# Air Quality Measurements Near Mushroom Farming Operations in Southeast PA


## AUTHORS

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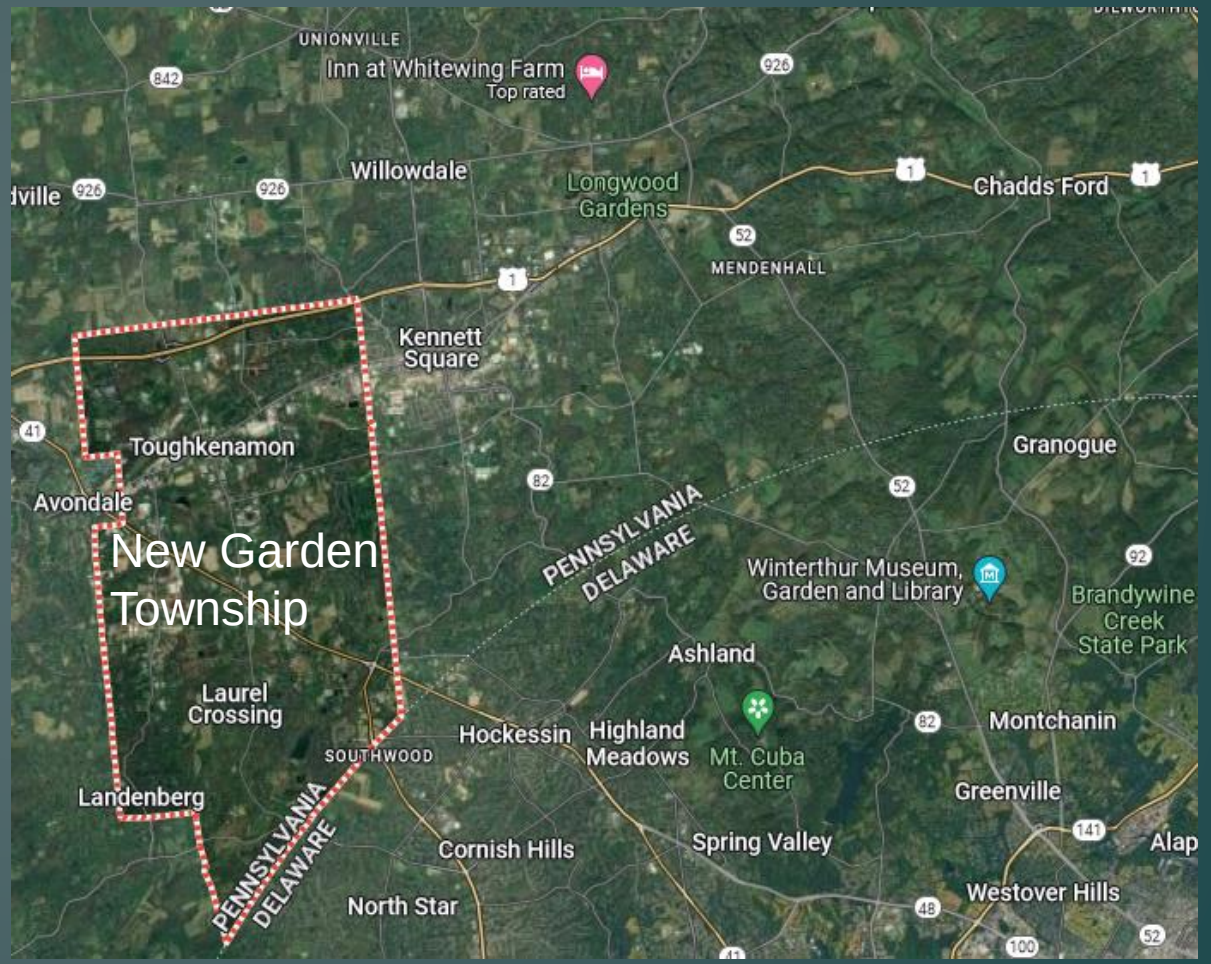
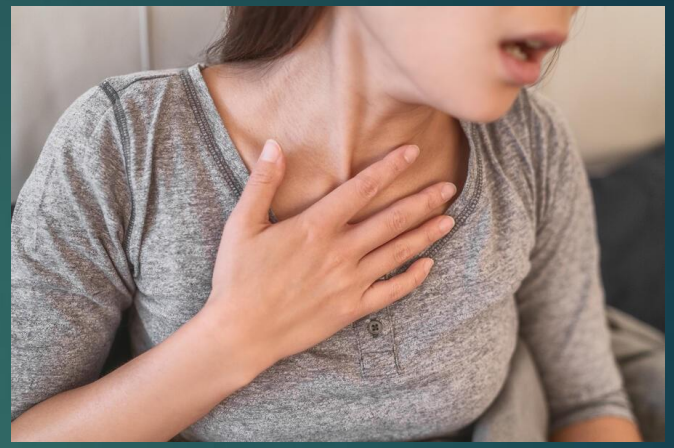
# Project Background and Origins

- Growth of mushroom industry
  - Half of fresh mushrooms grown in US come from South-East PA
- Residential Concerns:
  - Noxious Odor Complaints
  - Outdoor Metal Corrosion
  - Health
- Scope:
  - Conduct ambient air sampling in New Garden Township



