COLORADO
Air Pollution Control Division
Department of Public Health & Environment

Platte River Biogas Winter Report

December 18, 2024 – January 16, 2025

Background

● Platte River Biogas, LLC (PRB) is a facility in La Salle that processes manure into renewable gas. CDPHE and Weld County have received numerous health and odor concerns from nearby residents.
● Elevated levels of hydrogen sulfide (H_2S) from mobile monitoring and facility sensors led CDPHE to investigate further.
    ○ Hydrogen sulfide levels measured near open air manure pits on facility property on Oct. 30, 2024, were above health guideline values but within occupational limits.
    ○ Mobile monitoring at nearby residences on Dec. 15, 2024 indicated ambient concentrations were well below levels associated with short-term health impacts.
    ○ The Air Pollution Control Division is working with the facility to replace faulty sensors to ensure ongoing safety.
● CDPHE conducted additional monitoring from Dec. 18, 2024, to Jan. 16, 2025, at a nearby residence. This report assesses the potential public health impacts of H_2S levels measured during this deployment and presents the data collected during monitoring.

Summary of health perspective

Hydrogen sulfide measurements during one month of monitoring near PRB do not indicate levels associated with short-term health impacts to nearby residents. Additional monitoring is warranted under different conditions, such as in the summer, when ambient concentrations may be higher. More monitoring would allow for better assessment of health risk from long-term exposures. As part of HB21-1244, CDPHE will continue to study hydrogen sulfide levels here and at other places across the state as we work to understand the impacts of this priority air toxic. CDPHE will also continue working to propose health-based standards and emission control strategy regulations to reduce health risk from hydrogen sulfide in Colorado.

What we know

● Manure collection pits are used to control agricultural animal waste. This process releases methane gas, hydrogen sulfide, and other air pollutants.
● CDPHE measured hydrogen sulfide levels at homes near PRB from Dec. 18, 2024, to Jan. 16, 2025.
    ○ Hydrogen sulfide levels were below levels associated with short-term health impacts.[1]
    ○ Long-term health risks cannot be fully evaluated given the high variability in measured levels. Levels of hydrogen sulfide are also expected to be higher in the summer, therefore additional monitoring is planned.[2]
    ○ Hydrogen sulfide levels were frequently above the odor threshold, indicating that nearby individuals may notice the rotten egg smell.[3]
● Exposure to low levels of hydrogen sulfide can cause health impacts including headache, poor memory, tiredness, balance problems, fatigue, and eye, nose, and throat irritation.
● This deployment also measured benzene and toluene. These compounds did not exceed health guideline values.
● CDPHE has contacted the four residences within 3,000 feet of the facility.

What we don't know

● We are still learning about how much hydrogen sulfide may be released during different conditions. Environmental conditions like temperature influence the release of hydrogen sulfide, methane, and other gases from biogas facilities.
● Whether measured conditions represent normal operations at the facility and whether the facility was using best management practices to reduce potential emissions.
● Whether communities exposed to measured levels will experience health effects. Not all people have the same risk; age, gender, genetics, lifestyle, and other factors play a role in how exposure to a toxic substance impacts an individual's health.
● We didn't evaluate how hydrogen sulfide could combine with other air pollutants to impact health.

[1] The maximum 1-hour average hydrogen sulfide level was 20.3 ppb, which is below the health guideline value for short-term exposure of 70 ppb from the Agency for Toxic Substances and Disease Registry.

[2] The average hydrogen sulfide level was below the health guideline value for long-term exposure of 1.43 ppb from the EPA, but there was high variability in the measured levels.

[3] The odor threshold detection range is 0.5-300 ppb per the Agency for Toxic Substances and Disease Registry, indicating the level at which the rotten egg smell is first noticeable to different individuals.

What could be done to reduce the uncertainty

● Conduct additional monitoring to determine how hydrogen sulfide levels vary during different seasons and at different sources of hydrogen sulfide.
● Perform modeling to evaluate if the measured hydrogen sulfide levels are expected based on APCD's understanding of emission rates from either reported or permitted emissions from this facility.

