


MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

INTEROFFICE COMMUNICATION

TO: Kory Groetsch
Michigan Department of Health and Human Services (MDHHS)

FROM: Mary Ann Dolehanty, Director 
Air Quality Division (AQD)

DATE: January 5, 2022

SUBJECT: Elevated Ambient Air Hydrogen Sulfide Levels Detected Adjacent to
Residential Homes Near Dundee in Monroe County

Hydrogen sulfide (H₂S) concentrations of at least 1,000 ppb have been measured in the vicinity of residential homes in rural Monroe County just southwest of Dundee on numerous occasions since 2019. The H₂S is being generated by pivot irrigation systems that are utilizing groundwater containing high H₂S. The concentration and duration of the H₂S measured is concerning. The AQD recommends that the MDHHS further investigate the matter. The attached briefing paper provides detail on the issue as well as recommendations going forward.

BRIEFING PAPER
Elevated Ambient Air Hydrogen Sulfide (H₂S) Levels Detected Adjacent to
Residential Homes Near Dundee in Monroe County
December 9, 2021

Issue

Hydrogen sulfide (H₂S) concentrations of at least 1,000 parts per billion (ppb) have been measured in ambient air at residential homes in Monroe County just southwest of Dundee, on numerous occasions since 2019. The measured ambient air concentrations of H₂S at residential homes represent a human health concern based on health-based screening levels for H₂S used to protect public health, including sensitive subpopulations. The H₂S is being generated by irrigation systems that utilize ground water containing high concentrations of H₂S. A memorandum of understanding between the Michigan Department of Environment, Great Lakes, and Energy's (EGLE) Air Quality Division (AQD) and Michigan Department of Agriculture and Rural Development (MDARD) Right to Farm (RTF) Program exists for the investigation of agricultural nuisance odor complaints. MDARD uses Generally Accepted Agriculture and Management Practices (GAAMPs) for evaluating agricultural nuisance odor complaints. However, MDARD RTF Program staff indicated there are no GAAMPs for this particular issue and therefore no way of evaluating the nuisance odor complaints. The AQD believes that the Michigan Department of Health and Human Services (MDHHS) should be the lead agency to further investigate the matter to determine the level of health concern and develop a course of action to address it.

Background/Facts

The AQD regulates air pollution from industrial sources such as petroleum refineries, natural gas plants, kraft paper mills, manure treatment facilities, wastewater treatment facilities, and tanneries. Natural sources of H₂S include swamps, bogs, and volcanoes. H₂S air concentrations from natural sources range between 0.00011 and 0.00033 parts per million (ppm) (ATSDR, 2016). In urban areas, the air concentrations are generally less than 0.001 ppm (ATSDR, 2016): However; in this case, the source of elevated air concentrations of H₂S at residential locations is from ground water pumped through irrigation systems. The groundwater present in West Central Monroe County near Dundee comes from the Silurian-Devonian aquifer which contains unusually high levels of H₂S and can exceed 140 ppm (USGS, 1994) [US Geological Survey](#). This issue first became well known back in 2001, at a residence east of Dundee when two persons were hospitalized due to dangerous build-up of H₂S gas in their basement. (Note: Details about the incident can be found here: [EGLE Fact Sheet](#))

In the past, the AQD received odor complaints from Dundee area residents for H₂S that was determined to be from a nearby cement plant. In 2009-2010 the Holcim Cement Plant in Dundee was permanently shut down and demolished. The associated limestone quarry has continued to be mined by a subsidiary of Holcim called Aggregate Industries. Prior to its shutdown, the cement plant received numerous odor complaints. In 2012, the AQD started receiving odor complaints from residents living in a subdivision

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about 1.5 miles south of the Holcim quarry. The AQD investigated and found that the groundwater handling and discharge from the limestone quarry was the primary source of the H₂S related odor. The current quarry owner/operator, Lafarge/Holcim operates only the quarry. Several years ago, Holcim sold the separate cement bagging operation on the site which continues to operate and has an Air Use Permit to Install.