# Introduction

# Health Concerns



- Compost mixture for mushroom growth:
  - Horse/chicken manure
  - Straw
  - Grain byproducts
  - Calcium disulfate (gypsum)
- Decay of organic matter generates gases with associated heath concerns: hydrogen sulfide, methane, and ammonia
- Hydrogen Sulfide Exposure
  - **Low Concentrations** (0 ppm – 10 ppm) Strong odor of rotten eggs, irritation of eyes and respiratory system are common
  - **Elevated Concentrations** (10-50 ppm) Onset of dizziness, nausea, headache
  - **High Concentrations** (50 ppm and higher) Severe respiratory irritation, convulsions, coma, death, sense of smell becomes rapidly fatigued (lost ability to detect gas)

# $H_2S$ Exposure Regulations

## Occupational

- National Institute of Occupational Health and Safety (NIOSH)
  - Recommends no more than 10 ppm exposure up to 10 mins max
- Occupational Safety and Health Administration (OSHA)
  - Permits concentrations up to 20 ppm in an occupational setting

## General Public

- Ambient Standard established by PA Department of Environmental Protection
  - Concentrations released over the course of 1 hour should not exceed 0.1 ppm on average
  - Concentrations released over the course of 24 hours should not exceed 0.005 ppm on average

# Literature Review

- Pilot study in SE PA (Cobb et al., 1995)
  - Health effects reported by residents
  - Surveyed 75 people; could not link symptoms with exposure
  - No elevated air pollutants detected (sampled for 1 day only)
- Latinx Employees of Mushroom Industry (Sexsmith et al., 2022)
  - Building designs, measured $CO_2$, moisture, temperature, airflow
  - Did not investigate gas exposures among workers
- PA DEP/DOH data and highest conc. recorded in 2022
  - 0.2 parts per million (ppm)

# Objectives

- **Research Questions**:
  - Are there elevated concentrations of toxic gases?
  - How do concentrations vary over time?

# Goal

- Quantify general public exposure to methane, hydrogen sulfide, and ammonia gases released near fresh mushroom production facilities for 1 year

# Materials and Methodology

# Gas Sampling Devices

- G7 EXO Area Monitor
  - 3 devices located 100-600 feet from composting sites
  - Sampling for $NH_3$, $CH_4$, $H_2S$
  - Record readings in 10 second intervals from Feb 2023 - Feb 2024
  - Calibrated within manufacturer's specification; no more than every 180 days

# Weather Station & Area Monitor


Location A
Location B
Location C
Starr Rd

# RESULTS

# Of Concern

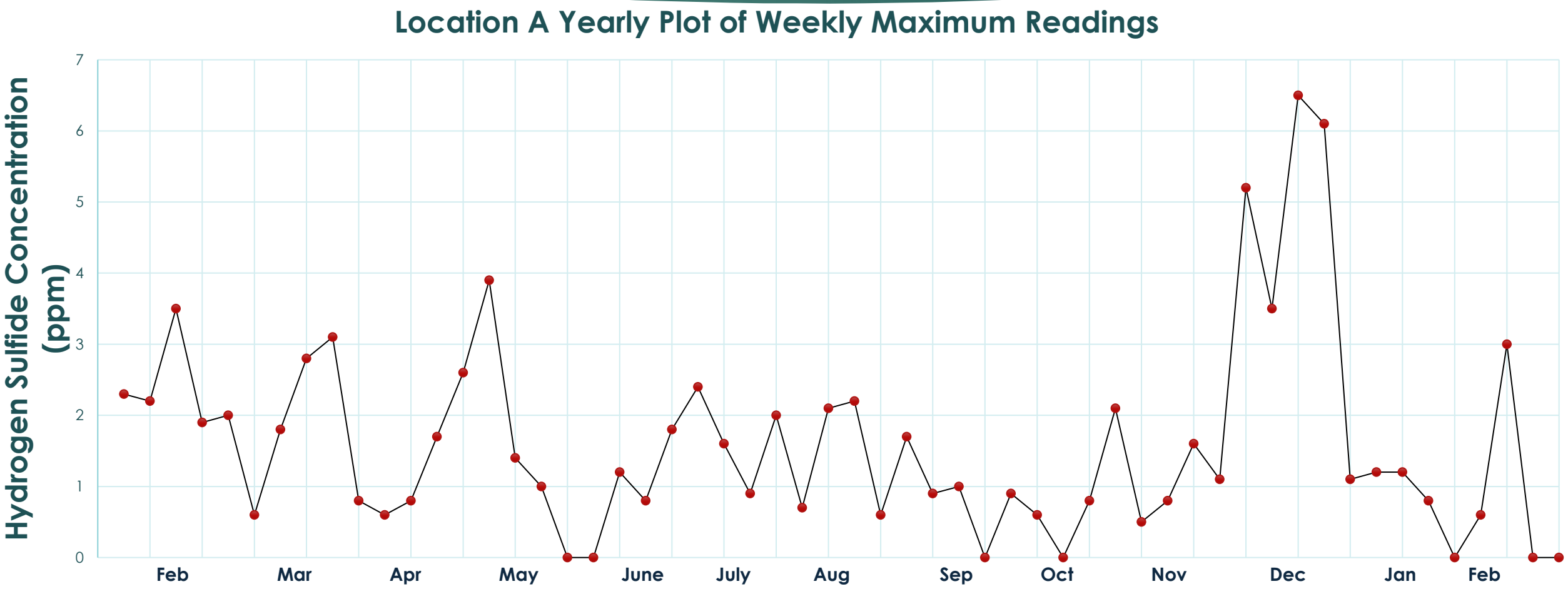
- Hydrogen Sulfide ($H_2S$) readings exceeded PA DEP regulation on Ambient Air Quality
  - Concern for general public and sensitive populations (e.g., asthma, children, pregnancy)
  - Elevated levels did not exceed occupational regulations
  - Elevated levels showed irregular patterns

