HEALTH CONSULTATION
Blood Lead Screening in Anniston, Alabama, August/September 2000>

EXPOSURE INVESTIGATION
Indian Wells and the Brimhall Sand and Gravel Company Site
BRIMHALL SAND AND GRAVEL COMPANY SITE
INDIAN WELLS, NAVAJO COUNTY, ARIZONA

OBJECTIVE

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted an Exposure Investigation to determine whether the residents of Indian Wells, Arizona, are exposed to airborne contaminants at levels of public health concern. The Indian Wells community is adjacent to the Brimhall Sand & Gravel Company site. ATSDR completed exposure investigations at six facilities similar to Brimhall and found substances related to gravel and asphalt production including volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and/or respirable dust (particulates) [1-5].

ATSDR and the Navajo Nation Environmental Protection Agency (NNEPA) collaborated to monitor ambient air concentrations of VOCs, PAHs, and crystalline silica from Brimhall's gravel and asphalt operations. The Indian Health Service (IHS) assisted in community outreach activities by setting up meetings with residents, providing tours of the surrounding area, and photographing site emissions.

BACKGROUND

The Brimhall Sand & Gravel Company is located in Indian Wells, Arizona. Brimhall produces gravel and asphalt on the site. The site is bound by unused agriculture land and foothills to the east, west, and south, and by a residence to the north. The asphalt plant is approximately 300 yards from the closest property in the residential area and approximately 500 yards from a tribal community center.

Brimhall's gravel processing involves dynamiting one of the Hopi Buttes. The gravel is stored in a series of large piles, which are sorted according to size. Brimhall uses the gravel, along with sand aggregate, lime, and bitumen, to prepare asphalt. The asphalt plant produces an average of 240 tons of asphalt per hour (tph), but can produce up to 300 tph. The operating permit allows the plant to operate between the hours of 7:00 am and 8:00 pm, Monday through Saturday. The asphalt operating season is approximately April through November, weather permitting (8 months) and the gravel handling operations continue all year.

The prepared asphalt is stored in an elevated storage bin, from which it is loaded onto dump trucks for transport to the work site. During preparation and storage, the asphalt mixture is maintained at hot temperatures, resulting in volatilization. The production plant has been fitted with a vacuum line to reduce the amount of vapor escaping into the atmosphere. However, vapors escape through loose fitting equipment during mixing and storage processes or when the asphalt is loaded onto dump trucks. Another potential VOC source is the exhaust from the heater engine.

RATIONALE

In July 2000, ATSDR received a petition from a Navajo family requesting a public health evaluation of the Brimhall site. Residents are concerned that dust and odors from the Brimhall site are adversely affecting their health. Because chemical-specific environmental data were not available for review at that time, ATSDR was unable to evaluate the public health significance of

potential ambient air exposures to nearby residents. To address the residents' concerns, ATSDR collected air samples and one soil sample.

TARGET POPULATION

Residents in the Indian Wells community who live adjacent to the gravel and asphalt operation are the primary focus of the investigation. The total potentially affected population is estimated to be 50 people. ATSDR received approval from one homeowner to sample air, and soil on the homeowner's private property.

ATSDR staff observed children playing in areas affected by the plume. Figure 1 shows an area near a swing set engulfed by the plume.The swing set is approximately 600 yards downwind of Brimhall's gravel piles (immediately to the right of the photo).

METHODS AND RESULTS

ATSDR conducted two sampling events, one in 2001 and one in 2002. Both were conducted near a resident's home located downwind of the facility. No control (i.e., upwind) samples were collected because electric power was not available to run the instrumentation at control locations (without a generator). However, because Brimhall is the only major operating plant for more than 50 miles, there will be little, if any, contribution of environmental contaminants from other facilities.

Air Sampling

- Volatile Organic Compounds (VOCs)

In July and August 2001, five air samples were collected and analyzed following the U.S. Environmental Protection Agency (EPA) method TO-14 for VOCs. (TO-14 is the name for a method used to test ambient air for toxic organic compounds.) A sample of ambient air was drawn into a SUMMA$^{Â®}$ canister through an 8-hour flow rate controlled opening. Samples were analyzed at a laboratory using gas chromatography/mass spectroscopy (GC/MS [ion trap]) with a cryogenically cooled trap to reduce the water vapor and concentrate the VOCs.