In 2015 the AQD and the WRD met with the then Holcim & Aggregate Industries owner/operators and local officials to address the ongoing odor complaint situation. At the request of the AQD, the source developed and implemented an H₂S odor mitigation plan. Despite this, odor complaints from this source have continued. The AQD is continuing to work with the source on further mitigation strategies. No assistance from the MDHHS is needed at this time regarding this particular H₂S issue.

Starting around 2017, the AQD started getting odor complaints from residents living in the Petersburg area, which is south of Dundee or about six miles SSW of the Holcim quarry. Some residents indicated that the odors were extreme to the point that they were afraid to leave their homes due to experiencing trouble breathing when nearby irrigators were turned on. (See attached map below which depicts the approximate impacted areas from both the Holcim quarry and the irrigation systems with H₂S.)

Around this time, irrigation systems were being installed for the first time in this area due to a change by local farmers into specialty crops such as cabbage and tomatoes which have a higher need for regular watering. (See attached photo below.)

In 2018 and 2019, the AQD conducted onsite investigations in the Petersburg area. AQD worked with the Department of Agriculture, specifically the RTF Program and Ben Tirrell, to contact one of the farmers operating irrigation systems near one of the primary complainants. We also received permission from the farmer to do some initial air monitoring within his fields. The purpose of this monitoring was to gather initial information that would give us a better idea about concentrations of H₂S in the air and basically give us some information to continue the discussion.

In 2019, the AQD received a CAIRPOL continuous air monitor from the United States Environmental Protection Agency (USEPA) that can be used for H₂S detection. This device is equipped with a small fan that allows it to pull in ambient air into the device which is continuously sampled. The device outputs a measured concentration of H₂S once per minute with a detection range of 1 to 1,000 ppb (1 ppm). It detects total reduced sulfur compounds (TRS). (Note: Based on published literature, the TRS compound in this case is believed to be almost entirely in the form of H₂S.) (See attached photo below of a deployed CAIRPOL station.)

The device was first deployed in a farmer's field directly under the pathway of an irrigator from July 10-18, 2019. (LAT 41.939197, LONG -83.726582) This time was

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chosen because July is the most common time for the irrigation systems to be utilized with more than 2 dozen center pivot irrigation systems installed in the nearby area. They are typically turned on and run continuously for a 24 to 48-hour period.

A review of initial results showed that the maximum 24 hour average concentration detected was 300 ppb. Over 2,800 separate one-minute average readings exceed the odor threshold of H₂S which is approximately 7 ppb. Over 940 readings exceeded the monitor's maximum detection range of 1,000 ppb. (Refer to attached spreadsheet (CAIRPOL DATA 2019) for results and attached chart below.)

In 2020, AQD purchased 2 CAIRPOL Units. On June 29, 2020, a single CAIRPOL unit was deployed just off Petersburg Road SW of Dundee in the backyard of a residential home located 0.73 miles from the irrigator and ½ mile from its closest approach. (LAT 41.930282, LONG 83.711509). This location was chosen because the resident had reported severe/suffocating like odors when the irrigators were operating at night under light winds with humid conditions. (Note: There were 6 homes closer to this irrigator than the home where the samples were taken). Data from June 29, 2020, through July 9, 2020, showed elevated H₂S levels on 6 separate evenings/overnight periods with low daytime readings. Over 67 minutes exceeded the detection range of the device. The highest 1-hour average was 978 ppb with the highest 24-hour average was 127 ppb. More data was obtained from July 9 to July 20, 2020, which showed more elevated levels but not as high compared to previous weeks. Finally, sampling continued from July 20 through August 3, 2020, with one more significant episode of elevated H₂S concentrations. Most notable was a 30-minute period at night that the CAIRPOL recorded 1000 ppb+ concentrations continuously. (Refer to attached spreadsheet (CAIRPOL DATA 2020) for results and attached chart below.)

On June 22, 2021, two CAIRPOL units were deployed at two different residences along Dennison Road. Due to excessive rainfall at the start of the monitoring period, the irrigators were not initially operated but irrigators use did commence later in the summer. Data was obtained for the 1XXX Dennison Road location from July 13, 2021, through August 31, 2021. (LAT 41.9119973, LONG -83.728693). Data was also obtained for the 2XXX Dennison location from August 5, 2021, to August 2021. (LAT 41.936363, LONG -83.731066) (See attached spreadsheets). Results were similar to previous years. Most notable was a reading of 1,000+ ppb continuously for 1.5 hours at the 2XXX Dennison location. (Refer to attached spreadsheets 1XXX Dennison CAIRPOL DATA 2021, 2XXX Dennison CAIRPOL DATA) for results and attached charts below).

