Health Consultation

WEST BRANCH OIL FIELDS

OGEMAW COUNTY, MICHIGAN

Prepared by the
Michigan Department of Community Health

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Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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

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

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Acronyms and Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
ATSDR	Agency for Toxic Substances and Disease Registry
H_2S	hydrogen sulfide
MDCH	Michigan Department of Community Health
MDEQ	Michigan Department of Environmental Quality
MRL	minimal risk level
ppb	parts per billion
ppm	parts per million
SO_2	sulfur dioxide
TRS	total reduced sulfur

Summary

Introduction	A resident of West Branch contacted the Michigan Department of Natural Resources and Environment (MDNE) and complained about a "rotten egg" odor causing eye irritation and a worsening of her respiratory problems. An investigation was conducted into the source of the odor, including stationing of a hydrogen sulfide meter in the vicinity of the resident's apartment. Levels of H_2S measured by the monitor were detectable but not reliably accurate due to the monitor's limit of detection in the ten-day sampling time. The resident was subsequently relocated and is no longer in the area.
Conclusion	MDCH cannot currently conclude whether H_2S concentrations reached levels that could harm people's health at the apartment complex. The detection limit on the H_2S monitor was higher than the MRL for intermediate duration exposure (20 ppb). H_2S measures did not exceed the acute H_2S MRL (70 ppb).
Basis of Conclusion	H_2S measure did not exceed 40 ppb and measures less than 60 ppb were not reliable due to the type of detection unit deployed. However, the proximity of the oil extraction operations are such that H_2S levels could become elevated if equipment failure were to occur.
Next Steps	MDCH will remain available to review future odor complaints reported to MDCH.
FOR MORE INFORMATION	If you have concerns about your health, you should contact your health care provider. Please call MDCH Division of Environmental Health at 1-800-648-6942 regarding this health consultation.

Purpose and Health Issues

A resident of the community contacted the Michigan Department of Environmental Quality (MDEQ) and complained about a "rotten egg" odor causing eye irritation and a worsening of her respiratory problems. An investigation was conducted into the source of the odor, including stationing of an Eagle Model Portable Multi-Gas Monitor to assess levels of hydrogen sulfide (H_2S) in the vicinity of the resident's apartment. Levels of H_2S measured by the monitor were detected but not reliably accurate due to the monitor's limit of detection in the ten-day sampling time. The resident was subsequently relocated and is no longer in the area.

Background

West Branch is the county seat of Ogemaw County, in the northeast Lower Peninsula with a population around 2,000 people (See Figure 1 for a map of West Branch.). The West Branch Oil Field is about 9 miles long and approximately 1 mile wide. West Branch Township has approximately 311 wells, run by primarily small companies, with most being outside of the city. Of those wells, 78 are "sour gas" wells, containing 400-54,995 ppm H_2S in the gas stream.