Measurement Introduction

As part of CDPHE's commitment to measuring air toxics of concern, the Platte River Biogas, LLC facility, a facility that converts manure into natural gas, was selected for air monitoring, beginning December 18, 2024. To monitor potential air toxics emitted from Platte River Biogas, a Teledyne T101 H_2S analyzer, an Aeris MIRA LDS analyzer, and an Entanglement Technologies AROMA-VOC were deployed within a Mobile Air Remote MOnitoring Trailer (MARMOT) for near real-time detection of hydrogen sulfide (H_2S), methane (CH_4), ethane (C_2H_6), benzene, toluene, ethyl benzene and xylenes (BTEX), which are air toxics and greenhouse gases potentially present in the conversion process. Data from this deployment can be found in the ATOPs data repository. These measurements were taken to determine whether the Platte River Biogas facility is emitting hydrogen sulfide, whether the hydrogen sulfide correlated with methane - , a potent greenhouse gas, and whether other air toxics of concern (BTEX) are being emitted from the facility. This report describes data collected for the deployment.

Measurement Methods

In order to measure hydrogen sulfide, methane and ethane, and BTEX, three instruments were used. For hydrogen sulfide, measurements were performed using a Teledyne T101 H_2S analyzer (hereafter referred to as Teledyne). The Teledyne measures hydrogen sulfide through fluorescence, a process in which a molecule emits visible light. In order for this process to occur, hydrogen sulfide must be changed to sulfur dioxide (SO_2) by heating which changes each individual hydrogen sulfide molecule to an individual SO_2 molecule. That SO_2 molecule then absorbs light from an ultraviolet lamp and re-releases visible light where it is detected to represent the hydrogen sulfide concentration. This process produces a measurement approximately once per second.

For methane and ethane, measurements were performed using an Aeris MIRA LDS analyzer (hereafter referred to as Aeris). The Aeris collects air samples, and quantifies methane and

ethane by how much infrared light has been absorbed by each compound. It collects data once per second.

For BTEX, measurements were performed using an Entanglement Technologies AROMA-VOC (hereafter referred to as AROMA). The AROMA consists of three main components: traps to collect BTEX and other volatile organic compounds (VOCs) from the air, a thermal separator to separate the sample into individual compounds (like benzene, toluene, ethyl benzene, and xylenes), and a detector to identify and quantify the concentrations of each compound in air approximately every 10 minutes per sample.

To perform these measurements, these instruments were deployed in a Mobile Air Remote MOnitoring Trailer (MARMOT) with a Gill Maximet GMX501 meteorological station at a residence directly west of the Platte River Biogas facility in La Salle, Colorado on 12/18/2024. The Maximet meteorological station measures wind speed, wind direction, temperature, solar radiation, and relative humidity. These meteorological measurements are used to determine the direction in which air toxics and greenhouse gases measured by the Teledyne, Aeris, and AROMA are coming from.

The resident provided shore power for the instruments, computer, and temperature control of the MARMOT shelter. This sampling location is approximately 2000 feet from the center of the Platte River Biogas facility (40.279339, -104.608783), as shown in Figure 1. This facility processes manure into renewable gas. The range of wind directions likely to incorporate emissions from Platte River Biogas (i.e., source winds) are greater than 23° and less than 97° (Figure 1).

Figure 1. Aerial view of the Platte River Biogas facility (yellow pin), including the location of the MARMOT monitoring station (blue tram), surrounding communities, and the range of wind directions coming from Platte River Biogas.

Measurement Results

While three instruments, the Teledyne, Aeris, and AROMA, were deployed, the majority of the results and discussion will center around the hydrogen sulfide measurements because hydrogen sulfide is the primary air toxic of concern emitted from the Platte River Biogas facility. Measurements are averaged to one hour. Hourly rolling averages, when used, are taken from minute-averaged data.