Health Assessment

EGLE has developed health-based screening levels for inhalation exposure to H₂S. For non-cancer effects, AQD calls these health-based screening levels Initial Threshold Screening Level (ITSLs) (see Table 1). ITSLs represent maximum exposure levels that are expected to be without an appreciable risk of health effects over a given exposure duration. They are based on the best available scientific information and are calculated to be protective for sensitive subpopulations, such as the elderly and infants. H₂S ITSLs for inhalation exposure are based on noncancer health effects of the respiratory system; H₂S has not been shown to cause cancer.

Table 1. Initial Threshold Screening Levels for Hydrogen Sulfide

ITSL Type	Value $\mu\text{g}/\text{m}^3$ (ppb)	Averaging Time
Acute	100 (70)	24-hour
Chronic	10 (7)	Annual

The residential exposures to H₂S are short-term in duration. This is based on the monitoring data described above and the recognition that the presumed source of H₂S is irrigation spray which only occurs during the dry summer months. Given this scenario, the AQD would use the acute ITSL to evaluate potential health impacts from industrial air emissions of H₂S. The acute ITSL is based on a study where lung function was evaluated in three male and seven female subjects with bronchial asthma requiring medication for 1–13 years; none of the subjects had severe asthma (Jäppinen et al., 1990). The subjects were exposed to 2 ppm hydrogen sulfide for 30 minutes. Respiratory function in response to a histamine challenge was assessed prior to exposure and after exposure. In two subjects, there were changes of over 30 percent in both airway resistance (Raw) and specific airway conductance (SGaw); these changes were suggestive of bronchial obstruction. Additionally, three of ten subjects complained of headaches after exposure. The 2-ppm concentration was considered a minimally adverse effect level because the changes in airway resistance and specific airway conductance were only observed in two of ten subjects. Because the study was conducted using asthmatics, who are likely to be a sensitive subpopulation, a partial uncertainty factor of 3 was used to account for human variability. An uncertainty factor of 3 was used for database deficiencies because of lack of studies on children exposed to H₂S and concern for short (30 minute) exposure duration in the principal study. An additional uncertainty factor of 3 was used to account for the conversion of a lowest-observed-adverse-effect-level (LOAEL) to a no-observed-adverse-effect-level (NOAEL). The total uncertainty factor of 30 was used as follows: ITSL = LOAEL/30; where LOAEL = 2 ppm. The ITSL = $2/30 = 0.07$ ppm or 70 ppb (rounded to 1 significant figure). (Note on unit conversion: 70 ppb H₂S is the same as $100 \mu\text{g}/\text{m}^3$.)

As noted above, exposures to 2 ppm (2,000 ppb) H₂S for as short as 30 minutes resulted in airway obstruction in a human population (Jäppinen et al., 1990). In 2021,

the residential monitoring data showed a 1 ½ hour time-period exceeding the 1 ppm (1,000 ppb) upper limit of the air sensor. Given the intensity and duration of the H₂S at the residential monitoring site there is a reasonable potential for adverse respiratory effects. Furthermore, the monitoring data shows exceedances of the acute ITSL. Exceedance of the acute ITSL from new industrial sources would not receive a permit to install under Michigan's Air Pollution Control rules.

During short-term exposures the indoor air concentrations of H₂S are expected to be less than the outdoor concentrations. However, given that olfactory fatigue to H₂S is a real possibility, residents could inadvertently go outside during episodes of high H₂S concentrations. The AQD believes it is unreasonable to advise that residents remain indoors during episodes of high H₂S. Therefore, it is recommended that the source of the H₂S emissions be substantially reduced to protect public health. Since the AQD has limited authority to regulate air emissions from farming operations, this issue may be better addressed by the authority granted to the MDHHS under the public health code.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2016. Toxicological Profile for Hydrogen Sulfide and Carbonyl Sulfide. Atlanta, Georgia: U.S. Department of Health and Human Services. Available at: [Toxicological Profile for Hydrogen Sulfide and Carbonyl Sulfide](#)