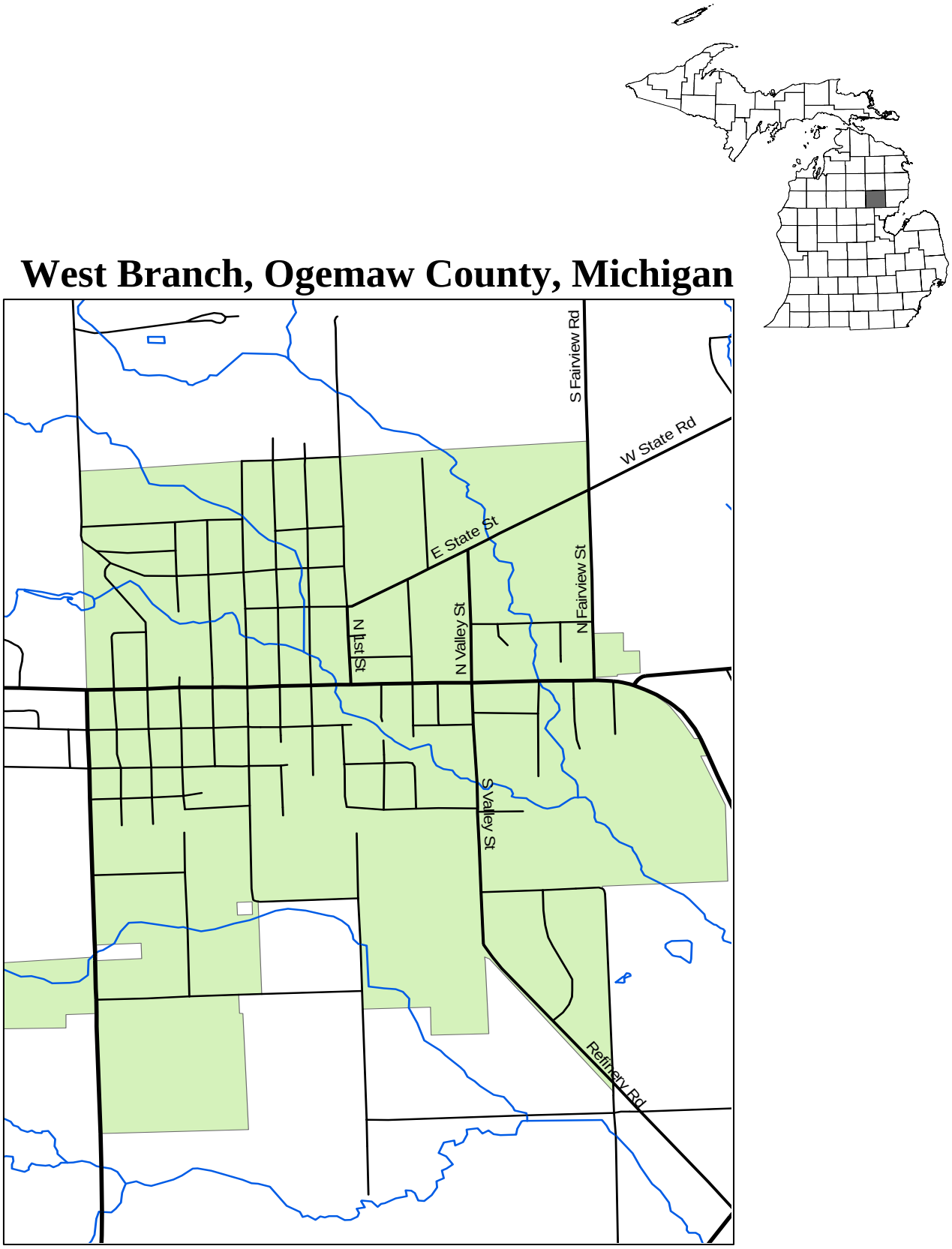

Figure 1: Map of West Branch in Ogemaw County, Michigan.

Discussion

Site Visit

Michigan Department of Community Health (MDCH) and MDEQ personnel visited several of the wells, tanks, and flaring stations in the West Branch area. Many did not have any sort of fencing to restrict access. Valves (Figure 2), and other controls of the system were easily accessible.

Figure 2: Easily accessible oil field equipment at the West Branch oil fields, Ogemaw County, Michigan.

Signage warning of poison gas seemed small, however are in compliance with regulatory requirements of a minimum of1.5 inch lettering and visible at 25 feet. People would need to be closer to clearly read the warning (Figure 3). Additionally, some flaring stations were unfenced and near vegetation (Figure 4).

Figure 3: Example of poison gas warning sign around West Branch oil field equipment, Ogemaw County, Michigan.

Figure 4: Example of a flaring station in the West Branch oil fields, Ogemaw County, Michigan.

One non-sour gas pumping station was located close to an elementary school. This pumping station had a fence with wires at the top, but the gate was bent, potentially allowing children access to that pump (Figure 5).

Figure 5: Pumping station for a non-sour gas well near an elementary school in West Branch, Ogemaw County, Michigan.

Environmental Contamination

Levels of H_2S were measured with an Eagle Model Portable Multi-Gas Detector equipped with a hydrogen sulfide sensor (part number: ES-23AH-H2S, RKI Instruments, Inc) capable of measuring levels of H_2S between 10-1000 parts per billion (ppb). However, reliable measures start at 60 ppb and measures between 10-50 ppb are not reliable. The machine was located in the parking lot of the resident's apartment complex from July 13-20 and 24-31, 2007 and recorded measurements 24 hours a day. H_2S levels did not exceed 40 ppb, a level that is in the lower end of the sensor's reliable detection limit. Most of these levels occurred between early morning and noon.