In 2001, a few VOCs were detected at trace levels. Carbon disulfide was detected once at 3.2 parts per billion by volume (ppb), which indicates that its distinctive sulfur smell is likely to be detected. Benzene, toluene, and methylene chloride were all detected at levels below 1 ppb, and acetone was detected at 3.8 ppb.

In September 2002, three air samples were collected and analyzed according to procedures consistent with the National Institute for Occupational Safety and Health (NIOSH) methods 1500, 1501, and 1003 for VOCs [7]. The sampling equipment consisted of a charcoal sorbent tube connected to a personal sampling pump. The sampling pumps were calibrated to collect approximately 1.5 liters of air through the sorbent tube and filter. The samples were collected over an 8-hour period (pre programmed into the samplers). No VOCs were detected (detection limits ranged from 0.4 to 4.9 ppb).

- Polycyclic Aromatic Hydrocarbons (PAHs)

In July and August 2001, five air samples were collected and analyzed according to procedures consistent with NIOSH method 5506 for PAHs. Samples were collected using a personal sampling pump and a filter head. The samples were collected over an 8-hour period (while the operations were occurring). The sampler head has two components: a polytetrafluoroethylene (PTFE) membrane to collect and retain particulate matter and a sorbent tube washed in XAD-2 resin to collect and retain gaseous phase compounds. Analytical detection procedures involved liquid chromatography and a fluorescence/ultraviolet detector. One PAH, acenaphthylene, was detected in 4 of the samples (ranging from 5-10 ppb).

In September 2002, three samples were collected and analyzed consistent with the modified NIOSH method 5515 for PAHs. The sampling equipment consisted of an XAD-2 sorbent tube and a PTFE filter connected to a personal sampling pump. The sampling pumps were calibrated to collect approximately 1.5 liters of air through the sorbent tube and filter. The samples were collected over an 8-hour period. No PAHs were detected (detection limits ranged from 1.9 to 6.1 ppb).

- Silica and Total Particulates

In July and August 2001, airborne particulates were collected using a sampling pump. The pump drew air through a tube connected to the specific collection device. Four samples for total suspended particulates were collected directly on a pre-weighed filter. Three samples were collected for respirable particulates, which were first separated by size with a cyclone separator. The cyclone separator captured particles that were 4.5 microns or smaller ("respirable"), and a pre-weighed filter collected the particles. Particulate measurements were made by weighing the filters (NIOSH method 0500), and then the particulate samples were analyzed for silica using x-ray powder diffraction (NIOSH method 7500). Samples were collected for 8-10 hours. Particulate monitors were attached to a data logger to characterize the peak particulate exposures.

For the 2001 sampling, the levels of total particulates detected were 10, 36, 25, and 2.7 micrograms per cubic meter (Âµg/m^3). Crystalline quartz was detected in two samples at 4 and 2 Âµg/m^3. Cristobalite and tridymite from the total particulate samples were both below the detection limit of 8 Âµg/m^3. The levels of respirable particulates detected were 20, 20, and 30 Âµg/m^3 (for each of the three days). In the respirable particulate samples, respirable cristobalite, tridymite, and quartz were all less than 8 Âµg/m^3 (the detection limit).

In September 2002, three particulate samples were collected and analyzed for silica and total particulates by NIOSH method 7500 (described previously). No quartz, cristobalite, or tridymite were detected in any of the samples (detection limit ranged from 8-20 Âµg/m^3). Respirable particulate was detected in one sample at 20 Âµg/m^3, but nothing was detected in the other two samples. Because of the concern for peak exposures to dust, two optical dust monitors (Data Ram-2000) were set up with a filter to record dust below 10 microns (PM10). These monitors showed average concentrations (19.7 Âµg/m^3) that agreed with the NIOSH samples (20 Âµg/m^3). The monitors recorded short-term peaks as high as 2207 Âµg/m^3 (instantaneous) and 280 Âµg/m^3 (15-minute average).

Soil Sampling

One surface (0-1 inch) soil sample was collected under the former swing set area and analyzed for silica, metals, and base/neutral and acid (BNA) compounds. For BNA analysis, the sample was spiked with a six-component surrogate mixture mixed with sodium sulfate, and the extract was concentrated and analyzed with GC/MS. The results indicated quartz was detected at 29%. Cristobalite and tridymite were not detected (detection limit 1%), nor were BNAs detected (detection limit 340 micrograms per kilogram [Âµg/kg]). All metals were within normal ranges for Arizona [8].