Michigan Department of Environmental Quality (MDEQ). 2018. Interoffice Communication: Initial Threshold Screening Level Derivation Update. Available at: [Initial Threshold Screening Level Derivation Update](#)

U.S. Environmental Protection Agency (EPA). 2003. IRIS Toxicological Review of Hydrogen Sulfide. Washington, DC, EPA/635/R-03/005. Available at: [Toxicological Review](#)

[Concise International Chemical Assessment Document 53](#)

*Note that different sources may use different units when referring to air concentrations.

1 ppb H₂S = 1.39 µg/m³ H₂S

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Recommendation

The AQD should refer this issue to the MDHHS for follow up and to ensure any potential health impacts are addressed as afforded under the Public Health Code.

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Photo of Pivot Point Irrigation System near Dundee

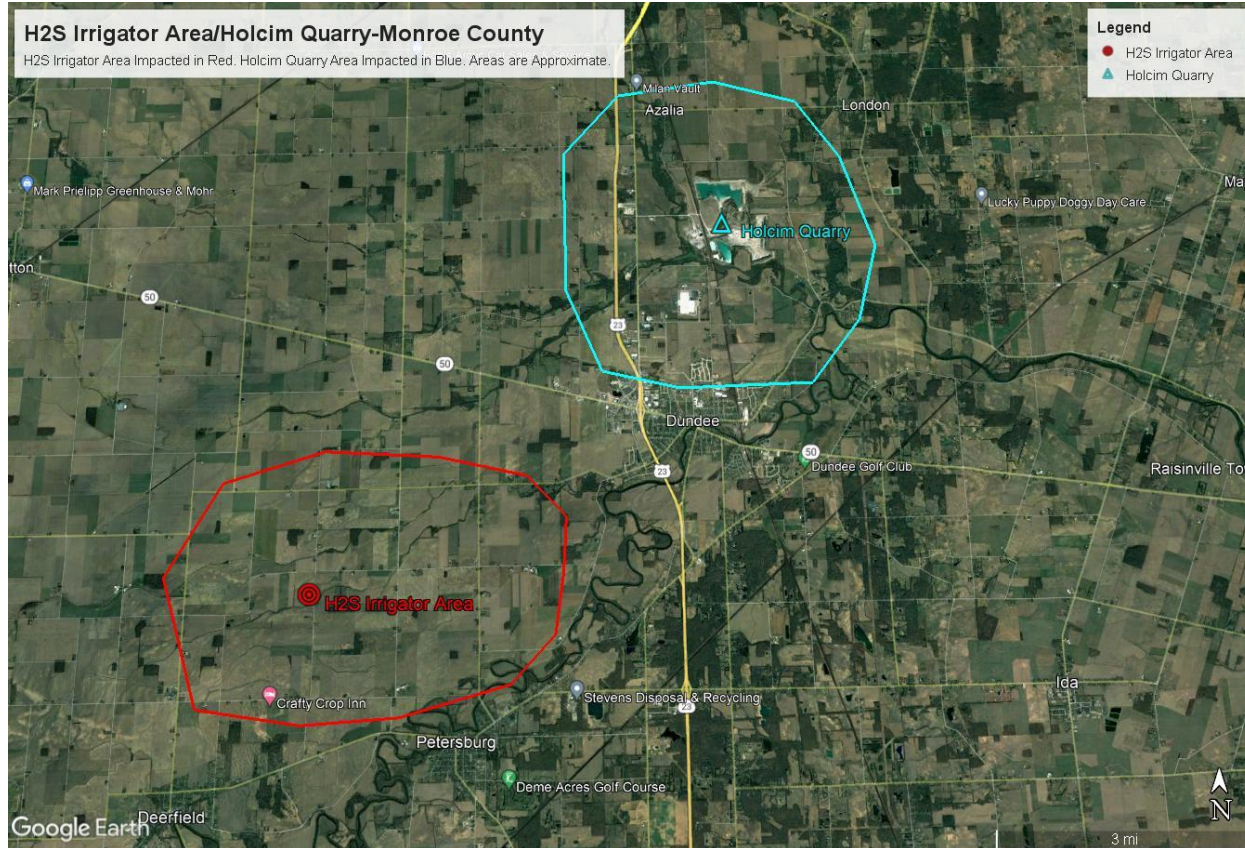


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Map of Impacted Areas from Both the Holcim Quarry and the Irrigation Systems with H₂S.