Exposure Pathways Analysis

An exposure pathway contains five elements: (1) the contaminant source, (2) contamination of environmental media, (3) an exposure point, (4) a human exposure route, and (5) potentially exposed populations. An exposure pathway is complete if there is a high probability or evidence that all five elements are present. Table 1 describes human exposure to H_2S from air in the vicinity of the West Branch oil fields.

Table 1: Exposure pathway for West Branch oil fields, Ogemaw County, Michigan.

Source	Environmental Transport and Media	Chemicals of Interest	Exposure Point	Exposure Route	Exposed Population	Time Frame	Status
Oil wells, pipelines and flaring systems	Air (gas)	Hydrogen sulfide	Outdoor and indoor air	Inhalation	Residents, workers, and visitors	Past	Potential
						Present	Potential
						Future	Potential

Toxicological Evaluation

Hydrogen sulfide (H_2S) is a colorless, flammable gas that smells like rotten eggs and can temporarily shut down a person's sense of smell at concentrations ranging between 100-200 parts per million (ppm). Sources of H_2S can either be natural, such as volcanoes, hot springs, and natural gas, or industrial, including wastewater treatment, tanneries, and pulp or paper mills. Ambient air concentrations can range from 0.11 ppb to greater than 90 ppb depending on proximity to natural or industrial sources. Areas of the U.S. without any natural or industrial H_2S sources nearby have ambient levels of 0.02-0.07 ppb. Humans can smell H_2S levels as low as 0.5 ppb. (ATSDR 2006)

People are primarily exposed to H_2S through the air they breathe. Acute exposure to high levels (thought to be greater than 500 ppm) can result in unconsciousness and death. Additional symptoms to acute exposure can include reduced respiratory function, eye and nasal irritation, headache, and nausea in humans (ATSDR 2006). People's responses can vary depending on the presences of other sulfur containing compounds, including sulfur dioxide (SO_2), which are often present in the air along with H_2S.

The Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk level (MRL) for acute-duration (up to 14 days) inhalation exposures is 0.07 ppm (70 ppb). This value was derived from a study in 1990 where ten individuals with asthma were exposed to 2 ppm of H_2S continuously for 30 minutes (Jappinen et al. 1990). While there were no statistical changes in respiratory function, three of the ten subjects reported headaches and two of the ten had a greater than 30% change in respiratory function, indicating bronchial obstruction. An additional study of a community in Oulu, Finland located near several industrial sources of H_2S reported that there was a significant correlation between weekly levels of H_2S and weekly attendance at a hospital for treatment of severe asthma attacks (Rossi et al. 1993). However, the authors noted that individuals with asthma were more sensitive to the presence of SO_2 than non-asthmatic individuals. SO_2 is a common contaminant along with H_2S at sour gas wells and was not analyzed for in West Branch air. The data from these two studies (Jappinen et al. 1990; Rossi et al. 1993) indicates that individuals with asthma may potentially be a sensitive population to H_2S exposure.

A MRL of 0.02 ppm (20 ppb) was set for intermediate-duration (15-365 days) exposure based on a study in 10-week-old Sprague-Dawley rats exposed to 0, 10, 30, or 80 ppm for 6 hours every day for ten weeks (Brenneman et al. 2000). Nasal tissue and olfactory nerve damage occurred in the rats exposed to 30 and 80 ppm H_2S.

Recently, the ATSDR conducted a multi-year study on a community in Nebraska exposed to eight industrial sources of H_2S, with measurements exceeding the Nebraska's Department of Environmental Quality total reduced sulfur (TRS) value of 100 ppb monthly, mainly due to H_2S levels (Inserra et al. 2002). As found in measurements at West Branch, there were higher levels of H_2S overnight with levels noted to be higher in the summer and fall seasons (Inserra et al. 2002). In agreement with the observation that the highest levels were found at night, a study in Finland noted that the highest concentration was measured at 2:00 am (Haahtela et al. 1992).