# Not of Concern

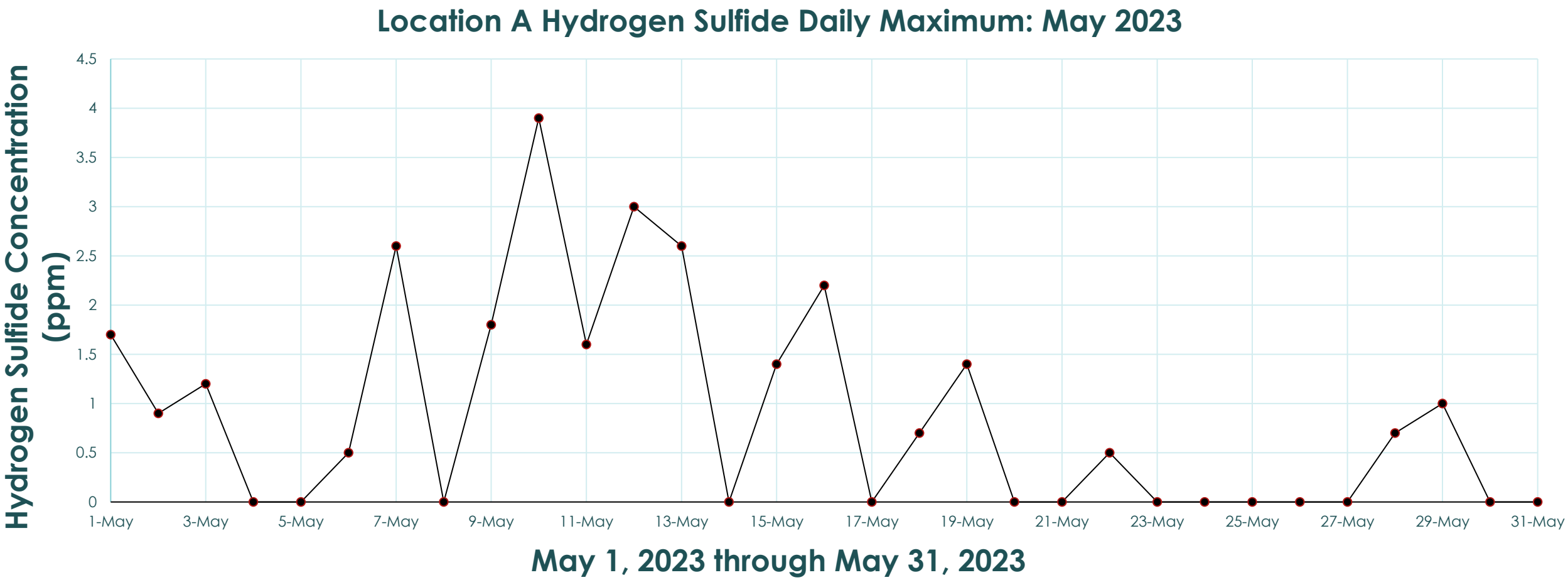
- No elevated levels of $NH_3$ were observed
- No elevated levels of $CH_4$ were observed