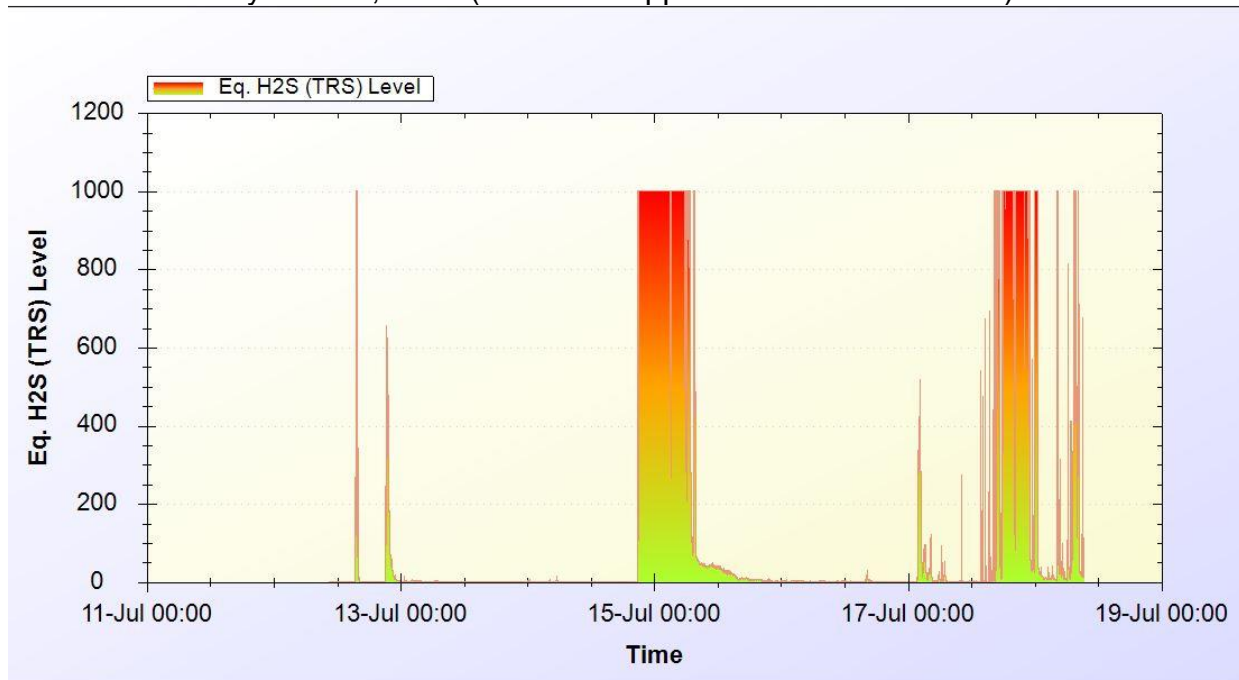
H₂S CAIRPOL Monitoring Station with Solar Array



