference standard area

x_{ia} = number of cases in ith age class of area a (similarly for s)

p_{ia} = x_{ia}/n_{ia} = incidence rate in ith age class of area a (similarly for s)

(Harold A. Kahn and Christopher T. Sempos, "Statistical Methods in Epidemiology", Oxford University Press, 1989, pp 85-136.)

The confidence interval for the SIR is the range of values for a calculated SIR with a specified probability (95%) of including the true SIR value:

$$\frac{[\sqrt{n} \pm (1.96 \times 0.5)]^2}{x}$$

Where n is the Number of Observed.
 x is the Number of Expected.

(Frumkin, H., Kantrowitz, W. (1987) Cancer Clusters in the Workplace: An Approach to Investigation. *Journal of Occupational Medicine*, Vol. 29 (No. 12):949-952.)

The confidence interval is used as a surrogate test of statistical significance (p-value). Both the p-value function and the spread of the function can be determined from the confidence interval. The difference between the observed versus the expected is considered significant if the confidence interval for the SIR does not include one (1.0) and if the SIR is greater than one (1.0).

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Appendix C - Air Sampling Data

Table 1. Four-Year Air Sampling Comparison in Brigham City, Box Elder County, Utah: 1997, 1998, 1999 & 2004

	1997	1998	1999	2004
No. Sample Sites	3	4	3	5
No. PM ₁₀ Samples	8	13	28	16
Mean PM ₁₀ Conc. (24-hr)	14 µg/m ³	14 µg/m ³	32 µg/m ³	27 µg/m ³
Highest PM ₁₀ Conc. (24-hr)	21 µg/m ³	32 µg/m ³	63 µg/m ³	68 µg/m ³
No. PM ₁₀ violations	0	0	0	0
No. TSP samples	33	48	44	108
Average TSP Conc. (24-hr)	56 µg/m ³	65 µg/m ³	105 µg/m ³	64 µg/m ³
Highest TSP Conc. (24-hr)	349 µg/m ³	232 µg/m ³	238 µg/m ³	329 µg/m ³
No. TSP Exceedances	1	0	0	2
EPA Comparison Values:				
PM ₁₀ -The 24-hour ambient air standard is 150 µg/m ³				
TSP- The former 24-hour ambient air standard was 260 µg/m ³				

Table 2. Total Suspended Particulates (TSP) and Respirable Particulates (PM₁₀) Detected During Sampling Events in Brigham City, Box Elder County, May-Sept. 2004.

Date	Max. 1-hr. wind gust (mph)	Prevailing Wind Direction	Sampling Locations						
			TSP Level Detected (µg/m ³)						PM ₁₀ Level Detected (µg/m ³)
			765 E. Eliason	1118 E. Eliason	20 No. 1250 East	350 So. 738 E.	100 So. 525 E.	765 E. Eliason	
18-May-04	18.8	0	59	74	Not set up	Not set up	Not set up		
20-May-04	17.4	0	58	53	37	38	Not set up		
26-May-04	13.7	3	Void-battery	29	14	Filter torn	16		
02-Jun-04	13.1	1	3	Not accessible	10	12	Void-battery		
04-Jun-04	15.3	0	87	Not accessible	59	215	110		
08-Jun-04	21.6	0	329	114	294	90	Void-battery		
15-Jun-04	15.2	1	32	Not accessible	24	235	176		
23-Jun-04	8.3	0	61	23	46	20	41		
25-Jun-04	10.2	0	56	39	44	139	62		
28-Jun-04	22.4	3	40	39	41	Void-battery	130		
07-Jul-04	18.0	4	98	117	Sampler Removed	63	24	33	
13-Jul-04	12.4	3	120	Not accessible		55	136	18	
15-Jul-04	14.9	0	69	14		35	116	Void-battery	
20-Jul-04	14.3	3	15	18		227	37	20	
27-Jul-04	10.1	0	165	33		54	57	68	
29-Jul-04	10.7	0	160	51		32	60	42	
04-Aug-04	14.3	3	108	18		9	38	27	
10-Aug-04	5.9	3	208	22		57	54	58	
12-Aug-04	12.9	0	43	28		51	72	Filter torn	
25-Aug-04	16.0	3	39	40		95	52	9	
31-Aug-04	10.2	3	84	20		31	19	26	
02-Sep-04	15.2	1	95	44		164	37	32	
08-Sep-04	9.1	3	90	55		33	16	40	
14-Sep-04	12.0	3	11	17		29	23	10	
23-Sep-04	6.7	0	31	Not accessible		10	18	5	
25-Sep-04	7.7	0	44	32		11	20	8	
27-Sep-04	14.1	0	34	22	48	73	12		
29-Sep-04	9.3	1	41	29	17	28	17		

Entries in **bold** indicate levels that exceed the corresponding CV.