# Location A Readings

# February 2023 to February 2024



# Location A Spring 2023



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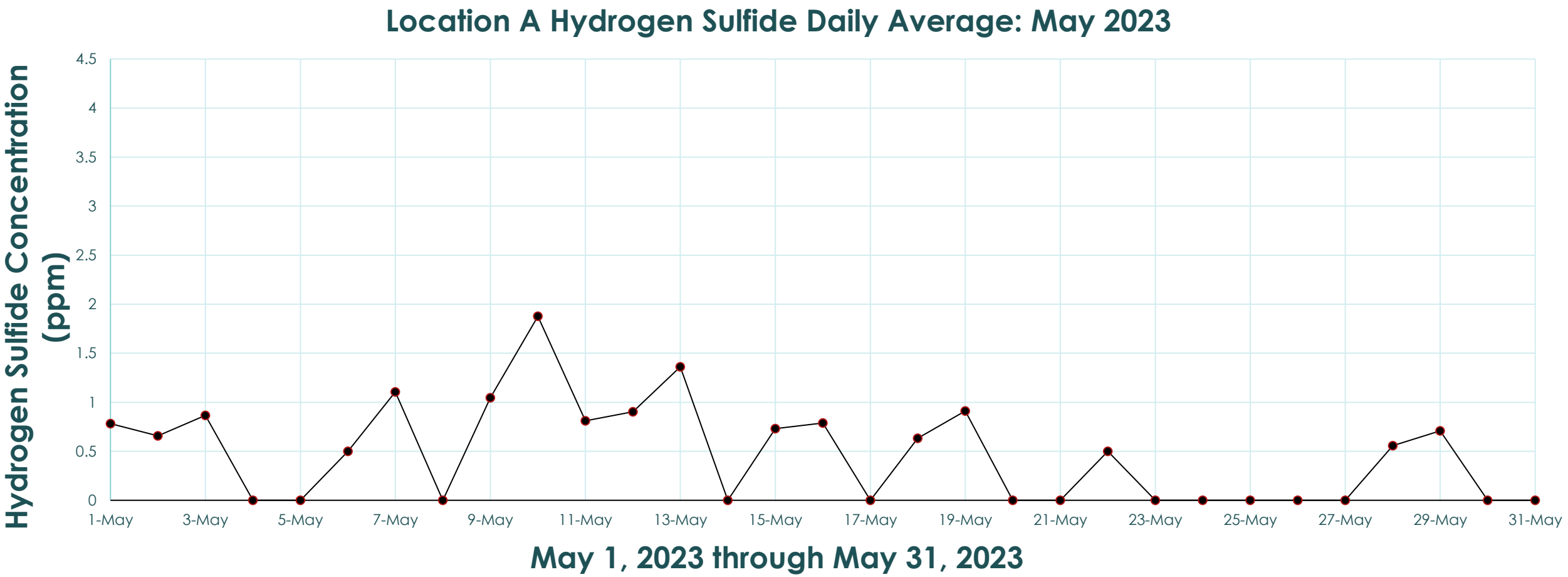
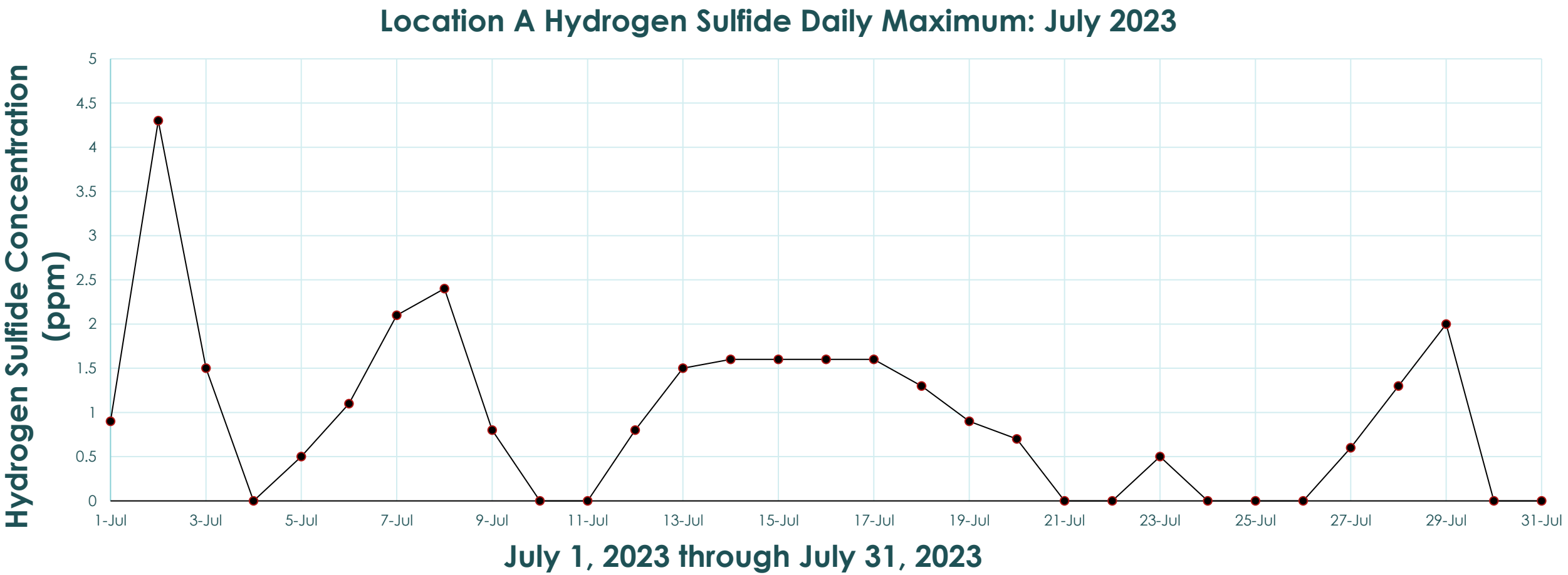
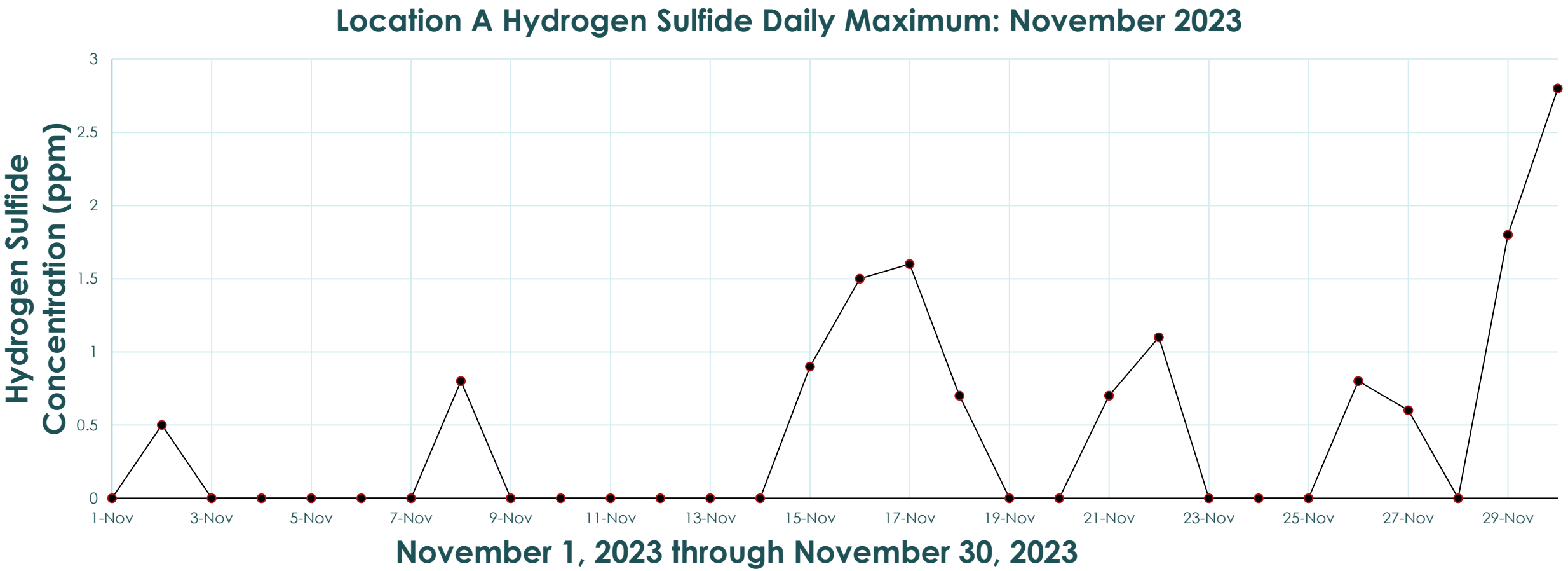