The time series trends of hydrogen sulfide, methane, ethane, wind speed, and wind direction are shown in Figure 2. Hydrogen sulfide correlates well with methane, and has weak to moderate correlation with ethane. During the deployment, there was some correlation of elevated hydrogen sulfide and methane when wind directions were above 23° and below 97°. All but one 1-hour-averaged hydrogen sulfide concentration above 10 ppb coincided with these

wind directions, suggesting air coming from the direction of the Platte River Biogas facility is the source of hydrogen sulfide at this residence.

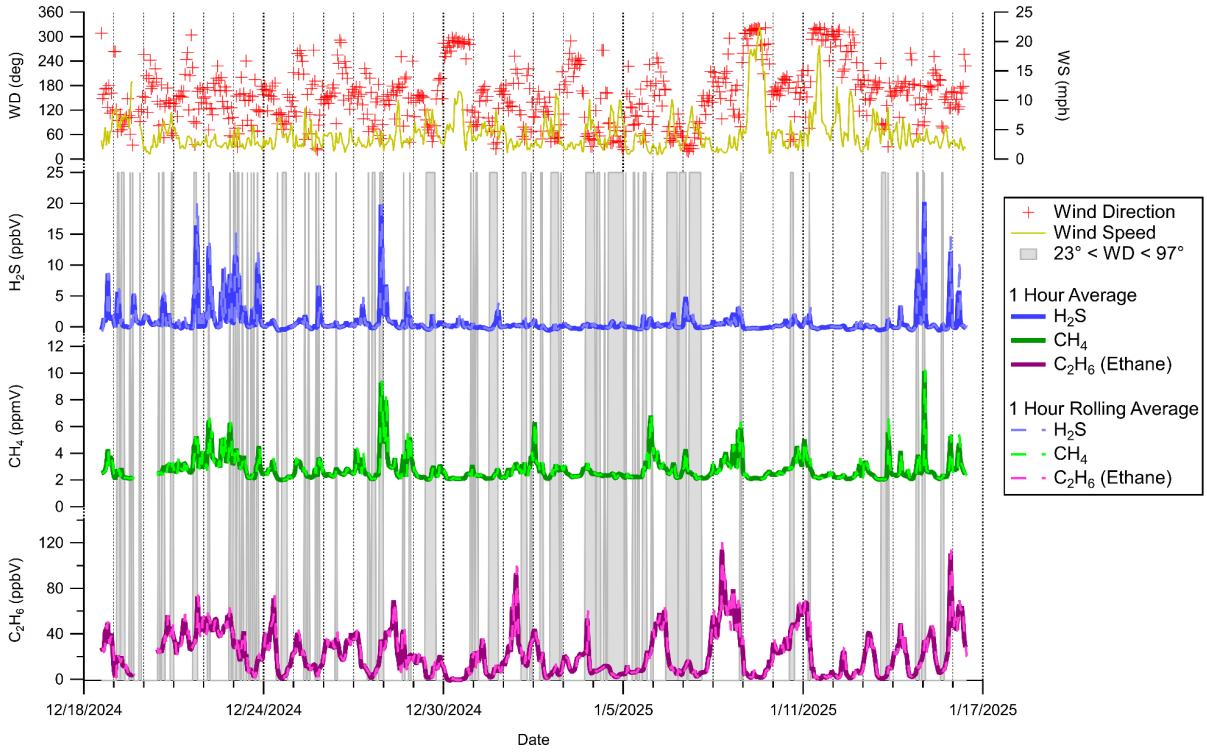

Figure 2. Four panels, from top to bottom, showing time series measurements of wind direction (red markers, left axis) and wind speed in mph (yellow line, right axis), hydrogen sulfide (H_2S) in ppbV (blue line), methane (CH_4) in ppmV (green line), and ethane (C_2H_6) in ppbV (purple line). Solid lines are one hour averages, dashed lines are rolling 1 hour averaged data. Gray shading shows periods of time when winds were coming from the direction of Platte River Biogas.