Table 3. Average Dust and Respirable Particulates Detected During Sampling Events in Brigham City, Box Elder County; 1997, 1998, 1999 & 2004.

Dust and Silica	Comparison Value (CV) ($\mu\text{g}/\text{m}^3$)	CV Source	Average Level Detected ($\mu\text{g}/\text{m}^3$)			
			Year of Sampling ‡ (approximately 24-hour samples)			
			1997	1998	1999	2004
Average TSP	260	EPA TSP	56	65	105	64
Respirable Dust	150	EPA PM-10 STD	14	14	32	27
‡ During each year of sampling we collected two types of samples: 1) total suspended particulates (TSP), and 2) respirable dust (PM_{10}). EPA TSP = Former EPA Standard for Total Suspended Particulates [EPA, 1998] EPA PM-10 STD = EPA Standard for 10 micron Particulates [EPA, 1998]						

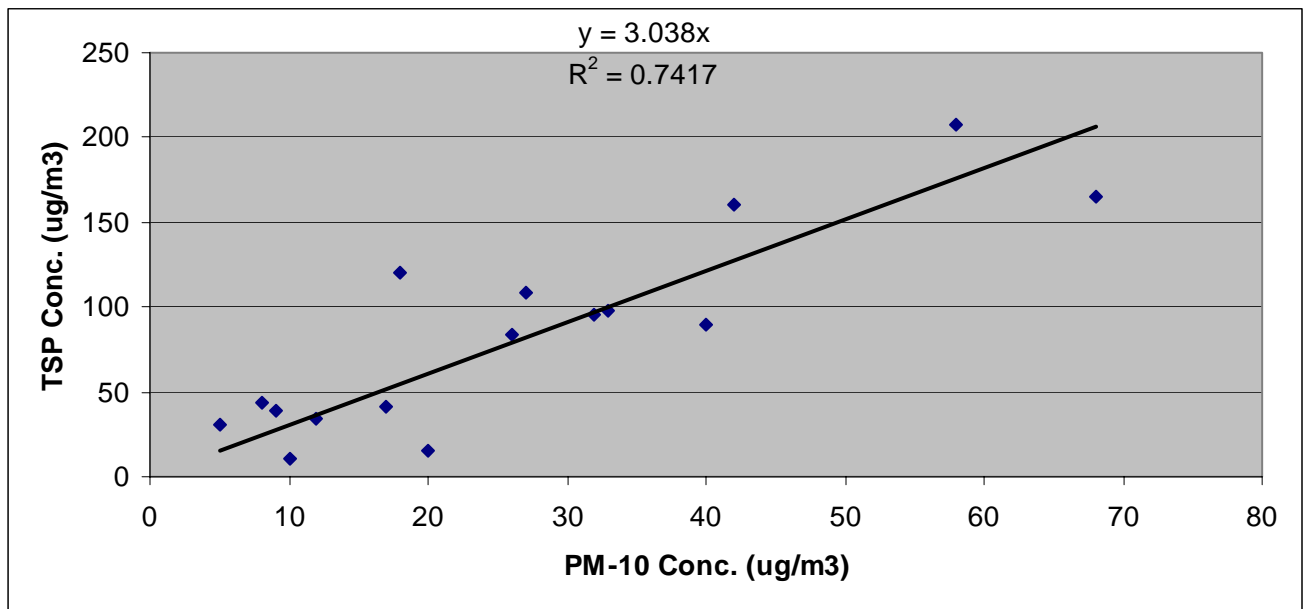
Table 4. Highest Concentration of Dust and Respirable Particulates Detected During Sampling Events in Brigham City, Box Elder County; 1997, 1998, 1999 & 2004.