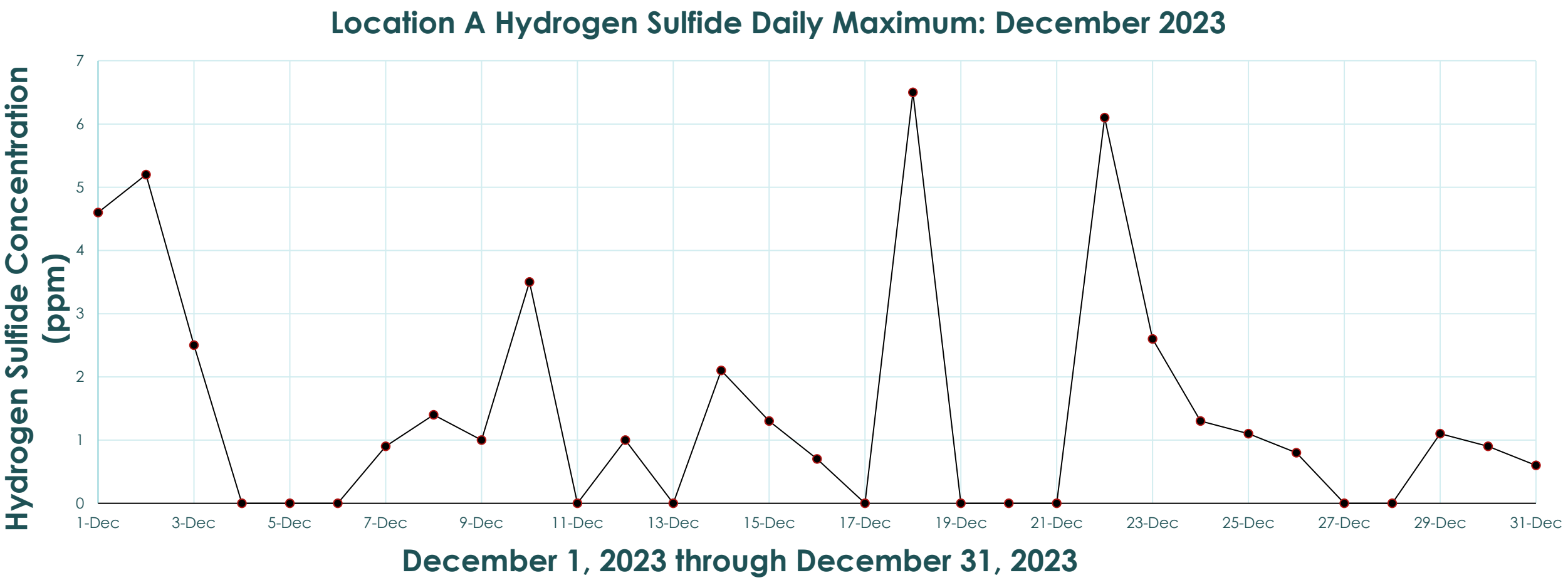
# Location A Summer 2023



# Location A Fall 2023

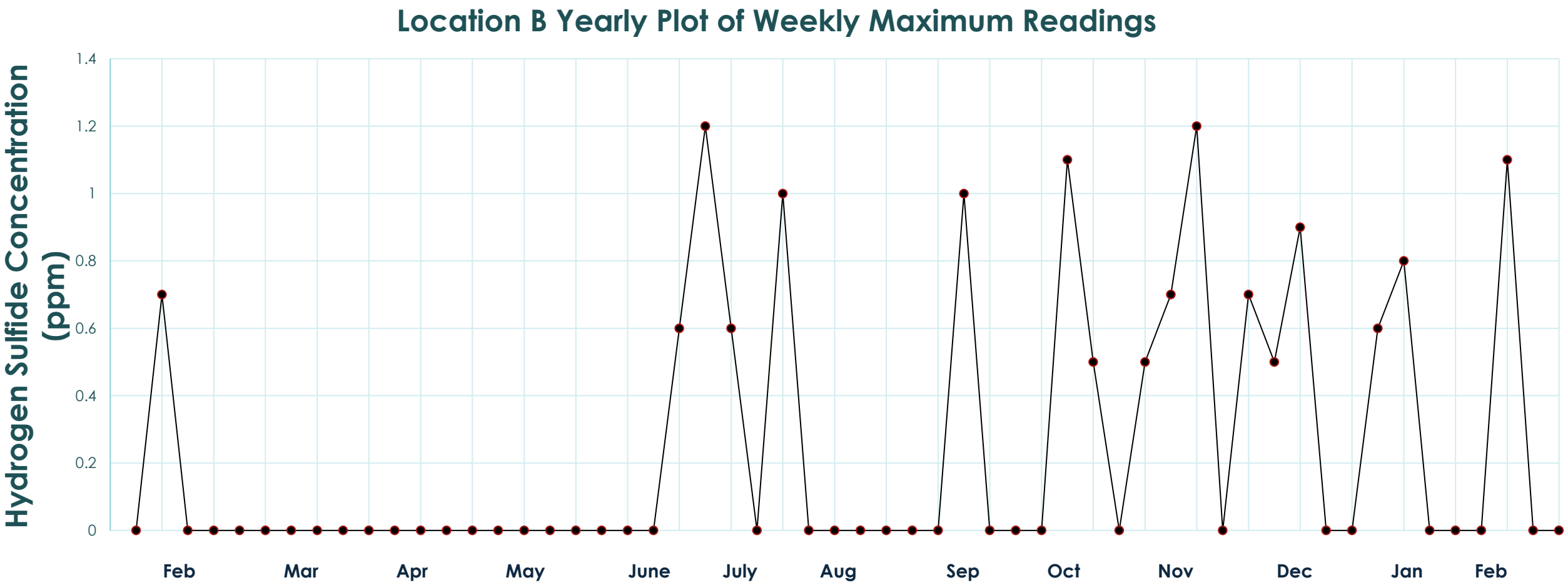


# Location A Winter 2023