For the deployment, there were 692 one-hour samples of hydrogen sulfide, resulting in an hourly data coverage of 99.7%. The average hydrogen sulfide concentration was observed to be 0.82 ppb. The median observation fell below the method detection limit (0.4 ppb) of the Teledyne, demonstrating a higher frequency of concentrations measured below the average. The maximum hydrogen sulfide rolling one-hour average concentration during the deployment was 20.3 ppb, observed on 01/15/2025 between 1:02 - 2:02 AM (Figure 2). This measurement was associated with a wind direction of 88°, consistent with the direction of the manure piles present at Platte River Biogas, based on satellite observation (Figure 1).

The maximum one hour rolling average hydrogen sulfide measurement also correlated with a methane measurement of 10.2 ppm (the maximum methane concentration observed), and an

ethane measurement of 34.8 ppb, both elevated relative to background (typically observed in unpolluted air) concentrations. As both methane and ethane are components of natural gas, this provides supporting evidence that the hydrogen sulfide observed is coming from the direction of Platte River Biogas facility, as it converts manure (which contains hydrogen sulfide) into natural gas, of which methane and ethane are primary components. It is possible that these emissions are influenced from the oil and gas wells 400 feet to the east of Platte River Biogas (Figure 1).

Of the 692 hourly-averaged hydrogen sulfide measurements, 18% were greater than 1 ppb, 5.9% were greater than 3 ppb, 4.2% were greater than 5 ppb, 1.1% were greater than 10 ppb, and 1 measurement was greater than 20 ppb. The majority (65%) were below the method detection limit.

The time series trends of meteorological data (wind direction/speed, temperature, and relative humidity), benzene and toluene, and hydrogen sulfide are shown in Figure 3. Benzene and toluene were measured by the AROMA co-located with the Teledyne T101 H_2S analyzer. There was little correlation between hydrogen sulfide and benzene, or toluene, with the exception of measurements made on 01/10/2025 and 01/11/2025 with wind directions between 29° and 70°. It is possible that these BTEX emissions are influenced by the oil and gas wells 400 feet east of Platte River Biogas (Figure 1). These results cannot exclude that some activities at Platte River Biogas emit BTEX, but they are infrequent and likely not tied directly to natural gas conversion.