Dust and Silica	Comparison Value (CV) ($\mu\text{g}/\text{m}^3$)	CV Source	Highest Level Detected ($\mu\text{g}/\text{m}^3$)			
			Year of Sampling ‡ (approximately 24-hour samples)			
			1997	1998	1999	2004
Average TSP	260	EPA TSP	349	232	238	329
Respirable Dust	150	EPA PM-10 STD	21	32	63	68
‡ During each year of sampling we collected two types of samples: 1) total suspended particulates (TSP), and 2) respirable dust (PM_{10}). EPA TSP = Former EPA Standard for Total Suspended Particulates [EPA, 1998] EPA PM-10 STD = EPA Standard for 10 micron Particulates [EPA, 1998]						

Table 5. Comparison of Total Suspended Particulates and Respirable Dust at Co-Located at 765 Eliason, Brigham City, Box Elder County, Utah

	PM ₁₀ (µg/m ³)	TSP (µg/m ³)
07-Jul-04	33	98
13-Jul-04	18	120
20-Jul-04	20	15
27-Jul-04	68	165
29-Jul-04	42	160
04-Aug-04	27	108
10-Aug-04	58	208
25-Aug-04	9	39
31-Aug-04	26	84
02-Sept-04	32	95
08-Sept-04	40	90
14-Sept-04	10	11
23-Sept-04	5	31
25-Sept-04	8	44
27-Sept-04	12	34
29-Sept-04	17	41
EPA Comparison Values: PM10 -The 24-hour ambient air standard is 150 µg/m ³ TSP- The former 24-hour ambient air standard was 260 µg/m ³		

**Graph 1. Comparison of TSP vs. PM-10 at Co-Located Site
Brigham City, Box Elder County, Utah
May-Sept. 2004**



Appendix D - Cancer Data

Presented are the number of observed cases, the number of expected cases, the Standardized Incidence Ratios, and 95 percent confidence intervals for cancer in census tract 9607.02 (Brigham City - 2000 Census) for each of the periods analyzed. The state of Utah was selected as the comparison population. Cancers presented are: *All sites, colon, breast, prostate, bladder and lung.*

The criteria established for determining a statistical significant difference in observed cases involved two statistical methods:

1. A Standardized Incidence Ratio greater than one (1.0).
2. A 95 percent confidence interval with limits that do not include one.

SIR means a Standardized Incidence Ratio.

Table 1. Five-year running statistical averages for the observed and expected number of cases, Standardized Incidence Ratios (SIR), Confidence Intervals (CI) (upper and lower 95% limits), and incidence rates (study and comparison) are presented for cancer from **All sites** in census tract 9607.02 (Brigham City) and Utah from 1992 – 2001 (2000 Census).

Five Year Periods	Observed Cases	Expected Cases	SIRs	Lower 95% CI	Upper 95% CI	Brigham City Rates	Utah Rates
1992 - 96	27	33	0.83	0.55	1.21	315.69	409.29
1993 - 97	23	32	0.72	0.46	1.08	269.15	405.17
1994 - 98	24	32	0.75	0.48	1.12	283.68	400.53
1995 - 99	31	32	0.96	0.65	1.36	383.07	403.83
1996 - 00	33	32	1.02	0.70	1.43	417.29	403.08
1997 - 01	38	32	1.17	0.83	1.61	482.63	402.48

Data Source: Utah Cancer Registry, 2001.

Incidence rates (study & comp) are the number of cases per 100,000 person years and are age-adjusted to U.S. 2000 standard population.

Table 2. Five-year running statistical averages for the observed and expected number of cases, Standardized Incidence Ratios (SIR), Confidence Intervals (CI) (upper and lower 95% limits), and incidence rates (study and comparison) are presented for **Colon** cancer in census tract 9607.02 (Brigham City) and Utah from 1992 – 2001 (2000 Census).

Five Year Periods	Observed Cases	Expected Cases	SIRs	Lower 95% CI	Upper 95% CI	Brigham City Rates	Utah Rates
1992 - 96	2	2	0.83	0.09	3.00	24.79	30.34
1993 - 97	2	2	0.85	0.10	3.08	24.93	29.69
1994 - 98	2	2	0.82	0.09	2.97	25.74	30.79
1995 - 99	3	2	1.26	0.25	3.67	38.36	30.21
1996 - 00	3	2	1.26	0.25	3.67	38.04	30.28
1997 - 01	3	2	1.29	0.26	3.76	37.72	29.57

Data Source: Utah Cancer Registry, 2001.

Incidence rates (study & comp) are the number of cases per 100,000 person years and are age-adjusted to U.S. 2000 standard population.