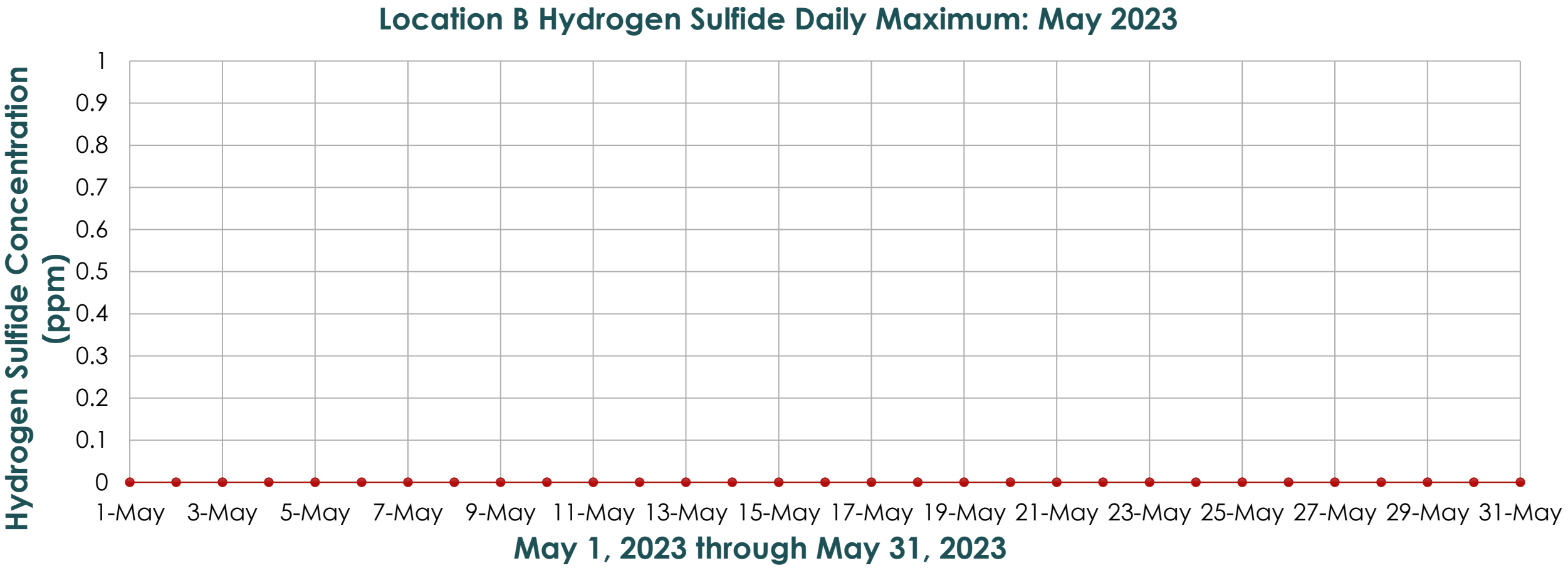


# Location B Readings

# February 2023 to February 2024



# Location B Spring 2023



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