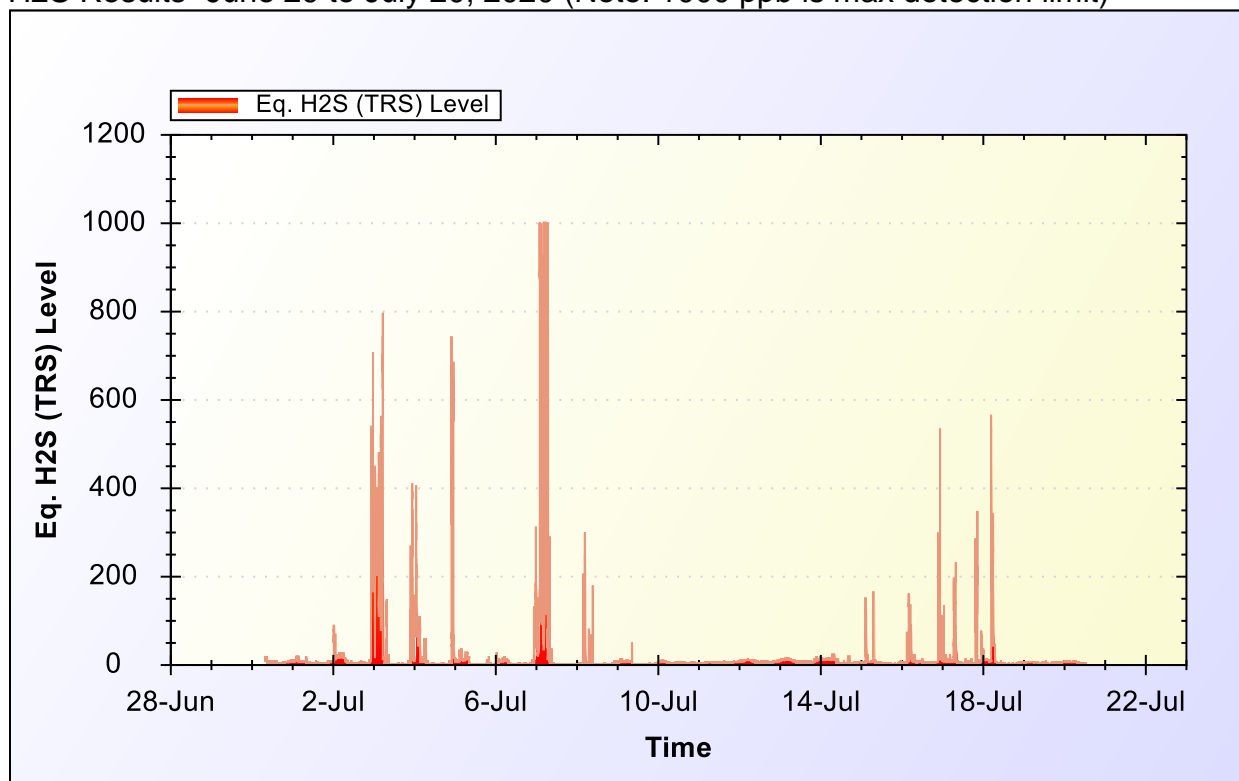
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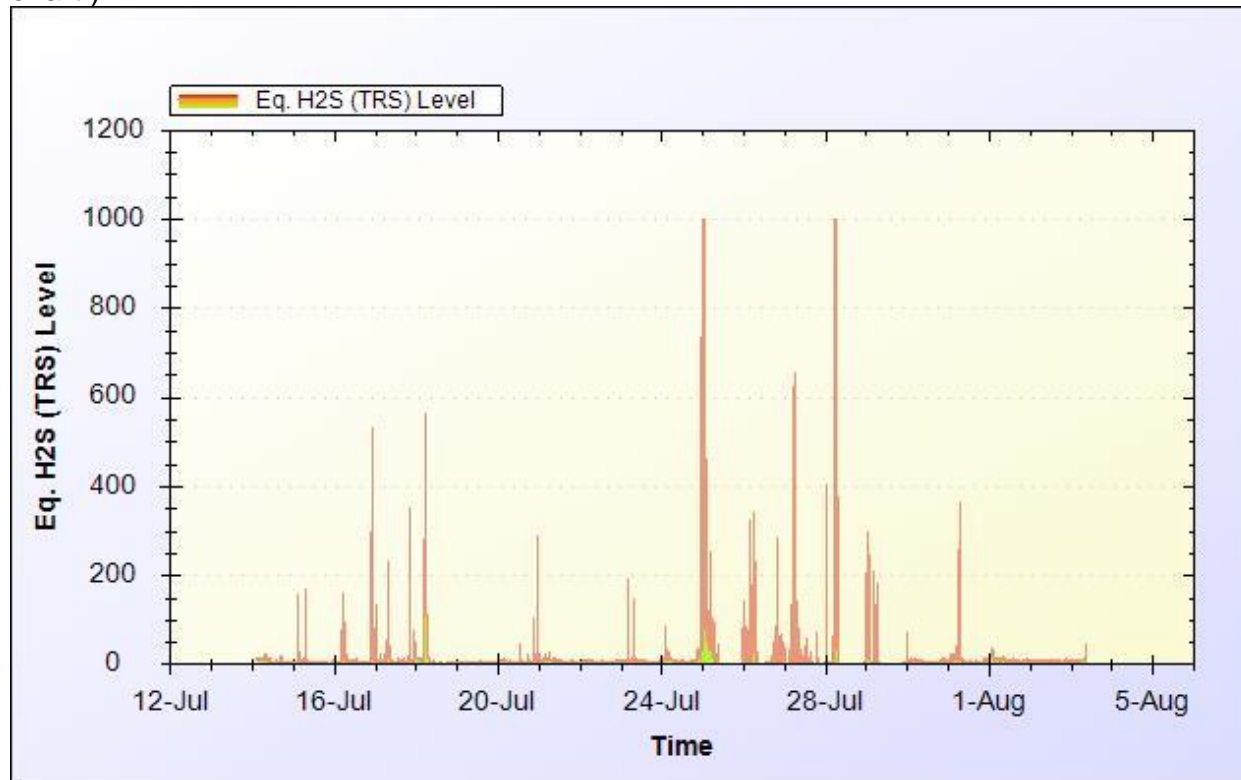
H2S Results -July 10 - 18, 2019 (Note: 1000 ppb is max detection limit)



