Health Consultation

AGUA FRIA MINING OPERATION

SUN CITY WEST, MARICOPA COUNTY, ARIZONA

Prepared by

Arizona Department of Health Services
Office of Environmental Health
Environmental Health Consultation Services

Summary

INTRODUCTION

In the *Agua Fria Mining Operation* health consultation, The Arizona Department of Health Services' (ADHS') top priority is to ensure that the community and residents have the best information possible to safeguard their health.

This report was written in response to a request from the Maricopa County Joint Environmental Task Force (JETF). They have concerns regarding high dust levels associated with the open mining operations along the Agua Fria River along the northwest corridor of Maricopa County. They believe that it may be linked to the high incidences of valley fever, and high death rates from lung cancer, cardiovascular and heart diseases in Sun City and Sun City West. The JETF alleges that the PM_{10} (particulate matters less than 10 micrometers in diameter) contains diesel smoke, particulates, carbon monoxide, nitrogen dioxide, sulfur dioxide and volatile organic compounds. There is a temporary PM_{10} air monitoring station is located on the Coyote Lake Golf Course near the mines. Another expressed concern is that the cement dust may contain chromium, cadmium and other heavy metals, even though there has been no speciation of the PM_{10} data to confirm or deny what is contained in the visible dust being emitted from the mining operations. The JETF also believes that when cement is being loaded onto the various trucks, the elevated PM_{10} must come from the cement dust and that it must be floating around the neighborhoods. With these plants in this area, they are concerned about the possibility of exposure to cement and fugitive dust along with unknown types and amounts of VOCs. This health consultation to evaluate the potential health effects associated with particulate matter exposures.

In conducting this health consultation, ADHS reviewed the available PM_{10} data, reviewed the literature concerning the concentrations of particulate matters found, compared the reported levels to acceptable comparison values, evaluated the potential exposure pathways and the duration of exposure, and considered the characteristics of the exposed population. ADHS also reviewed some health status indicators published by the Maricopa County Department of Public Health.

CONCLUSIONS & BASIS FOR DECISIONS

ADHS concludes the following:

- *Potential Public Health Hazard for short-term exposure* (usually over a 24-hour period, but possibly as short as one hour): The monitoring data shows that the levels of PM_{10} detected at the Coyote Lake monitoring station exceeded the NAAQ standard occasionally. High levels of PM_{10} could harm the health of certain sensitive population. During high PM_{10} events, certain sensitive populations are susceptible

to more serious symptoms, including cough, phlegm, wheezing, shortness of breath, bronchitis, increased asthma attacks, and aggravation of lung or heat disease. Consequently, increasing numbers of emergency visits may be observed.

- *Indeterminate Public Health Hazard for long-term exposure*:

  Following the WHO assumption, the prediction suggested that there could be a public health hazard. However, the prediction may over- or under-estimate the actual risk due to local geography, meteorology and specific PM sources. Also, the detected PM_{10} concentrations may not fully represent the typical concentrations in area of high population density due to the size of the monitoring station.

  Increased and decreased age adjusted death rates due to different health indicators have been observed. Yet, based on the available information, we cannot conclude the higher or lower age-adjusted rates are associated with the PM exposures. ADHS feels that additional information such as actual $PM_{2.5}$ concentrations are necessary before a public health conclusion can be made.

- Insufficient monitoring data are available to comment on exposure to the chemical components of air pollution (i.e. metals, VOCs, etc).
- Valley Fever: ADHS' surveillance system discovered that 2007 age adjusted rates of reported coccidioidomycosis (a.k.a. "cocci") is statistically higher in the Northwest Valley (NWV). However, after investigation, the CDC's EpiAid Team found that the reported cocci incidence from the surveillance data might not have been accurate due to artifacts such as increased provider awareness, increased testing frequency and snowbird effects. They determined that likely a combination of factors distorts the true incidence of cocci in the northwest valley. These limitations for the investigation were: (1) in general, data used were existing data and are subject to the limitations of each study, (2) the commercial lab data may not be representative of the entire state of Arizona, and (3) the canine lab data may not be representative due to the influence of socioeconomic status of dog health care seeking behaviors and dog licensing practices

To ensure the safety of the public , ADHS provided the following recommendations to the Maricopa County:

NEXT STEPS

- It is important to develop a comprehensive sampling plan/network to continue monitor PM_{10} and start to monitor $PM_{2.5}$, which is critical in determining long-term health effects associated with PM exposures. The Maricopa County Air Quality Department indicated that they are

currently seeking a permanent site within the area to measure typical concentrations in area of high population density.

- Currently the Maricopa County Air Quality Department does not have the ability to conduct PM speciation monitoring. ADHS encourages them to develop such ability since the levels of metal, other inorganics, and ionic species are important parameters for evaluating health concerns. The Maricopa County Air Quality Department is developing the ability to perform VOC monitoring and analysis with the Mobile Air Monitoring Vehicle.
- Continue to issue warnings on days when levels of air pollution are expected to reach potentially unhealthy levels and to communicate these warnings to the local media. Residents are encouraged to heed these warnings, which generally recommend residents, especially persons with respiratory conditions, to remain indoors and to avoid moderate levels of exercise as much as possible. By following these precautions, residents can protect themselves from air pollution in the area as it occasionally reaches potentially unsafe levels.
- To minimize the amount of particulate matter released to the air, effective air pollution/dust control measures should be developed/initiated/enforced. The Maricopa County Air Quality Department is developing, initiating and enforcing more effective air pollution (including dust) control measures in the area and in the entire county.
- Continue to monitor valley fever cases in the area.