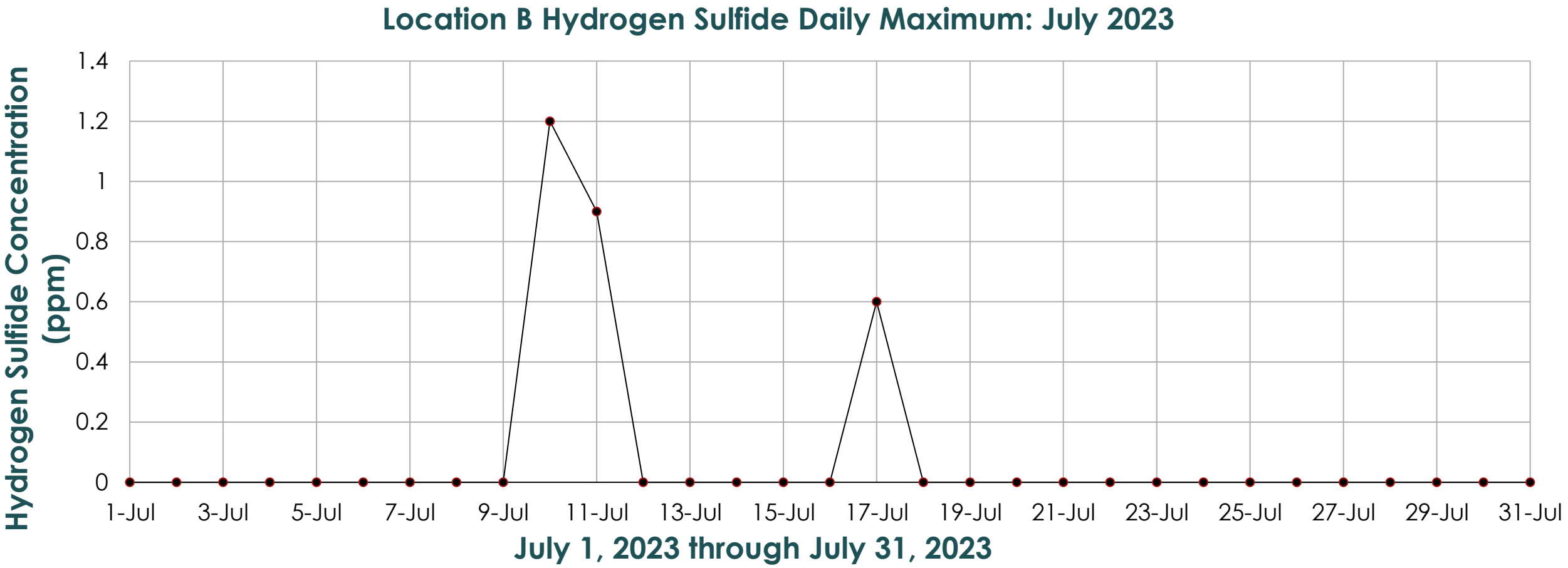

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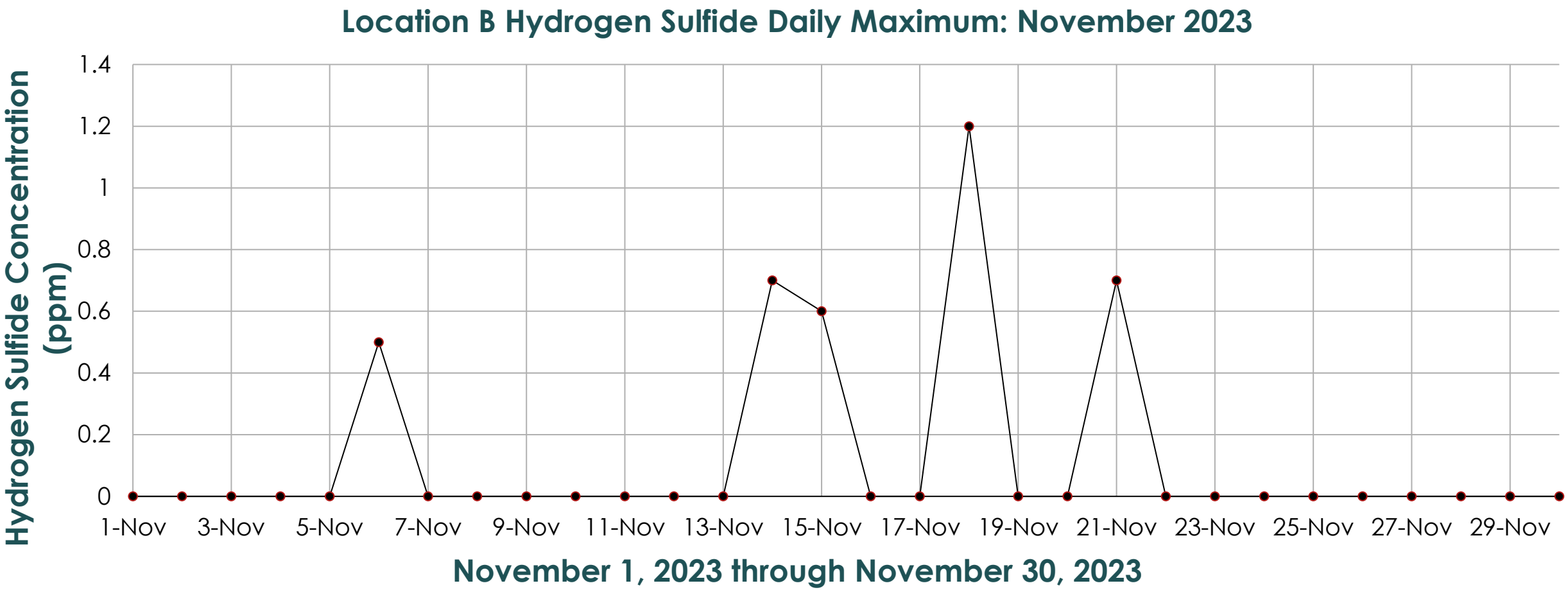