H₂S Results -June 29 to July 20, 2020 (Note: 1000 ppb is max detection limit)



H₂S Results -July to August 3, 2020 (Note: Some of the results overlap with previous chart.)

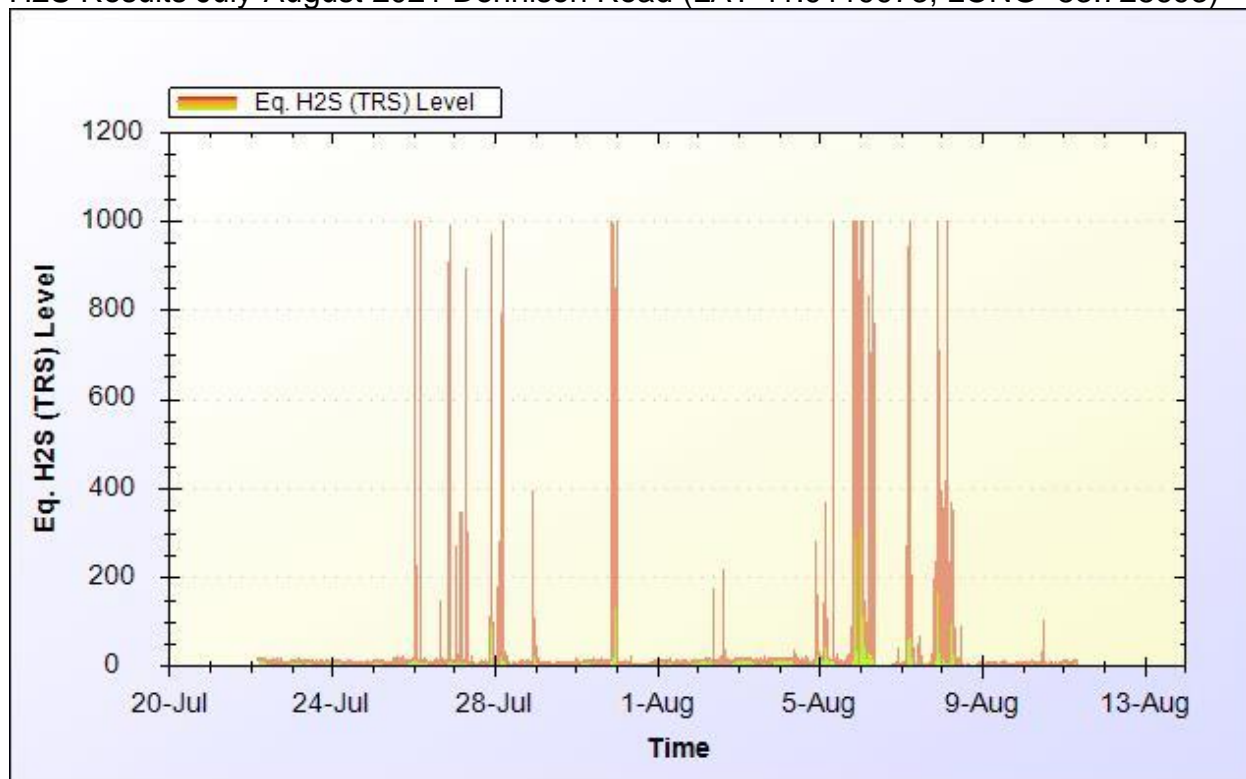


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H₂S Results July-August 2021 Dennison Road (LAT 41.9119973, LONG -83.728693)