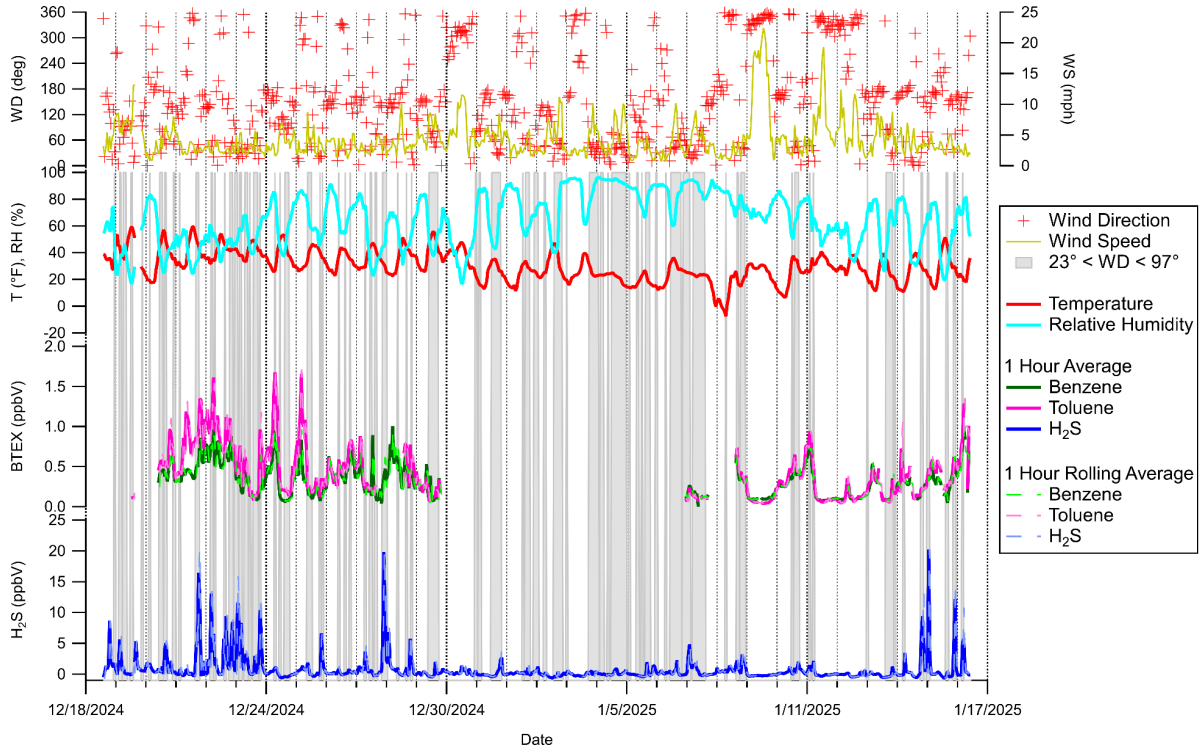

Figure 3. Four panels showing measurements, from top to bottom, of wind direction in degrees (red markers, left axis), wind speed in mph (grey line, right axis), temperature in °F (red line), relative humidity in % (RH, cyan line), benzene in ppbV (green line), toluene in ppbV (pink line), and hydrogen sulfide (H_2S) in ppbV (blue line). Solid lines are one hour averages, dashed lines are rolling one hour averages. Gray shading shows periods of time when winds were coming from the direction of Platte River Biogas.

In order to evaluate the source winds of hydrogen sulfide pollution, a polar plot was generated (Figure 4). These plots show the wind direction (described by angle) and wind speed (shown as distance from the plot center) measured for each hydrogen sulfide one hour measurement. By color-coding the plot by hydrogen sulfide concentration, the source direction of hydrogen sulfide pollution can be identified. The highest hydrogen sulfide concentrations were observed from winds that were coming from NE of the residence, typically at lower wind speeds (wind speeds < 5 mph), as shown in Figure 4. This suggests that the majority of hydrogen sulfide pollution observed at the residence is from source winds from the direction of the Platte River Biogas facility.

