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March 7, 2013

William Wiley
Air Quality Department Director
Maricopa County Air Quality Department
Air Monitoring Division
2145 S 11th Ave #170
Phoenix, AZ 85007

Dear Mr. Wiley,

RE: [redacted] Hydrogen Sulfide (H_2S) Preliminary Study

Arizona Department of Health Services (ADHS) received you request to conduct a health assessment to determine if any acute health adverse effects could happen to the residents at the [redacted]. We received two set of data from the Maricopa County: The first sampling activity was conducted by the URS Corporation in January 2011, and the second sampling activity was conducted by the Maricopa County Air Quality Department (MCAQD) in February 2013. For the purpose of this assessment, ADHS used the second set of the data since it is more recent and will better represent the current exposure condition. The following summarizes our methodology and assessment results.

General Assessment Methodology

ADHS generally follows a three-step methodology to assess public health issues related to environmental exposures. First, ADHS obtains representative environmental data for the site of concern and compiles a comprehensive list of site-related contaminants. Second, ADHS identifies exposure pathways, and then uses health-based comparison values to find 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 exposures are sufficient to impact public health.

Available Environmental Data

ADHS conducted the assessment based on the five-day air monitoring results conducted by the MCAQD Air Monitoring Division. MCAQD used Jerome J605 Hydrogen Sulfide Analyzer (Jerome Meter) to measure the hydrogen sulfide (H_2S) concentrations. The auto range is set to

record the H_2S concentrations every 5 minutes. With this setting, the minimum detection limit is 3 parts per billion (ppb) and the maximum detection limit is 10 parts per million (ppm; 1 ppm = 1,000 ppb). When the sample concentration exceeds the maximum detection limit of 10 ppm, the values will be displayed as "High Concentration." A total of 15 "High Concentration" results were recorded. NOTE: For the purpose of the assessment, ADHS assumed it to be 10 ppm when the data point shows as: High Concentration. Due to this limitation, the actual extent of the adverse health effect cannot be fully assessed, if there is any.

Exposure Pathway Analysis

Identifying exposure pathways is important in a health consultation because adverse health impacts can only happen if people are exposed to contaminants. The presence of a contaminant in the environment does not necessarily mean that people are actually coming into contact with that contaminant. Exposure pathways have been divided into three categories: completed, potential, and eliminated.

There are five elements considered in the evaluation of exposure pathways:

1) a source of contamination
2) a media such as soil or ground water through which the contaminant is transported
3) a point of exposure where people can contact the contaminant
4) a route of exposure by which the contaminant enters or contacts the body
5) a receptor population

Completed pathways exist when all 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.

The residents can breathe in H_2S from the ambient air. The resident filed a complaint about foul odors, rotten egg smell on their property. ADHS further evaluated the completed exposure pathways to determine whether realistic exposures are sufficient in magnitude, duration or frequency to result in acute adverse health effects.

Comparison to Health-based Comparison Values for Ambient Air Samples

The health-based comparison values (CVs) are screening tools used with environmental data relevant to the exposure pathways. The health-based CVs are concentrations of contaminants that the current public health literature suggests are "harmless." These comparison values are quite conservative, because they include ample safety factors that account for the most sensitive populations. ADHS typically uses comparison values as follows: if a contaminant is never found at levels greater than its CV, ADHS concludes the levels of corresponding contamination are "safe" or "harmless." If, however, a contaminant is found at levels that are 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 than

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.

ADHS calculated the one-hour average concentration of H_2S. The values of one-hour rolling average ranged from 0 ppm to 1.99 ppm (Note: the maximum value may be higher because of the assumption mentioned previously). 206 out of 885 one-hour rolling average exceeded the one-hour Arizona Ambient Air Quality Guideline (AAAQG) of 0.13 ppm. After consultation with ATSDR and due to the nature of the data, ADHS calculated the approximate 24-hour average concentrations of H_2S by using the starting and ending time of the sampling activities. The results indicated that the 24-hour averages were: (1) 0.06 ppm for samples collected from 2:40 pm February 11 to 2:40 pm February 12; (2) 0.36 ppm for samples collected from 3:05 pm February 12 to 3:05 pm February 13; and (3) 0.3 ppm for samples collected from 3:10 pm February 13 to 3:10 pm February 14 (Note: the actual values may be higher because of the assumption mentioned previously). Two out of the three 24-hour H_2S average concentrations exceeded the 24-hour AAAQG (0.08 ppm) and acute Minimal Risk Level (MRL) for exposure less than 14 days, which is developed by the Agency for Toxic Substances and Disease Registry (ATSDR). Consequently, ADHS conducted further analysis to determine if the exposure was sufficient to impact public health.