FOR MORE INFORMATION

If you have concerns about your health, you should contact your health care provides. Please call ADHS at 602-364-3128 and ask for more information on the Agua Fria Mining site.

Purpose

The co-chair of the Maricopa County Joint Environmental Task Force (JETF) contacted the Arizona Department of Health Services (ADHS) to express their concerns regarding high dust levels associated with the open mining operations along the Agua Fria River along the northwest corridor of Maricopa County. They expressed concern that the dust contains diesel smoke, volatile organic compounds (VOCs) and heavy metals such as chromium and cadmium. This health consultation aims to provide an evaluation regarding potential health effects related to particulate matter exposures.

Background

Site Description: The mining operations are located in three separate areas along an 8-mile stretch of the Agua Fria River Basin. The area is contained between the Happy Valley Road to the north, the Highway 303 loop to the north west, the El Mirage Road (aka Loop 303) to the south west, North 107th Avenue to the east and Grand Avenue (aka Highway 60) to the south. Appendix A, Figure 1A-C shows the locations of the open pit mines in relation to the surrounding neighborhoods. According to the Maricopa County Air Quality and the Arizona Department of Environmental Quality Air Quality Division, there are 28 separate operations being conducted among the 15 companies operating at 11 different addresses along the eight-mile stretch of the Agua Fria River. The operations include 11 concrete batch plants, 4 asphalt batch plants, 12 crushing and screening operations, and 1 mining operation. Appendix B summarizes the various companies and their operation in the Agua Fria River Basin.

Demographics: Sun City and Sun City West are active adult (55 and older) residential retirement communities constructed in the 1970s by a private investor. As of the 2000 Census, there were 38,309 and 26,344 people residing in Sun City and Sun City West, respectively. In Sun City and Sun City West, the population is concentrated in the post-retirement years and the majority of the population is White (66.6%).

Table1. Population statistics for Sun City and Sun City West, AZ (US Census 2000)

Characteristic	Sun City & Sun City West		Maricopa County		US	
	Number of people	% of distribution	Number of people	% of distribution	Number of people	% of distribution
Age Distribution						
< 20 years old	0	0	916,924	29.9	80,473,265	28.6
20 – 44 years old	1,587	2.0	1,188,680	38.7	104,004,252	36.9
45 – 64 years old	13,486	17.0	607,566	19.8	61,952,636	22.0
> 65	64,256	81.0	358,979	11.6	34,991,753	12.4
Total Population	79,329		3,072,149		281,421,906	

Statement of Issues: The Maricopa County JETF expressed their concerns regarding the occurrence of valley fever, cardiovascular disease and lung cancer in their communities. Valley fever (Coccidioidomycosis) is primarily a disease of the lungs that is common in the southwestern United States and northwestern Mexico. It is caused by the fungus *Coccidioides sp*., which grows in soils in areas of low rainfall, high summer temperatures, and moderate winter temperatures. These fungal spores become airborne when the soil is disturbed by winds, construction, farming and other activities. Some community members believe these effects are related to exposure to air pollutants coming from the mining operation and high dust levels.

The JETF also alleges that the contributors to the high rates are the particulate matter (PM) air pollution from the generators that run the operations, the equipment to mine and move the stone and earth to the screening, crushing and processing plants, and the trucks used to haul the final product offsite. They believe that the PM_{10} (particles less than 10 micrometers in diameter) data collected from a monitoring station near one of the mines demonstrates the connection. They believe that the PM_{10} contains diesel smoke, particulates, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and volatile organic compounds (VOCs). The PM_{10} air monitoring station is located on the Coyote Lake Golf Course near the mines. Another expressed concern is that the cement dust may contain chromium, cadmium and other heavy metals, even though there has been no speciation of the PM_{10} data to confirm or deny what is contained in the visible dust being emitted from the mining operations. The JETF also contends that when cement is being loaded onto the various trucks, the elevated PM_{10} must come from the cement dust and that it must be floating around the neighborhoods. With these plants in this area, they are concerned about the possibility of exposure to cement and fugitive dust along with unknown types and amounts of VOCs.

Background Information of Particular Matter: Airborne particulate matters represent a complex mixture of organic and inorganic substances such as dust, pollen, soot, smoke and liquid droplets. These particles vary in size, composition and origin. They are classified by the aerodynamic properties (size) because size determines the transport and removal of particles from the air and their deposition within the respiratory system, and is partly associated with the chemical composition and sources of particles. Based on size, the US Environmental Protection Agency (EPA) groups particle pollution into two categories:

- "Inhalable coarse particles," such as those found near roadways and dust industries, are larger than 2.5 micrometers (μm) and smaller than 10 μm in diameter.
- "Fine particles," such as those found in smoke and haze, are 2.5 μm in diameters and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries, and automobiles react in the air.

PM_{10} is used to describe particles with an aerodynamic diameter smaller than 10 μm. It includes both the coarse and fine particles. The particles contained in the PM_{10} size fraction may reach the upper part of the airways and lung. Smaller particles (in particular $PM_{2.5}$: particles with an aerodynamic diameter smaller than 2.5 μm) penetrate more deeply into the lung and may reach the alveolar region.

General Assessment Methodology: ADHS generally follows a two-step methodology to comment on public health issues related to environmental exposures. First, ADHS obtains representative environmental data for the site of concern and compile a comprehensive list of site-related contaminants. Second, ADHS used health-based comparison values to identify those contaminants that do not have a realistic possibility of causing adverse health effects. For the remaining contaminants, ADHS reviews recent scientific studies to determine if the extent of environmental contamination indicates a public health hazard.