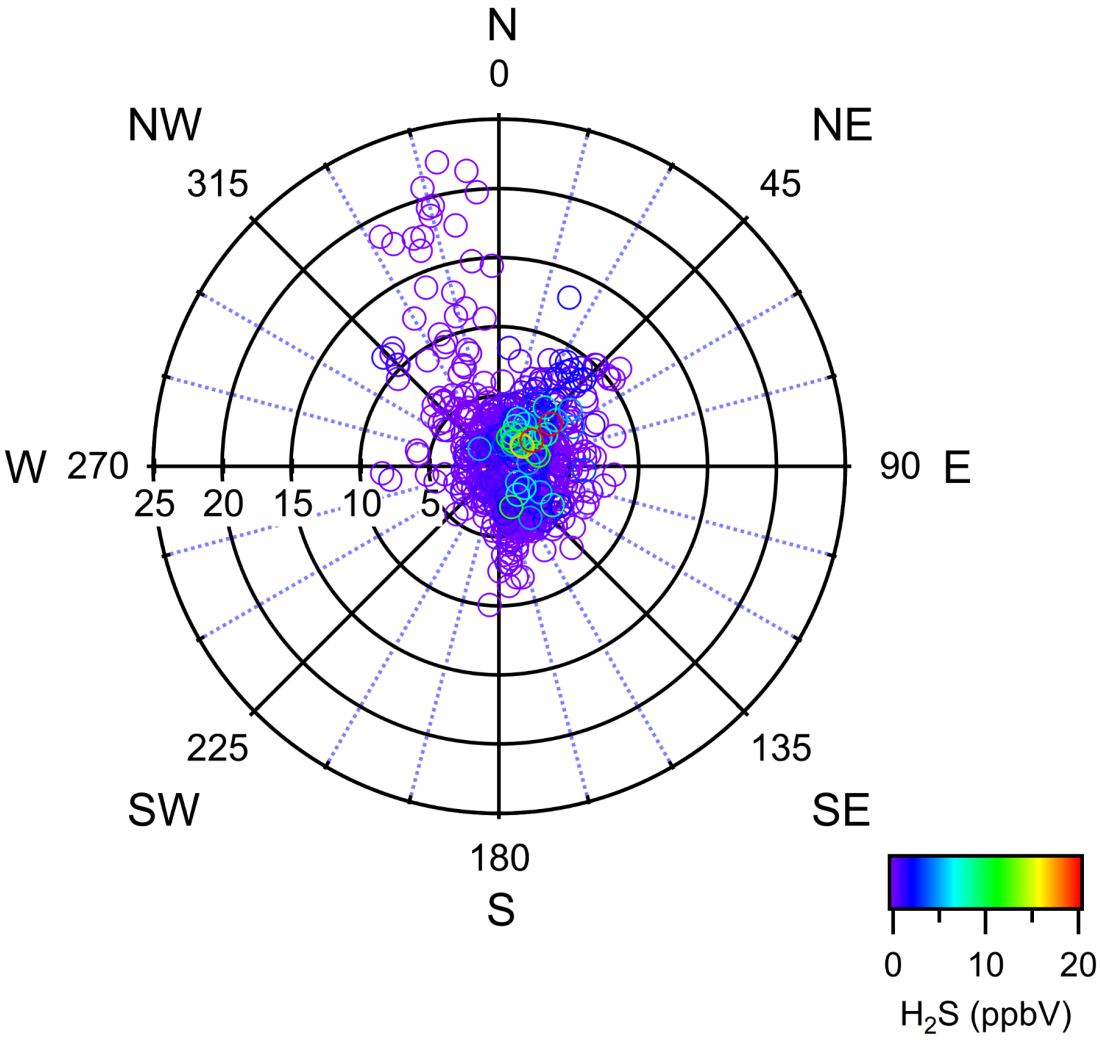

Figure 4. Polar plot of one hour averages of wind speed and wind direction. The angle data is wind direction (degrees) and the radial data is wind speed (mph). Each marker is colored by the hydrogen sulfide (H_2S) concentration determined at the same time a given wind speed and direction measurement is made to demonstrate the potential source winds of the pollution.

Table 1 reports the sampling statistics for the rolling one hour averages of the measurements shown in Figures 2-4, as well as health guideline values (HGV) for each compound. The averages, standard deviations, and medians are calculated by representing negative values as zeroes, and measurements below the method detection limit as half the method detection limit values. Minimum values are the smallest value observed above the method detection limit for a

given instrument. The median hydrogen sulfide value was below the method detection limit, therefore no value is reported. The median represents the middle measurement: half the measurements are greater, half are less, and 65% of all measurements were below the method detection limit. The average represents all the concentration measurements divided by the number of measurements. Therefore, the hydrogen sulfide median concentration is less than the average (0.82 ppb) due to a large number of measurements occurring below the hydrogen sulfide method detection limit compared to fewer measurements where hydrogen sulfide is greater (Figure 5).