QUALITY ASSURANCE

By using at least one blank sample for each sampling method (or one for every 10 samples), ATSDR was able to ensure that none of the samples were contaminated during shipping or laboratory handling. All samples were compared to ensure confidence in the collection methods [9]. The collection times for some samples collected during the first sampling period were longer than the method recommended; however, the data are usable because the amounts of chemicals collected were minute. Therefore there was no chemical overloading on the samples which

sometimes reduces the ability to evaluate large quantities of chemicals. Accuracy of the analysis was evaluated via laboratory recovery data and instrument calibration results.

Sample collection, storage, and analysis description were documented on the chain-of-custody forms. The originals of these forms were sent to the laboratory with the samples. Copies of the chain-of-custody forms were made by ATSDR before shipment. The chain-of-custody forms are generated once a contract-laboratory has been contacted and the site-specific sampling media are identified (some laboratory-specific information needs to be entered before site work begins). Some minor errors in the chain-of-custody forms made it difficult to identify which sample was collected first during the 2001 sampling period.

CONFIDENTIALITY

At the request of the homeowner, this report will only be available to the participant homeowner and other federal, state, or local environmental or public health agencies. Confidentiality will be protected in accordance with federal and state laws [10].

DISCUSSION

Most of the VOC and PAH emissions are expected to be generated by the asphalt batch plant. Most of the respirable dust and crystalline silica are expected to be generated by the handling of gravel piles and the blasting of rock.

PAHs and VOCs from the Asphalt Plant

In July and August 2001, one PAH (acenaphthylene) was detected at levels ranging from 5-10 ppb. These levels are above typical ambient levels (<0.02 ppb), but are consistent with levels found in neighborhoods around similar asphalt sites [3-5]. Acenaphthylene is one of the least toxic of the PAHs [11]. No adverse health effects are anticipated at the levels of acenaphthylene detected near the Brimhall site. In addition, two VOCs were detected in 2001 (carbon disulfide and acetone) at levels below health guidelines and would not, therefore, be likely to result in adverse health effects [12, 13]. Benzene, toluene, and methylene chloride (all detected at less than 1 ppb) were also below levels of health concern [14-17].

Because the asphalt plant did not operate at peak levels during 2001, ATSDR returned in 2002 for a second sampling. In September 2002, samples were collected downwind of the asphalt batch plant both during operation and during a thermal inversion. On September 24, 2002, visible emissions were observed from the asphalt batch plant at 6:30 am during an inversion (see Figure 2). This time is 30 minutes earlier than the start time (7:00 am) allowed by the operating permit.

Overall, during the 2001 and 2002 sampling periods, VOC and PAH levels were at or below the detection limits. These values are consistent with data collected in other communities near asphalt plants [1-5]. No adverse health effects are anticipated.

Dust and Silica from the Gravel Pile

During all sampling periods, the wind was blowing from Brimhall toward the samplers and dust was observed (see Figure 3).

Monitoring and sampling data showed that respirable dust was less than 36 Âµg/m^3 per day (and averaged 20 Âµg/m^3 per day). EPA has a 24-hour average ambient air standard of 150 Âµg/m^3. ATSDR concurs with EPA that by maintaining the levels below 150 Âµg/m^3 for a day, the general population is protected. However, this guideline might not be entirely adequate to protect sensitive populations like people with asthma/bronchitis from exposures to short-term peak levels that could cause respiratory difficulty. The short-term peaks were as high as 2207 Âµg/m^3 (instantaneous) and 280 Âµg/m^3(15-min average). There are no peak exposure health guidance

levels. However, the measured peaks pose a potential for exposures that might cause some irritation and respiratory difficulty in sensitive populations.
Crystalline silica made up 29% of the total dust (typical of sand near similar sites), and crystalline silica (quartz) was detected in the respirable dust at trace levels. All levels were below levels that pose a public health hazard [18-20].
All metals were found at levels typical of this area. Arsenic, was found at 3 mg/kg in soil from the former swing set area. This level is comparable to the mean level of 6.5 mg/kg for this portion of Arizona. No adverse health effects are likely at these levels.
Figure 3: Visible Dust Emissions