Discussion

Available Environmental Data for the Site: ADHS evaluated the available environmental sampling information for potential exposure at the Agua Fria Basin. ADHS was provided with: (1) PM_{10} air monitoring results by the Maricopa County Air Quality Division; (2) Air Permit Evaluation Sheet for Lafarge North America. Neither of the data set contains analytical results for volatile organic compounds or metals. Thus, potential health effects associated with VOC or metal exposures cannot be evaluated.
The Lafarge North America is a crushing, screening, and hot mix asphalt plant. According to Maricopa County Air Quality Division, the Lafarge North America facility is located at 21209 W Beloat Rd, Buckeye, AZ 85326, which is approximately 30 miles away from Sun City. Therefore, this evaluation report cannot be used to represent the amount of air pollutants emitted into the air in the greater Sun City area although there are four similar plants in the area.

Daily PM_{10} data

Since April 2007 the Maricopa County Air Quality Division has been conducting PM_{10} air monitoring in the Agua Fria River Basin. The short-term monitoring activity was prompted by complaints from the Sun City and Sun City West community members. The complaints have been ongoing since 2000 when the mining operations along an eight-mile stretch of the Agua Fria River were expanded.

Daily PM_{10} data has been collected on an hourly basis by the Maricopa County Air Quality Division. The air samples are collected from the Coyote Lakes monitoring station located at 115th Avenue and Union Hills Road in the middle of the Agua Fria River Basin next to the mining operations. The monitoring station is on the edge of Sun City and less than 1 mile away from the Sun City West. According to the Maricopa County Air Quality Report, the wind directions and speeds were monitored but the data did not meet federal regulations and is therefore not official and is not entered into database. According to the Maricopa County's website, the prevailing wind direction in the winter comes from the northwest and in the summer comes from the south (http://www.fcd.maricopa.gov/Education/monsoon.aspx, See Appendix A, Figure 2). The air monitoring data represent the PM_{10} concentrations immediately downwind from the mining operations and the ambient PM_{10} levels at the edges of the Sun City and Sun City West. Table 2 summarizes the air monitor sampling results collected from 4/1/2007 to 1/31/2008.

Table 2. Summary for particulate matter 10 (PM_{10}) data collected from April 1st, 2007 to January 31st, 2008.

Month	Number of Samples	Range of 24-hour Average Concentrations ($\mu g/m^3$)	Monthly Average Concentration ($\mu g/m^3$)	10-month Average Concentration ($\mu g/m^3$)
04/2007	717	15.4 – 118.8	50.7	
05/2007	737	16.7 – 86.0	47.2	
06/2007	716	25.0 – 125.0	54.2	
07/2007	737	10.6 – 273.5	52.5	
08/2007	741	19.3 – 121.5	46.0	
09/2007	715	18.6 – 111.8	41.9	
10/2007	739	25.7 – 312.9	61.2	
11/2007	714	16.1 – 103.0	59.0	
12/2007	737	7.2 – 55.2	20.3	
01/2008	737	5.5 – 89.0	22.6	
Summary	7,290	5.5 – 312.9	——	45.5

Exposure Pathway Analysis: Identifying exposure pathways is important in a health consultation, because presence of a contaminant in the environment does not necessarily mean that people are actually coming into contact with that contaminant, thereby allowing the contaminant to be a threat to public health. Exposure pathways have been divided into three categories: completed, potential, and eliminated. There are five elements considered in the evaluation of exposure pathways:

- a source of contamination,
- a media such as soil or air through which the contaminant is transported,
- a point of exposure where people can contact the contaminant,
- a route of exposure by which the contaminant enters or contacts the body; and
- a receptor population

Completed pathways exist when the five elements are present and indicate that exposure to a contaminant has occurred in the past and/or is occurring presently. In a potential exposure pathway, one or more elements of the pathway cannot be identified, but it is possible that the element might be present or might have been present. In eliminated pathways, at least one of the five elements is or was missing, and will never be present. Completed and potential pathways, however, may be eliminated when they are unlikely to be significant. Identifying an exposure pathway does not admit the presence or concentration of potential contaminants; it is simply a way of determining the possibility of exposure as if the contaminants were present in the medium. Table 3 shows the exposure pathways for this site. If one or more of the exposure

pathways are potential or complete, ADHS then considers whether exposure to the chemicals present may be harmful to people.

Table 3. Exposure pathway evaluation

Exposure Pathway Elements					Time Frame	Type of Exposure Pathway
Source	Media	Point of Exposure	Route of Exposure	Estimated Exposed Population		
Fugitive dust from mining operations; Emission from traffic and factories	Air	Ambient Air	Inhalation	People who live/work in Sun City and Sun City West	Past	Completed
					Current	Completed
					Future	Potential

Comparison to the health-based comparison values: The health-based comparison values are screening tools used with environmental data relevant to the exposure pathways. The health-based comparison values are concentrations of contaminants that the current public health literature suggest are "safe" or "harmless". These comparison values are quite conservative, because they include ample safety factors that account for most sensitive populations. ADHS typically uses comparison values as follows: if a contaminant is never found at level greater that its CV, ADHS concludes the levels of corresponding contamination are "safe" or "harmless". If, however, a contaminant is found at levels at greater than its comparison value, ADHS designates the pollutant as a contaminant of interest and examines potential human exposures in greater detail. Comparison values are based on extremely conservative assumptions. Depending on site-specific environmental exposure factors (e.g. duration and amount of exposure) and individual human factors (e.g. personal habits, occupation, and/or overall health), exposure to levels greater the comparison value may or may not lead to a health effect. Therefore, the comparison values should not be used to predict the occurrence of adverse health effects.