Table 3. Five-year running statistical averages for the observed and expected number of cases, Standardized Incidence Ratios (SIR), Confidence Intervals (CI) (upper and lower 95% limits), and incidence rates (study and comparison) are presented for **Lung** cancer in census tract 9607.02 (Brigham City) and Utah from 1992 – 2001 (2000 Census).

Five Year Periods	Observed Cases	Expected Cases	SIRs	Lower 95% CI	Upper 95% CI	Brigham City Rates	Utah Rates
1992 - 96	1	3	0.38	0.00	2.13	10.58	32.81
1993 - 97	1	3	0.39	0.01	215	12.88	32.56
1994 - 98	1	3	0.39	0.01	2.17	11.21	32.34
1995 - 99	1	3	0.39	0.01	2.17	11.50	32.43
1996 - 00	2	2	0.81	0.09	2.92	25.47	31.36
1997 - 01	3	2	1.24	0.25	3.62	37.07	30.83

Data Source: Utah Cancer Registry, 2001.

Incidence rates (study & comp) are the number of cases per 100,000 person years and are age-adjusted to U.S. 2000 standard population.

Table 4. Five-year running statistical averages for the observed and expected number of cases, Standardized Incidence Ratios (SIR), Confidence Intervals (CI) (upper and lower 95% limits), and incidence rates (study and comparison) are presented for **Breast** cancer in census tract 9607.02 (Brigham City) and Utah from 1992 – 2001 (2000 Census).

Five Year Periods	Observed Cases	Expected Cases	SIRs	Lower 95% CI	Upper 95% CI	Brigham City Rates	Utah Rates
1992 - 96	1	5	0.21	0.00	1.19	13.06	61.23
1993 - 97	1	5	0.21	0.00	1.18	13.01	61.57
1994 - 98	2	5	0.41	0.05	1.50	24.08	62.68
1995 - 99	5	5	1.02	0.33	2.38	65.80	63.07
1996 - 00	6	5	1.22	0.45	2.66	77.1	63.24
1997 - 01	5	5	1.00	0.32	2.34	64.38	63.95

Data Source: Utah Cancer Registry, 2001.

Incidence rates (study & comp) are the number of cases per 100,000 person years and are age-adjusted to U.S. 2000 standard population.

Table 5. Five-year running statistical averages for the observed and expected number of cases, Standardized Incidence Ratios (SIR), Confidence Intervals (CI) (upper and lower 95% limits), and incidence rates (study and comparison) are presented for **Prostate** cancer in census tract 9607.02 (Brigham City) and Utah from 1992 – 2001 (2000 Census).

Five Year Periods	Observed Cases	Expected Cases	SIRs	Lower 95% CI	Upper 95% CI	Brigham City Rates	Utah Rates
1992 - 96	7	7	0.95	0.38	1.96	83.81	90.09
1993 - 97	6	7	0.89	0.32	1.93	68.45	83.64
1994 - 98	6	6	0.94	0.34	2.05	69.95	79.63
1995 - 99	6	6	0.94	0.34	2.04	71.26	80.47
1996 - 00	7	6	1.09	0.44	2.25	89.07	81.06
1997 - 01	7	6	1.09	0.44	2.25	92.24	81.48

Data Source: Utah Cancer Registry, 2001.

Incidence rates (study & comp) are the number of cases per 100,000 person years and are age-adjusted to U.S. 2000 standard population.

Table 6. Five-year running statistical averages for the observed and expected number of cases, Standardized Incidence Ratios (SIR), Confidence Intervals (CI) (upper and lower 95% limits), and incidence rates (study and comparison) are presented for **Bladder** cancer in census tract 9607.02 (Brigham City) and Utah from 1992 – 2001 (2000 Census).

Five Year Periods	Observed Cases	Expected Cases	SIRs	Lower 95% CI	Upper 95% CI	Brigham City Rates	Utah Rates
1992 - 96	0	1	0.00	0	2.72	0.00	14.63
1993 - 97	1	1	0.75	0.01	4.16	10.88	16.78
1994 - 98	1	1	1.73	0.01	4.04	11.21	17.29
1995 - 99	2	1	1.40	1.16	5.06	27.44	17.91
1996 - 00	2	1	1.41	0.16	5.10	27.21	17.84
1997 - 01	3	1	2.13	0.43	6.24	39.54	17.74

Data Source: Utah Cancer Registry, 2001.

Incidence rates (study & comp) are the number of cases per 100,000 person years and are age-adjusted to U.S. 2000 standard population.