Blasting of Rock
No blasting (detonation) occurred during either sampling period. Therefore, no samples exist to evaluate the impact of blasting activities. Because the gravel piles contain the same material that is in the rock and the airborne dust has been measured, it is reasonable to assume that blasting will produce greater amounts of the same material. Given that crystalline quartz was measured in the air at 2-4 Âµg/m^3 when the dust was 20-36 Âµg/m^3(from the facility and not detected when the wind was not blowing from the facility [however only one sample was collected]) it is possible that the peak quartz levels might measure as high as 50 Âµg/m^3 downwind during blasting (or 250-450 Âµg/m^3 of respirable dust).[(1)] Although expected to occur for periods less than an hour, this concentration is equal to NIOSH's permissible exposure limit (PEL) for workers during an 8-hour day.
LIMITATIONS
The ambient concentrations measured during of the investigation are the only data collected from this site. Long-term average concentrations may be different and peak maximum concentrations are likely to be higher (such as on very windy days and during blasting). However, no dust measurements were collected during blasting. And the dusty conditions observed while sampling (see Figure 3) were not as severe as those seen in Figure 1 when no sampling occurred.
CONCLUSIONS
Residents of Indian Wells who live downwind of the Brimhall Sand & Gravel Company site are exposed to airborne emissions. On the basis of limited ambient air and soil sampling conducted near the Brimhall site during July and August 2001 and in September 2002, ATSDR concludes the following:

1. Conservative calculations suggest that peak dust emissions from blasting could approach levels of public health concern. Concentrations of respirable dust and crystalline silica measured near a residence in Indian Wells could pose an indeterminant (short-term) public health hazard. Some peak concentrations were measured that, if sustained, could cause respiratory irritation in sensitive individuals. Peak concentrations could be higher than the levels recorded because the dust observed during sampling was not as intense as the dust observed when no measurements were made.
2. Concentrations of PAHs, VOCs, respirable dust, and crystalline silica detected in ambient air samples from a residence in Indian Wells pose no chronic (i.e., long-term) public health hazard. Measurements were made while the facility was operating, and samples were collected downwind from the facility. Although, short-term (acute) exposures are occasionally higher, the average long-term exposure levels will be lower and not likely to result in chronic adverse health effects.

3. Concentrations of PAHs and VOCs detected in ambient air samples from a residence in Indian Wells pose no apparent acute (i.e., short-term) public health hazard. The concentrations of PAHs and VOCs are below levels known to result in adverse health effects. And, although it is unlikely that the samples were collected during a worst-case event, the concentrations detected directly downwind were low enough to indicate that these chemicals are unlikely to approach hazardous levels even during peak emissions.
4. Concentrations of metals, including arsenic, in a soil sample collected near a residence in Indian Wells are unlikely to result in adverse health effects at the levels detected.
5. During the September 2002 sampling, the asphalt batch plant operated earlier in the day than is allowable by permit.

RECOMMENDATIONS

1. Use effective dust suppression techniques, such as wetting surfaces, reducing pile size, constructing erosion fences, and reducing operations during windy days to reduce the short-term impact of dust emissions that might cause respiratory discomfort [21, 21].
2. Plan the blasting periods when the wind is blowing away from the community to prevent unnecessary quartz exposures.
3. Restrict all operations until after sunrise on calm days to protect from emission-trapping inversions. The current operating permit (later than 7:00 am) should prevent operating during most inversions; however, sunrise occurs later than 7:00 am, in the spring and in the late summer.

PUBLIC HEALTH ACTION PLAN

The actions described in this section are designed to ensure that this exposure investigation identifies public health hazards and provides a plan of action to mitigate and prevent adverse health effects resulting from exposure to hazardous substances in the environment.

Completed Actions

- July 2001 â€“ATSDR staff trained NNEPA staff to collect ambient air samples.
- July to September 2001 â€“NNEPA staff collected ambient air samples.
- September 2002 â€“ATSDR staff collected ambient air, surface wipe, and soil samples.

Ongoing Actions

- IHS staff will continue to investigate and record the health concerns of the Indian Wells community.
- ATSDR is discussing dust control measures with NNEPA and Brimhall

Planned Actions

- NNEPA will ensure that prudent dust control strategies are being practiced by Brimhall and that Brimhall is operating within their permit restrictions.