As shown in Table 4, the detected hourly PM_{10} levels ranged from 0 to 4198.6 micrograms per cubic meter of air ($\mu g/m^3$), and the 24-hour average PM_{10} levels ranged from 5.5 to 312.9 $\mu g/m^3$. ATSDR does not have any comparison value for PM_{10}. US EPA and World Health Organization (WHO) have standards/guidelines for PM_{10}. Two of the reported 24-hour PM_{10} average exceeded the US EPA National Ambient Air Quality Standard (NAAQS) 24-hour PM_{10} standard of 150 $\mu g/m^3$. One hundred and twelve (112) of the reported 24-hour PM_{10} average exceeded the WHO 24-hour PM_{10} guideline of 50 $\mu g/m^3$. The 10-month average PM_{10} level exceeded the WHO annual PM_{10} guideline of 20 $\mu g/m^3$ (see Table 4).

Table 4. Detected 24-hour and monthly average particulate matter 10 (PM_{10}) concentrations and their comparison values

Range of 24-hour average concentrations (μg/m^3)	Number of samples	EPA 24-hour PM_{10} standard (μg/m^3)	Number of samples exceeded EPA 24-hour PM_{10} Standard	WHO 24-hour PM_{10} standard (μg/m^3)	Number of samples exceeded WHO 24-hour PM_{10} standard
5.5 – 312.9	7,290	150	2	50	112

Range of monthly average concentrations (μg/m^3)	Number of samples	10-month average concentration (μg/m^3)	EPA annual PM_{10} standard (μg/m^3)	WHO annual PM_{10} standard (μg/m^3)	Does it exceed WHO annual PM_{10} standard
20.3 – 61.2	10	45.5	Not available	20	Yes

Public Health Implication

Short-term Exposure

Short-term (usually over a 24-hour period, but possibly as short as one hour) exposure to particulate matters has been linked to a number of health outcomes, from respiratory issues that come and go to emergency room visits and hospital admissions to increased risk of death. There is also increasing evidence to show that adverse effects are not only on the respiratory system, but also on the cardiovascular system (Samet et al. 2000 a,b; Zanobetti and Schwartz 2003). These studies generally appear to confirm likely excess risk of cardiovascular disease-related hospital admission for US cities in the range of 2 to 9% per 50 μg/m^3 PM_{10}, especially among the elderly (≥ 65 years old). Recent epidemiologic studies (Samet el at. 2000a; Katsouyanni et al. 2001; Cohen et al. 2004; Mar et al. 2000, 2003) provided evidence of positive associations for total non-accidental mortality (total deaths minus those from accident/injury) with PM_{10}. The findings of these studies suggested that the health risks associated with short-term exposures to PM_{10} are likely to produce an increase in total non-accidental mortality of around 0.5% for each 10 μg/m^3 increment in the daily concentration. Therefore, a PM_{10} concentration of 150 μg/m^3 would be expected to translate into a roughly a 5% increase in daily mortality. Significant associations have been reported with respiratory hospital admissions in several Canadian studies, where the reported mean concentrations ranged from 6 to 12 μg/m^3 and maximum concentrations from 25 to 68 μg/m^3 (Yang et al. 2004; Chen et al. 2004, 2005; Lin et al. 2002, 2005). In addition, the elderly are more vulnerable to the effects of exposure to air pollution due to changes with age in the body's ability to remove chemicals and repair damage. They are more likely to have pre-existing lung and heart diseases. Exposure to PM_{10} can worsen the conditions

of people with pre-existing heart or lung disease. It can also aggravate the frequency and severity of attacks among asthmatics. The air monitoring data suggested that 24-hour average concentration of PM_{10} periodically exceeded the health-based standards and has the potential to do so in the future. For short term exposure, this indicates that the nearby residents may see an occasional increase in emergency room visits during high PM_{10} events, when the demographic of the at-risk population is taken into account.

Long-term Exposure

A number of epidemiologic studies have continued to report associations between long-term exposure (on the order of months to years) to fine particles ($PM_{2.5}$) and mortality (Dockery et al. 1993; Pope et al. 1995; Krewski et al. 2000; Pope et al. 2002; Laden et al. 2006) as well as morbidity health endpoints: development of chronic respiratory illness or symptoms (Dockery et al. 1996; Raizenne et al. 1996; McConnell et al. 2003), changes in lung function (Gauderman et al. 2000, 2002, 2004; Goss et al. 2004), and the development of cardiovascular disease (Kunzli et al. 2005). However, the available evidence is considered insufficient to link health problems to long-term exposure to coarse particles. The WHO annual PM_{10} guideline is determined based on the $PM_{2.5}$ guideline value and an assumed $PM_{2.5}/PM_{10}$ ratio of 0.5. The proportion of fine and coarse particles likely varies substantially between places, however, depending on local geography, meteorology and specific PM sources. A $PM_{2.5}/PM_{10}$ ratio of 0.5 is typical of developing country urban areas and is at the bottom of the range (0.5-0.8) found in developed country urban areas (WHO 2005). With this same assumption, the predicted $PM_{2.5}$ levels at the Agua Fria Mining operations would be 22.75 $\mu g/m^3$, which is over the NAAQ annual $PM_{2.5}$ standard of 15 $\mu g/m^3$.

It is important to note that there is some scientific debate regarding the levels of particulate matter that is considered protective for all segments of the population. Threshold concentrations for $PM_{2.5}$ or PM_{10} (i.e. a level below which no adverse health effects are likely) have not been established within the scientific literature. The low end of the range of concentrations at which adverse health effects has been demonstrated is not greatly above the background concentration, which for $PM_{2.5}$ has been estimated to be 3~5 $\mu g/m^3$ in both the US and western Europe (WHO 2005).