***Public Health Implications**: This section will provide general toxicological information and site-specific exposure evaluation.*

Hydrogen sulfide is a gas released from many natural and manmade sources. Some industrial sources include sewage treatment facilities, manure-handling operations, pulp and paper mills, petroleum refineries, and food processing plants (ATSDR 2006). Steel mills and cement manufacturing facilities can have operations (e.g., wastewater treatment) known to release hydrogen sulfide gases. However, these two industries are not listed among the largest emissions sources of H_2S documented in various recent environmental health reviews (e.g., ATSDR 2006; WHO 2003).

Hydrogen sulfide has a characteristic rotten-egg odor that is detectable at concentrations as low as 0.5 ppb. Inhalation is the primary exposure route for hydrogen sulfide exposure. The gas is rapidly absorbed by the lungs. In the body, hydrogen sulfide is primarily converted to sulfate and is excreted in the urine rapidly.

Exposure to hydrogen sulfide can result in a reduction of oxygen used in cells. Nervous and cardiac systems are especially vulnerable to this effect because they have the highest oxygen demand. In the central nervous system, it may result in death due to respiratory arrest. Hydrogen sulfide also irritates skin, eyes, mucous membranes, and the respiratory tract (ATSDR 2006; WHO 2003).

The health based CV's used in this assessment includes the AAAQG and ATSDR's MRL. ATSDR established an acute MRL of 0.07 ppm based on the changes in respiratory functions among the exposed population. Three males and seven females with bronchial asthma were exposed to 2 ppm hydrogen sulfide for 30 minutes. The results from two individuals indicated bronchial obstruction. In addition, three out of the 10 individuals reported headaches after exposure. Therefore, 2 ppm concentration was considered a Lowest Observed Adverse Effect Level (LOAEL). ATSDR derived the MRL based on the study and an uncertainty factor of 27 (3 for using a minimal LOAEL, 3 for human variability and 3 for database deficiencies).

ADHS calculated 30-minute rolling average concentration of H_2S. The values of 30-minute rolling average ranged from 0 ppm to 3.95 ppm (Note: the maximum value may be higher because of the assumption mentioned previously). 31 out of 968 30-min rolling averages equal or exceed the LOAEL of 2 ppm. Therefore, ADHS determined that the detected concentrations at the [redacted] could cause adverse health effects such as headaches, eye irritation, respiratory irritation, cough, dizziness, nausea. Some of the symptoms are consistent with complaints from the residents. However, the maximum adverse health effect cannot be assessed due to the limitation of the data as mentioned previously.

Based on the findings, ADHS makes the following recommendations to the residents, responsible party and/or Maricopa County Air Quality Division:

1. The residents should consult their physician to discuss their symptoms.
2. Take immediate steps to help control (prevent or reduce) the release of H_2S from potential emission sources.
3. Monitor the levels of H_2S to verify that the control measures are effective.

If you have any questions, please contact me at (602) 803-3740 or linh@azdhs.gov.

Sincerely,

Hsini Lin, ScD, MSPH
Environmental Toxicologist

References:

1. Agency for Toxic Substances and Disease Registry (ATSDR). 2006. Toxicological Profile for Hydrogen Sulfide. Atlanta, GA: US Department of Health Services, Public Health Service
2. World Health Organization (WHO). 2003. Concise International Chemical Assessment Document 53: Hydrogen Sulfide: Human Health Aspects. Geneva, WHO.
3. Maricopa County Air Quality Department (MCAQD). 2013. [redacted] Hydrogen Sulfide (H_2S) Preliminary Study. Air Monitoring Division, MACQD, Phoenix, AZ.