PREPARERS OF REPORT

Greg Zarus
Atmospheric Scientist
Exposure Investigation and Consultation Branch
Division of health Assessment and Consultation
Agency for Toxic Substances and Disease Registry
Danielle Langmann
Environmental Health Scientist
Exposure Investigation and Consultation Branch

Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Reviewed by:
Susan Metcalf
Chief, Exposure Investigations Section
Exposure Investigations and Consultation Branch
Division of Health Assessment and Consultation
John Abraham, PhD.
Chief, Exposure Investigations and Consultation Branch
Division of Health Assessment and Consultation

REFERENCES

1. Agency for Toxic Substances and Disease Registry. CAL Met exposure investigation, Mission Valley, CA. Atlanta: US Department of Health and Human Services; 1999.
2. New York Department of Health and Agency for Toxic Substances and Disease Registry. Prima asphalt exposure investigation, Suffolk, NY. Atlanta: US Department of Health and Human Services; 2002.
3. Agency for Toxic Substances and Disease Registry. Stansbury Park asphalt exposure investigation, Salt Lake, UT. Atlanta: US Department of Health and Human Services; 2001.
4. Utah Department of Health and Agency for Toxic Substances and Disease Registry. Spanish Valley asphalt exposure investigation (protocol), Tooele, UT. Salt Lake City, UT. Atlanta: US Department of Health and Human Services; 2001.
5. Agency for Toxic Substances and Disease Registry. Salisbury asphalt exposure investigation (protocol), Rowan, NC. Atlanta: US Department of Health and Human Services; 2001.
6. Agency for Toxic Substances and Disease Registry. Exposure investigation of asphalt and dust emissions (protocol), Navaho Nation, Indian Wells, AZ. Atlanta: US Department of Health and Human Services; 2001.
7. National Institute for Occupational Safety and Health. Analytical methods compendium of methods, Department of Health and Human Services (NIOSH). 1994. Publication 94-113 (August 1994). http://www.cdc.gov/niosh/nmam/
8. Shacklette HT, Boerngen JG. Element concentrations in soils and other surficial materials of the conterminous United States. US Geological Survey Professional Paper 1270. Washington, DC: Government Printing Office; 1984.
9. Environmental Protection Agency. Quality assurance/quality control guidance for removal activities. Sampling QA/QC plan and data validation procedures. Washington, D.C.: US Environmental Protection Agency, Office of Emergency and Remedial Response; 1990. EPA/540/G-90/004
10. US Department of Justice. Privacy Act of 1974. The Office of Information and Privacy in coordination with the Office of Management and Budget. House Comm. on Gov. Operations and Senate Comm. on Gov. Operations, 94th Cong., 2nd Sess., S. 3418

    (Public Law 93-579) 1974. http://www.usdoj.gov/04foia/04_7_1.html

11. Agency for Toxic Substances and Disease Registry. Toxicological profile for polycyclic aromatic hydrocarbons (update). Atlanta: US Department of Health and Human Services; 1995.
12. Agency for Toxic Substances and Disease Registry. Toxicological profile for carbon disulfide (update). Atlanta: US Department of Health and Human Services; 1996.
13. Agency for Toxic Substances and Disease Registry. Toxicological profile for acetone. Atlanta: US Department of Health and Human Services; 1994.
14. Environmental Protection Agency. National air quality and emissions trends report. Research Triangle Park, NC: Environmental Protection Agency; 1998.
15. Environmental Protection Agency. Ambient air benzene concentrations in 39 U.S. cities, 1984-1986. Research Triangle Park, NC: Environmental Protection Agency; 1987.
16. Agency for Toxic Substances and Disease Registry. Toxicological profile for benzene (update). Atlanta: US Department of Health and Human Services; 1997.
17. Environmental Protection Agency. Health effects assessment summary tables. Research Triangle Park, NC: US Environmental Protection Agency; 1974. EPA-540-R-97-036.
18. Environmental Protection Agency Ambient levels and noncancer health effects of inhaled crystalline and amorphous silica; Research Triangle Park, NC: US Environmental Protection Agency. November 1996EPA/600/R-95/115.
19. NIOSH 1997. National Institute for Occupational Safety and Health. *NIOSH Pocket Guide to Chemical Hazards.* U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention.
20. Calvert GM et al. Occupational silica exposure and risk of various diseases: an analysis using death certificates from 27 states of the United States. National Institute for Occupational Safety and Health. Occupational and Environmental Medicine. 2003;60:122-129. http://oem.bmjjournals.com/cgi/content/abstract/60/2/122 .
21. Jutze GA, et al. Investigation of fugitive dust sources emissions and control. Research Triangle Park, NC: US Environmental Protection Agency; 1974. EPA-45013-74-036a.
22. Cowherd C Jr., et al. Development of emission factors for fugitive dust sources. Research Triangle Park, NC: US Environmental Protection Agency; 1974. EPA-45013-74-03.