Health Status Indicators

The Maricopa County JETF expressed their concerns regarding the mining operation and high dust levels. They think it cause the high incidences of valley fever, and high death rates from lung cancer, cardiovascular and heart diseases in Sun City and Sun City West. ADHS reviewed the *Health Status Report for Cities and Towns in Maricopa County* published by Maricopa County (MCDP2010) and try to determine if the incidences of valley fever and death rates from lung cancer, cardiovascular and heart disease in Sun City and Sun City West are statistically higher than the rest of Maricopa County after other factors are taken into account.
The rates listed in Table 5a are crude incidences, which is defined as the number of new cases divided by the population at risk in a specific time period. It is usually conventionally expressed as annual rates per 100,000 persons. The crude incidences does not account for differences in

population age structure which can result in inaccurate comparison of incidences between populations.

Table 5 a. Health Status Indicator (crude rates—before age-adjustment) for Sun City and Sun City West, AZ

2007 Crude Rates				
Cause of Death	Sun City / Sun City West (population = 64,653)		Maricopa County (population = 3,045,149)	
	Number	Crude Rate (per 100, 000)	Number	Crude Rate (per 100, 000)
Lung / Bronchus Cancer	152	235	1370	45
Cardio Vascular Disease	708	1095	7129	234
Heart Disease	546	845	5518	181

Table 5b Health Status Indicator (after age-adjustment) for Sun City and Sun City West, AZ

2007 Age Adjusted Rates						
Cause of Death	Sun City / Sun City West (population = 64,653)			Maricopa County (population = 3,045,149)		
	Age Adjusted Rate	Confidence Interval		Age Adjusted Rate	Confidence Interval	
		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Lung / Bronchus Cancer	67	57	78	49	46	52
Cardiovascular Disease	219	203	235	257	251	263
Heart Disease	167	153	181	199	194	205

Death or incidence rates can be adjusted for any demographic factor such as race or any combination of factors, such as age, sex and race. The most commonly used adjustment is for age. Age-adjusted rates are commonly used in comparative mortality analyses since age is such a prime factor in mortality, especially with chronic diseases such as heart disease and diabetes. For example, counties with higher percentages of older residents will almost always have much higher crude death rates for all deaths as well as for major chronic conditions, compared to counties with younger populations. Conversely, counties with younger populations will tend to have higher crude rates for deaths due to unintentional injuries, especially motor vehicle crashes. Age-adjusted death rates eliminate the bias of age in the makeup of the populations being compared, thereby providing a much more reliable rate for comparison purposes.

Due to the unique age distribution in Sun City and Sun City West (81% are 65 years older or over), we expect to see higher death rates for major chronic disease such as heart disease and diabetes. Age adjustment changes the amount that each age group contributes to the overall rate in each community, so that the overall rates are based on the same age structure. Rates that are

based on the same age distribution can be compared to each other without the presence of confounding by age. Adjustment is accomplished by first multiplying the age-specific rates of disease by age-specific weights. The weights used in the age adjustment of cancer data are the proportion of the standard US population (2000 census data) within each age group. The weighted rates are then summed across the age groups to give the age-adjusted rate.

Age adjusted rates for Sun City/Sun City West and Maricopa County show mortality rates in Sun City/Sun City West are closer to those of Maricopa County than originally estimated when not accounting for age distribution. For example: Before age-adjustment, the death rates associated with heart disease was 546 per 100,000 for Sun City/Sun City West, and 181 per 100,000 for Maricopa County in 2007 (Table 5a). After age-adjustment, the death rates associated with heart disease was 167 per 100,000 for Sun City/Sun City West, and 199 per 100,000 for Maricopa County in 2006 (Table 5b).

The 2007 cardiovascular disease and heart disease age adjusted rates (219 and 167; CI: 203-235, 153-181) are statistically lower for Sun City and Sun City West than the rates for Maricopa County (257 and 199; CI: 251-263, 194-205). The 2007 lung and bronchus cancer age adjusted rate (67; CI 57-78) is statistically higher for Sun City and Sun City West than the rate for Maricopa County (49; CI 46-52). However, based on the available information, we cannot conclude the higher or lower age-adjusted rates are associated with the PM exposures.

Valley Fever

ADHS has monitored valley fever cases and found that 2007 age adjusted rates of reported coccidioidomycosis (a.k.a. "cocci") in the Northwest Valley (NWV) were statistically higher than rates for Maricopa County (Table 6). ADHS requested assistance from the Centers for Disease Control and Prevention (CDC). The CDC sent an EpiAid Team to Arizona to investigate whether the rates were indeed higher, or if there was something influencing the rates in the NWV differently than in Maricopa County. Sometimes there are other factors that make disease rates seem higher in one population than in another, but if those factors are made equal or removed, the disease rates could actually be similar between the population of interest and the comparison population.

Table 6. 2007 Age adjusted rates of reported coccidioidomycosis (a.k.a. "cocci")

County	Total Cases	Age Adjusted Rate	Lower Confidence Bound	Upper Confidence Bound
MARICOPA	3460	92	89	95
	Total Cases	Age Adjusted Rate	Lower Confidence Bound	Upper Confidence Bound
Sun City	102	223	106	341
Sun City West	85	208	43	374

Epidemiologists call outside factors that influence actual disease rates "artifacts." The EpiAid Team wanted to investigate five possible artifacts that could be influencing the Valley Fever rate in the NWV. The first artifact they investigated was Provider Surveys. With the provider survey, they hypothesized that increased provider awareness was leading to increased testing, and therefore an increase in cases. Their results showed that northwest valley providers were 2.6 times more likely to attend cocci continuing medical education than providers in the rest of metro Phoenix. Also NWV providers are 1.7 times more likely to counsel their patients regarding cocci, and 1.4 times more likely to provide the correct treatment for cocci. The EpiAid Team interpreted the results to mean that providers in the northwest valley may know more about cocci. Therefore, they determined the results weakly supported the hypothesis that the increased incidence was due to artifact.