An additional study was conducted on the Nebraska population to assess potential neurobehavioral effects of exposure comparing people exposed to greater than 90 ppb to people with exposed to less than 50 ppb (Inserra et al. 2004). No statistical differences were found in this study although the authors noted that their assigned exposure groups might have resulted in a "mis-classification bias". A third study was conducted on this area by the ATSDR to determine if hospital visits for respiratory diseases correlated with elevated H_2S and TRS levels. Exposure was classified as high if one or more of the 30-minute rolling averages for the day was ≥30 ppb TRS or H_2S and low if all of the day's averages were <30 ppb (Campagna et al. 2004). This study found that there was a positive association between hospital visits for asthma for both children under 18 years of age and adults the day after a high exposure to H_2S, with a more positive association occurring with the children compared to the adults. Additionally, digestive diseases, conditions not associated with H_2S exposure, were also examined. There was no association between H_2S or TRS levels and hospital visits due to digestive diseases. The authors noted that asthma or other respiratory diseases might be a problem with exposure to H_2S and TRS.

The above discussion applies to residents and other people that are not receiving their exposure through required work-related activities. Occupational exposure levels for H_2S were set by the

American Conference of Governmental Industrial Hygienists (ACGIH) in order to reduce the possibility of eye and respiratory tract irritation among other adverse effects and are currently 10 ppm for a continuous 8-hour exposure during a 40-hour work week and 15 ppm for short term exposure (less than 15 minutes of continuous exposure). In agreement with these values, Jappinen et al. (1990) evaluated respiratory function of 26 pulp mill workers, with an occupational exposure ranging from 1-11 ppm on the testing days. No differences were found in the respiratory function of these workers, including those who smoked or had preexisting allergies. However, these ACGIH values are currently under review and may be lowered in the near future. One reason for this adjustment is the possibility that H_2S may cause eye irritation at levels as low as 25 ppb, averaged over 24 hours (Haahtela et al. 1992). Additionally, as discussed above with the ATSDR studies in Nebraska, incidences of hospital visits increased with high exposure, defined as one 30-minute rolling average of greater than or equal to 30 ppb, which was below the ATSDR levels for an acute exposure (Campagna et al. 2004).

Children's Health Considerations

Children may be at greater risk than adults from exposure to hazardous substances at sites of environmental contamination. Children engage in activities, such as playing outdoors and on the ground and may encounter hazardous substances for a longer time than adults. They are shorter than most adults, and therefore breathe dust, soil, and vapors found closer to the ground. H_2S is denser than air and may be more concentrated near the ground than higher up. Due to their lower body weight and higher intake rate, such as increased respiration and hand-to-mouth activities, may receive a larger dose of hazardous substance per unit of body weight. Children under 18 years of age had a stronger association between hospital visits for asthma and a high exposure to H_2S (on the day previous) as compared to the association with adults (Campagna et al. 2004).

The developing body systems of children can sustain permanent damage if toxic exposures are high enough during critical growth stages. Injury during key periods of growth and development could lead to malformation of organs (teratogenesis), disruption of function, and premature death. Exposure of the mother could lead to exposure of the fetus, via the placenta, or affect the fetus because of injury or illness sustained by the mother (ATSDR 1998). The obvious implication for environmental health is that children can experience substantially greater exposures to toxicants in soil, water, or air than adults can.

Conclusions

MDCH cannot currently conclude whether H_2S concentrations reach levels that could harm people's health at the apartment complex. The detection limit on the H_2S monitor was higher than the MRL for intermediate duration exposure (20 ppb). H_2S measures did not exceed the acute H_2S MRL (70 ppb).

Recommendations

- MCHD should remain available to consult on odor complaints in West Branch.
- The health consultation should be made available to the public on the internet.
- The health consultation should be provided to the regional office of the MDNRE that covers West Branch.

Public Health Action Plan

- MDCH will remain available to consult on future odor complaints in West Branch.
- MDCH will make the health consultation available on the internet.
- MDCH will provide the health consultation to the MDNRE regional office that covers West Branch.

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Certification

This Health Consultation was prepared by the Michigan Department of Community Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures. Editorial review was completed by the cooperative agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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