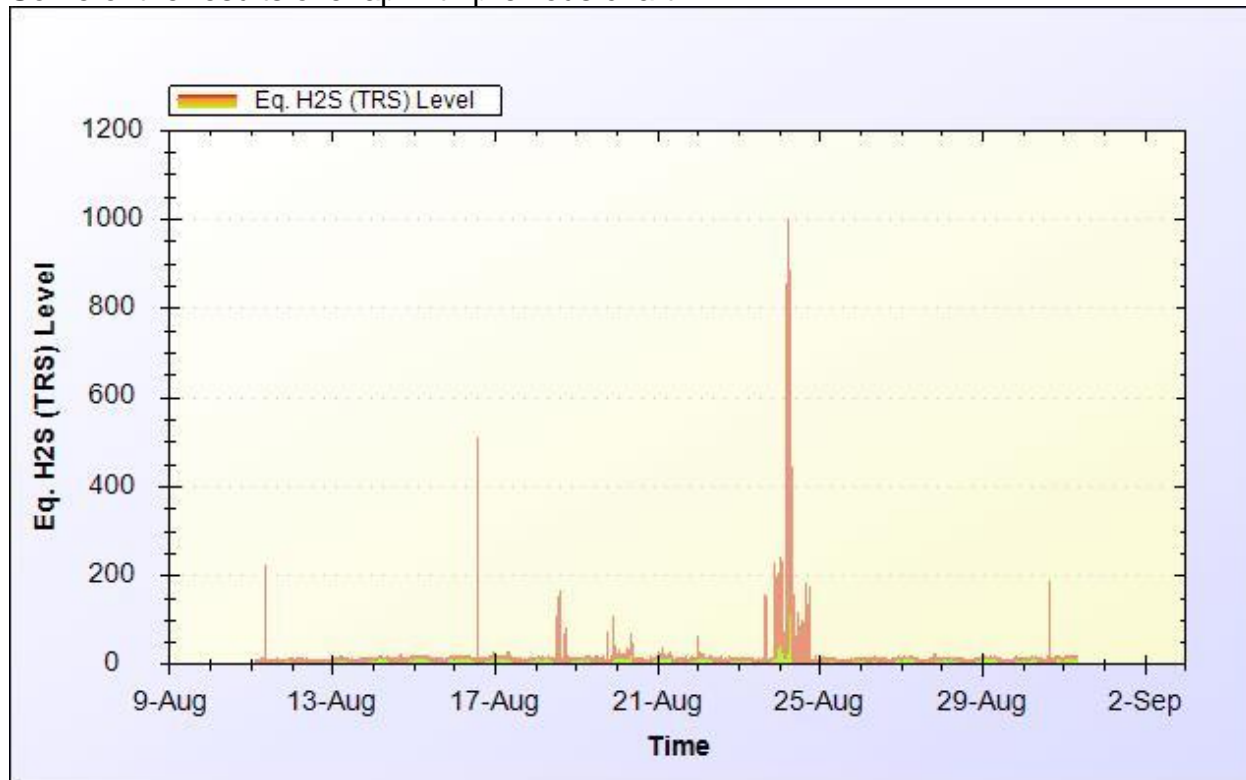


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H₂S Results August 2021 Dennison Road (LAT 41.9119973, LONG -83.728693) Note: Some of the results overlap with previous chart.



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H₂S Results August 2021 Dennison Road Location #2 (LAT 41.936363, LONG - 83.731066)