Secondly, after their analysis of the enhanced surveillance database, the EpiAid Team hypothesized that patients in the NWV may have a higher incidence of cocci because they may be tested more frequently as a result of seeking medical attention sooner, and therefore would be diagnosed earlier with less severe disease. The EpiAid Team found that patients in the NWV were diagnosed sooner after symptoms, with an average of 79 days between seeking care and getting a diagnosis, compared to an average of 170 days for the rest of metro-phoenix. They also found that fewer patients in the NWV had multiple symptoms prior to being tested (4% vs. 22%; with a risk ratio of 1.2). The four symptoms the team used included Cough, fatigue, chills, dyspnea. Based on these results, the EpiAid Team determined that these results were weakly supportive of the hypothesis that the increased incidence is due to artifact.

Thirdly, the EpiAid Team looked at commercial lab data. The team hypothesized that increased testing may have yielded a lower percent testing positive. For example, in a community with aggressive testing practices, there might be more cases reported, but a lower overall proportion of positive tests. The team found that the northwest valley had neither the lowest nor highest percent testing positive, which the team determined that the findings from this component did not support the hypothesis that the increased incidence was due to artifact.

Fourthly, the team hypothesized that data would show higher rates of cocci in dogs from the NWV. Dogs get cocci infection and have been used as a surveillance proxy; and therefore, the comparative incidence of cocci in dogs should be similar to the incidence in humans. However, the results actually showed the opposite of what was expected. The incidence in NWV dogs was 0.8% in 2007 vs. 3.4% in other areas of metro Phoenix. The p value was <0.001. Furthermore, the percent testing positive was approximately 30% in both areas (RR 1.0). With the canine study, we saw decreased rates of cocci in the northwest valley. The team determined that these results may support the hypothesis that the increased incidence in the human population is due to artifact.

Finally the EpiAid Team wanted to look at the "Snowbird Effect." The team hypothesized that a large population of snowbirds may artificially increase the numerator. For example, Joe Goldenyears is a resident of Wisconsin but lives in Arizona from October to May every year. When he is diagnosed with cocci by his doctor in Arizona, his data add to the numerator, but not the denominator because he is a resident of Arizona. Cocci cases are automatically reported by

the lab to the state surveillance system. A prior study showed that snowbirds increase the state population by 5% in Arizona each winter, but there were not any more specific data available.

The EpiAid Team estimated a 20% vacancy rate for the NWV, and recalculated the incidence to account for the possible effect of the snowbirds. In Sun City, a 20% snowbird rate decreases the incidence from 258 per 100,000 to 206 per 100,000. They went on to say that a 40% snowbird rate decreases the incidence to 103 per 100,000, which becomes similar to the overall rate for metro phoenix. With the snowbird study, the team saw that the NWV has an influx of transient winter residents who may alter the calculation of the incidence of cocci. The EpiAid team concluded that this evidence supports the hypothesis that the increased incidence is due to artifact.

After evaluating the five hypotheses, the CDCs EpiAid Team concluded that the reported cocci incidence from the surveillance data might not have been accurate. They determined that likely a combination of factors distorts the true incidence of cocci in the northwest valley. The Five components of this investigation point to strong possibility of artifact. The CDC's team noted several limitations of their study. These limitations were: (1) in general, data used were existing data and are subject to the limitations of each study, (2) the commercial lab data may not be representative of the entire state of Arizona, and (3) the canine lab data may not be representative due to the influence of socioeconomic status of dog health care seeking behaviors and dog licensing practices.

ATSDR Child Health Concern

ATSDR recognizes that the unique vulnerabilities of infants and children require special emphasis in those communities faced with contaminants in environmental media. A child's developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages. Children, even those without pre-existing illness or chronic conditions, are more susceptible to air pollution because their lungs are still developing, and they are often engaged in outdoor activities, making them more sensitive to pollution than healthy adults. All health analyses in this report take into consideration the unique vulnerability of children.

Limitation

The predicted $PM_{2.5}$ concentration suggested that there could be a public health hazard. Yet, the Coyote Lake monitoring station is a middle scale station, which has dimensions ranging from 0.06 to 0.62 miles. As a result, the detected PM_{10} concentrations may not fully represent the typical concentrations in area of high population density and the predicted $PM_{2.5}$ concentration can be over-, or under-estimated.

Conclusions

On the basis of available information and demographics, ADHS concludes the following:

- Short-term exposure: Potential Public Health Hazard

  The monitoring data shows that the levels of PM_{10} detected at the Coyote Lake monitoring station exceeded the NAAQ standard occasionally. High levels of PM_{10} could harm the health of certain sensitive population (i.e. individuals with asthma and other respiratory disease, individuals with reduced lung function, individuals with cardiovascular disease, the elderly and children). During high PM_{10} events, certain sensitive populations are susceptible to more serious symptoms, including cough, phlegm, wheezing, shortness of breath, bronchitis, increased asthma attacks, and aggravation of lung or heat disease. Consequently, increasing numbers of emergency visits may be observed.