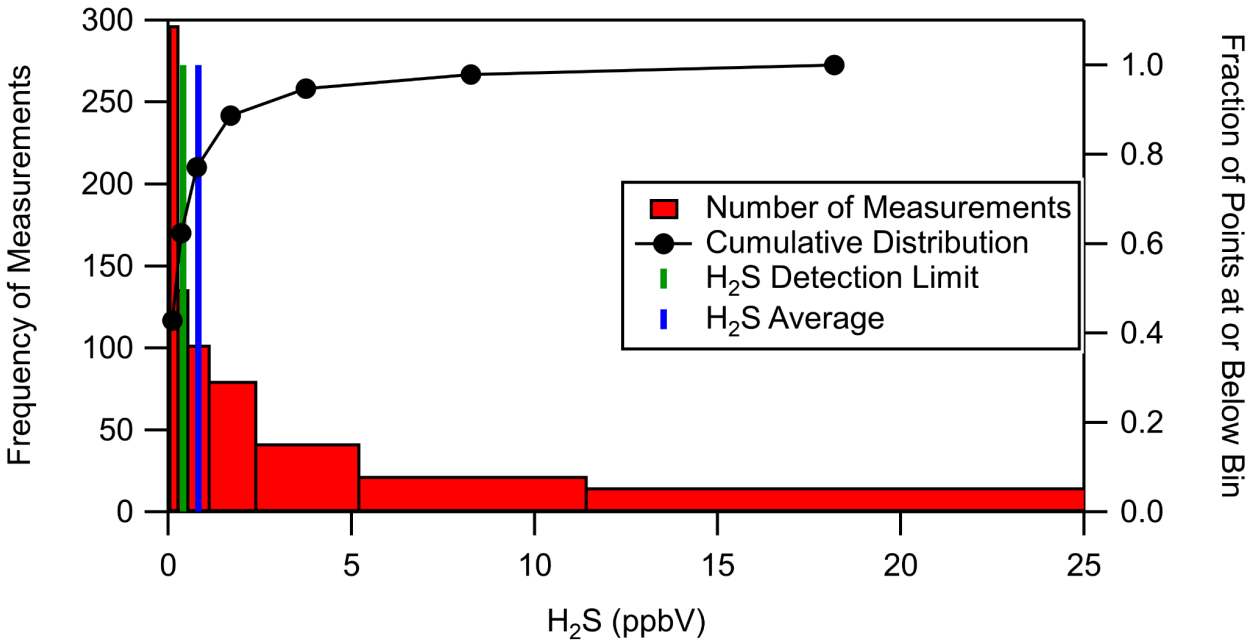

Figure 5. Plot showing a histogram of hydrogen sulfide (H_2S) measurements. The left axis shows the number of hydrogen sulfide (H_2S) measurements for a given binned concentration on the bottom axis. The fraction of points at or below the binned concentration (black circle markers and black lines) is read from the right axis. The method detection limit (green vertical line) intersects with the point where 65% of the measurements are below that value, and is read from the bottom axis. The blue vertical line is the average of all hydrogen sulfide one hour averaged measurements, and is read from the bottom axis.

Table 1. Statistical data (min, max, average, standard deviation) for the cumulative sampling periods, one-hour health guideline value (HGV) and chronic HGV. Median, average, and standard deviation are from one hour averages. The minimum, and maximum from one hour rolling averages of one minute data, except benzene and toluene, which are rolling one hour averages from the AROMA sampling time resolution (~10 minutes). One-hour HGV values are compared to maximum one-hour values, chronic HGV values are compared to average values.

	Reporting Period (Dec. 18 - Jan. 16)						
	Average	**Standard Deviation**	**Median**	**Min**	**Max**	**One-Hour HGV**	**Chronic HGV**
Hydrogen Sulfide (H_2S) (ppbV)	0.82	2.1	Below Detection Limit	0.40	20.3	70	1.43
Methane (CH_4) (ppmV)	2.79	0.87	2.49	2.01	10.22	*	*
Ethane (C_2H_6) (ppbV)	22.2	18.9	17.9	0.50	120.9	*	*
Benzene (ppbV)	0.32	0.21	0.30	0.062	1.0	9	3
Toluene (ppbV)	0.42	0.33	0.34	0.12	1.7	2000	1327
Wind Speed (mph)	4.3	3.1	3.6	0.7	22.9	N/A	N/A
Temperature (°F)	30.2	11.3	29.0	-8.1	59.7	N/A	N/A
Relative Humidity (%)	64.7	19.8	66.0	16.2	96.4	N/A	N/A

***Methane and ethane have no acute or chronic health guideline values reported.

Measurement Summary

During the measurement period of December 18, 2024 to January 16, 2025, average hydrogen sulfide concentrations were 0.82 ppb with a median value below the limit of detection. A maximum one hour rolling average of 20.3 ppb occurred on 01/15/2024 between 1:02 - 2:02 am. Elevated hydrogen sulfide concentrations were observed from source winds coming from the direction of the Platte River Biogas facility. These hydrogen sulfide enhancements correlated with elevated methane and ethane suggesting that the Platte River Biogas facility is the main source of hydrogen sulfide air toxics at the residence.