- Long-term exposure: Indeterminate Public Health Hazard

  Following the WHO assumption, we used a $PM_{2.5}/PM_{10}$ ratio of 0.5 to predict the potential long-term health effects. The prediction suggested that there could be a public health hazard. However, this may over- or under-estimate the actual risk since the proportion of fine and coarse particles is likely varying substantially between places, depending on local geography, meteorology and specific PM sources. Besides, the Coyote Lake monitoring station is a middle scale station. As a result, the detected PM_{10} concentrations may not fully represent the typical concentrations in area of high population density.

  The age adjusted rates shows that (1) death rates due to cardiovascular disease and heart diseases are statistically lower for Sun City and Sun City West than the rates for Maricopa County; (2) death rate due to lung and bronchus cancer is statistically higher for Sun City and Sun City West than the rate for Maricopa County. However, based on the available information, we cannot conclude the higher or lower age-adjusted rates are associated with the PM exposures. ADHS feels that additional information such as actual $PM_{2.5}$ concentrations are necessary before a public health conclusion can be made.

- Insufficient monitoring data are available to comment on exposure to the chemical components of air pollution (i.e. metals, VOCs, etc).
- Valley Fever: ADHS' surveillance system discovered that 2007 age adjusted rates of reported coccidioidomycosis (a.k.a. "cocci") is statistically higher in the Northwest Valley (NWV). However, after investigation, the CDC's EpiAid Team found that the reported cocci incidence from the surveillance data might not have been accurate due to artifacts such as increased provider awareness, increased testing frequency and snowbird effects. They determined that likely a combination of factors distorts the true incidence of cocci in the northwest valley. These limitations for the investigation were: (1) in general, data used were existing data and are subject to the limitations of each study, (2) the commercial lab data may not be representative of the entire state of Arizona, and (3)

the canine lab data may not be representative due to the influence of socioeconomic status of dog health care seeking behaviors and dog licensing practices

Recommendations

ADHS recommends Maricopa County conducting/supervising the following actions to ensure that residents of Sun City and Sun City West are not exposed to unhealthy levels of air pollution that may originate from mining operation or other emission sources in the area:

- It is important to develop a comprehensive sampling plan/network to continue monitor PM_{10} and start to monitor $PM_{2.5}$, which is critical in determining long-term health effects associated with PM exposures. The Maricopa County Air Quality Department indicated that they are currently seeking a permanent site within the area to measure typical concentrations in area of high population density.
- Currently the Maricopa County Air Quality Department does not have the ability to conduct PM speciation monitoring. ADHS encourages them to develop such ability since the levels of metal, other inorganics, and ionic species are important parameters for evaluating health concerns. The Maricopa County Air Quality Department is developing the ability to perform VOC monitoring and analysis with the Mobile Air Monitoring Vehicle.
- Continue to issue warnings on days when levels of air pollution are expected to reach potentially unhealthy levels and to communicate these warnings to the local media. Residents are encouraged to heed these warnings, which generally recommend residents, especially persons with respiratory conditions, to remain indoors and to avoid moderate levels of exercise as much as possible. By following these precautions, residents can protect themselves from air pollution in the area as it occasionally reaches potentially unsafe levels.
- To minimize the amount of particulate matter released to the air, effective air pollution/dust control measures should be developed/initiated/enforced. The Maricopa County Air Quality Department is developing, initiating and enforcing more effective air pollution (including dust) control measures in the area and in the entire county.
- Continue to monitor valley fever cases in the area.

Public Health Action Plan

- ADHS will post this finalized health consultation on its internet site. Also, copies of this report will be sent to the cities of Sun City and Sun City West.
- ADHS will notify the citizen groups in cities of Sun City and Sun City West when the health consultation is finalized.
- ADHS will conduct a public meeting with the community members in cities of Sun City and Sun City West when the health consultation is finalized.
- ADHS will continue to evaluate any new air quality data obtained by the Maricopa County Air Quality Division.

- ADHS will evaluate any laboratory data resulting from any air sampling data around the Agua Fria River Basin in the area of question.
- If future changes in the air quality indicate a need to revise the current conclusion, another health consultation will be prepared, and all stakeholders will be informed
- ADHS will continue to monitor valley fever cases.

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Appendix A: Site Map

Figure 1a. Aerial photo of northern end of the Agua Fria River Basin open pit mining and cement plant operation. Note: the Happy Valley Parkway to the north and the N. Estrella Park (aka Loop 303) to the west. The map is adapted from MapQuest.

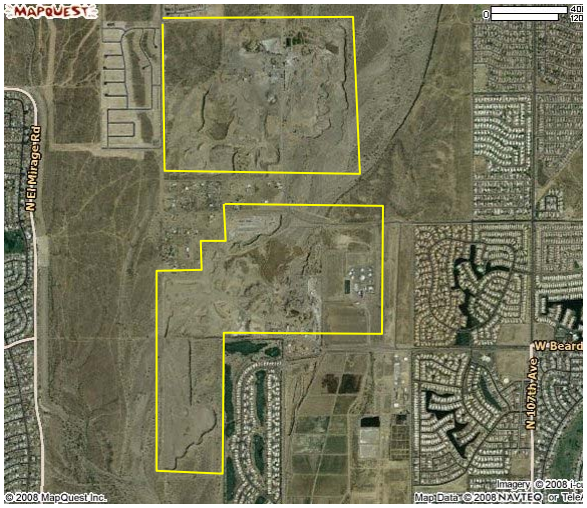

Figure 1b. Aerial photo of central area of the Agua Fria River Basin open pit mining and cement plant operations. In photo there are two separate areas of operations surrounding a residential area in the middle. The map is adapted from MapQuest.

Figure 1c. Aerial photo of southern area of the Agua Fria River Basin open pit mining and cement plant operations. In photo the mining operations extend from Bell Road to the north (on edge of top of photo) along river basin corridor to Grand Avenue (aka Highway 60) to the south which turns eastward at bottom of photo. Note proximity of residential areas to east and west all along mining corridor. The map is adapted from MapQuest.

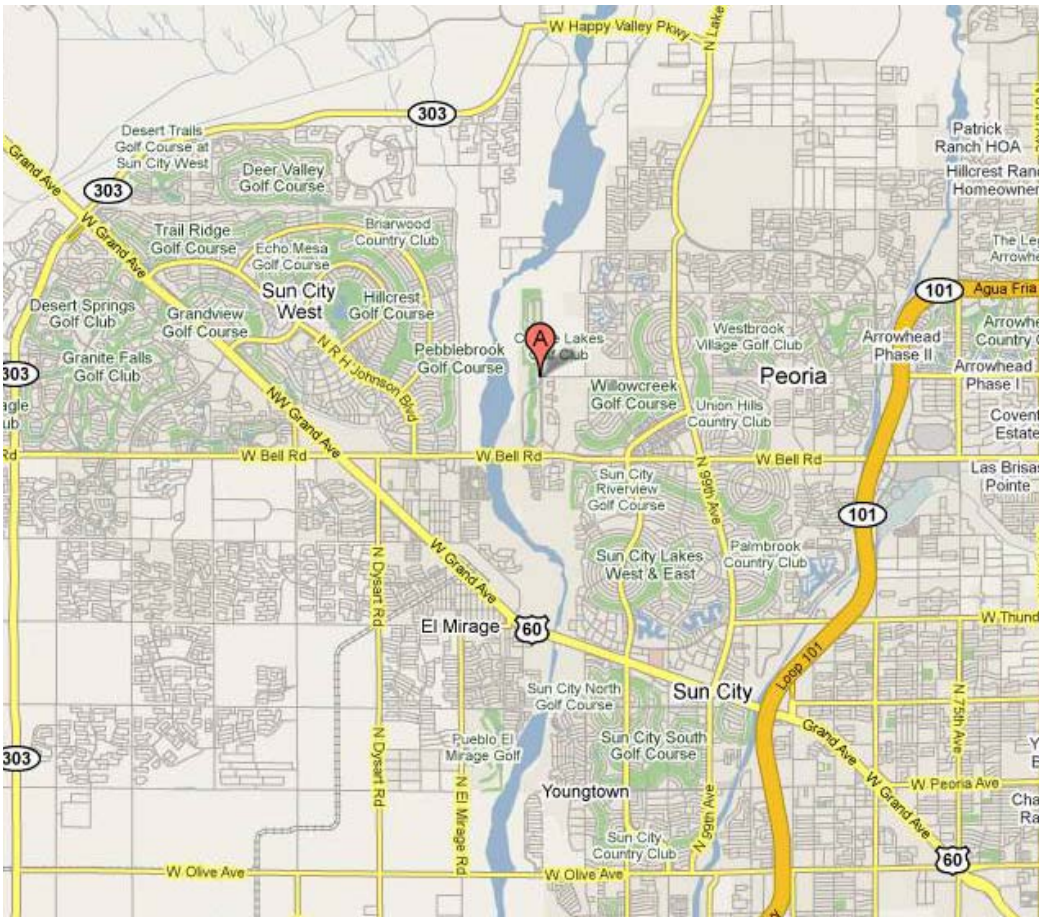

Figure 2. map shows the location of air monitoring station, Sun City and Sun City West. The map is adapted from Google map.

Appendix B Companies Operating in Agua Fria River Basin

Company	Permit	Operation	Allowed PM_{10} (Tons/year)
Accessible Concrete	ADEQ 43898	Concrete Batch Plant	8.8
AZ Materials	MCAQD 030232	Concrete Batch Plant	7.0
Cemex	MCAQD 990613	Concrete Batch Plant; Crushing & Screening	16.1
Cemex (Rinker)	MCAQD 050090	Hot Mix Asphalt Plant; Crushing & Screening	12.1
Chandler Ready Mix	MCAQD 980639	Concrete Batch Plant; Crushing & Screening	10.3
Hanson Aggregates Arizona Inc.	MCAQD 020248	Concrete Batch Plant	2.0
Kilauea Crushing	MCAQD 070034	Crushing & Screening	6.0
LaFarge	MCAQD 000188	Crushing & Screening; Mining	18.9
Maricopa Ready Mix	MCAQD 980797	Concrete Batch Plant	2.9
Miller Equipment	MCAQD 070057	Concrete Batch Plant	1.5
Mission Materials	ADEQ 40539	Hot Mix Asphalt Plant; Crushing & Screening	7.3
Phoenix San Man	MCAQD 070058	Crushing & Screening	3.5
Rinker	ADEQ 41250	Concrete Batch Plant	8.7
Rinker	MCAQD 010117	Concrete Batch Plant	20.0
Rinker	MCAQD 050015	Crushing & Screening; Generator	4.5
RMI Ready Mix	MCAQD 000187	Concrete Batch Plant	3.7
Superstition Crushing	ADEQ 38533	Crushing & Screening	13.6
Superstition Crushing	ADEQ 44735	Crushing & Screening	13.6
Vulcan	ADEQ 26688	Hot Mix Asphalt Plant; Crushing & Screening	8.5
Vulcan Materials	MCAQD 970105	Hot Mix Asphalt Plant; Crushing & Screening; Concrete Batch Plant	28.3

Data source: Maricopa County Joint Environmental Task Force