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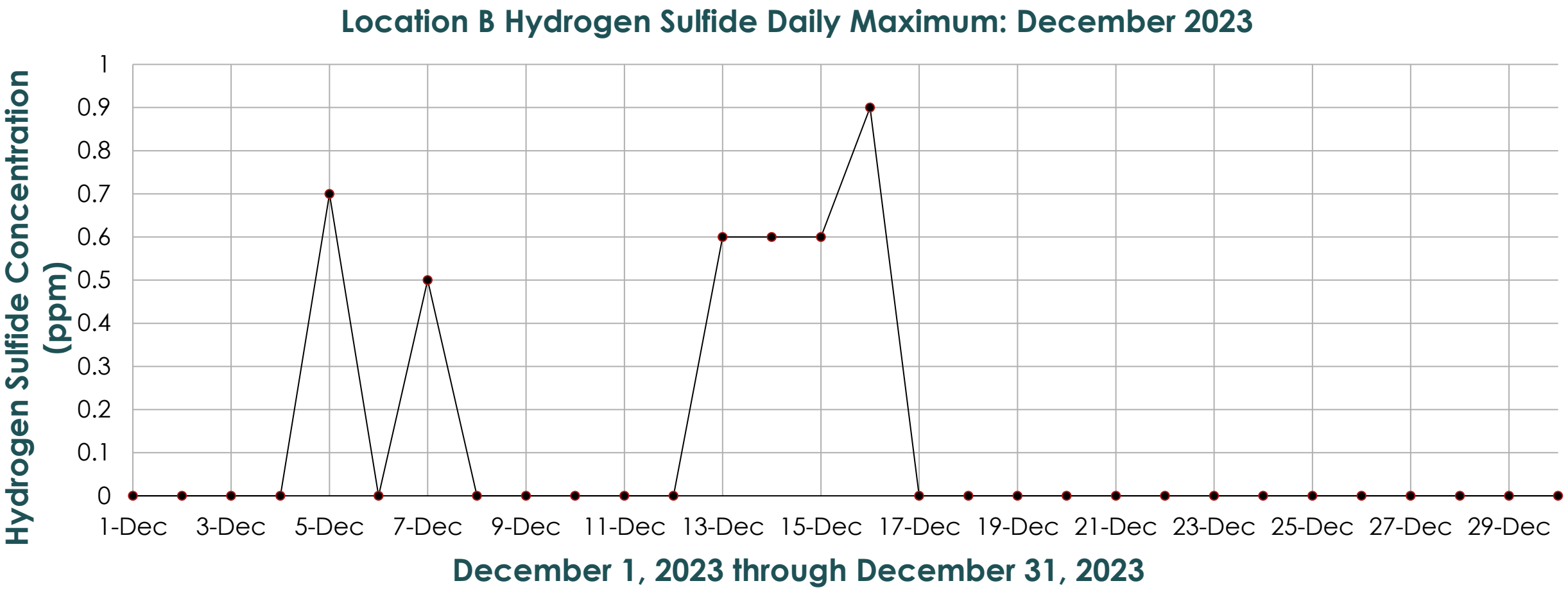
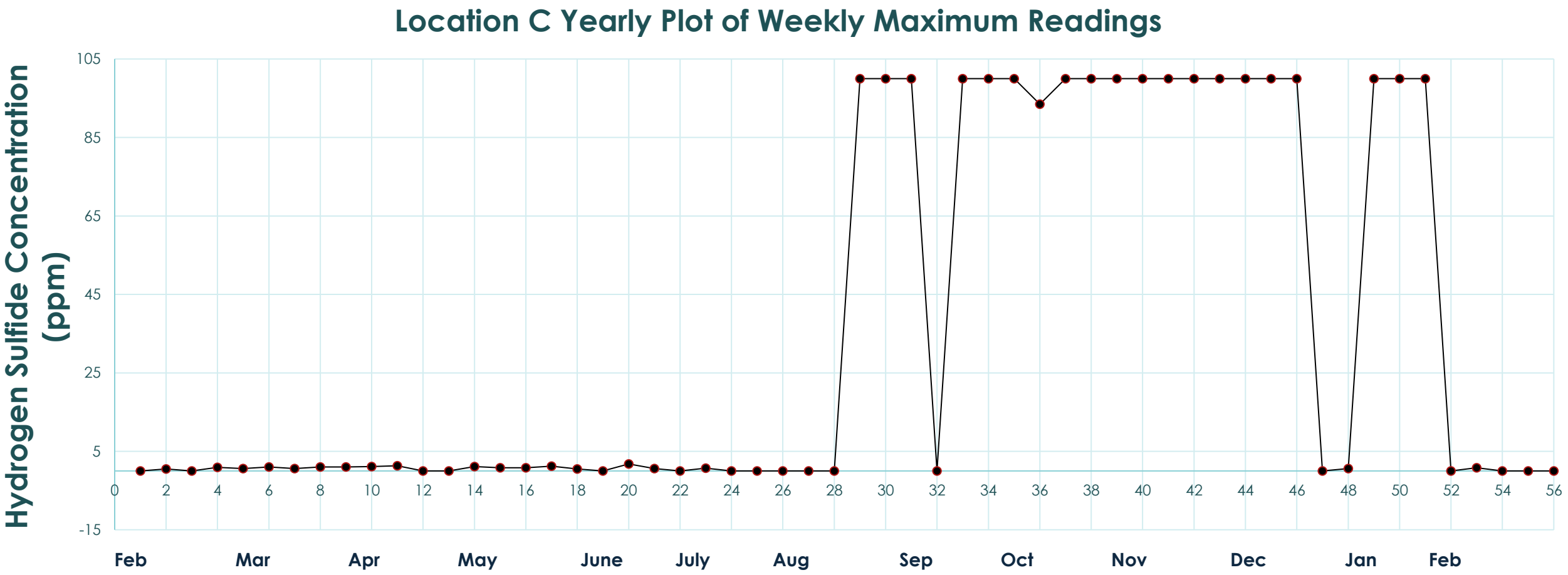
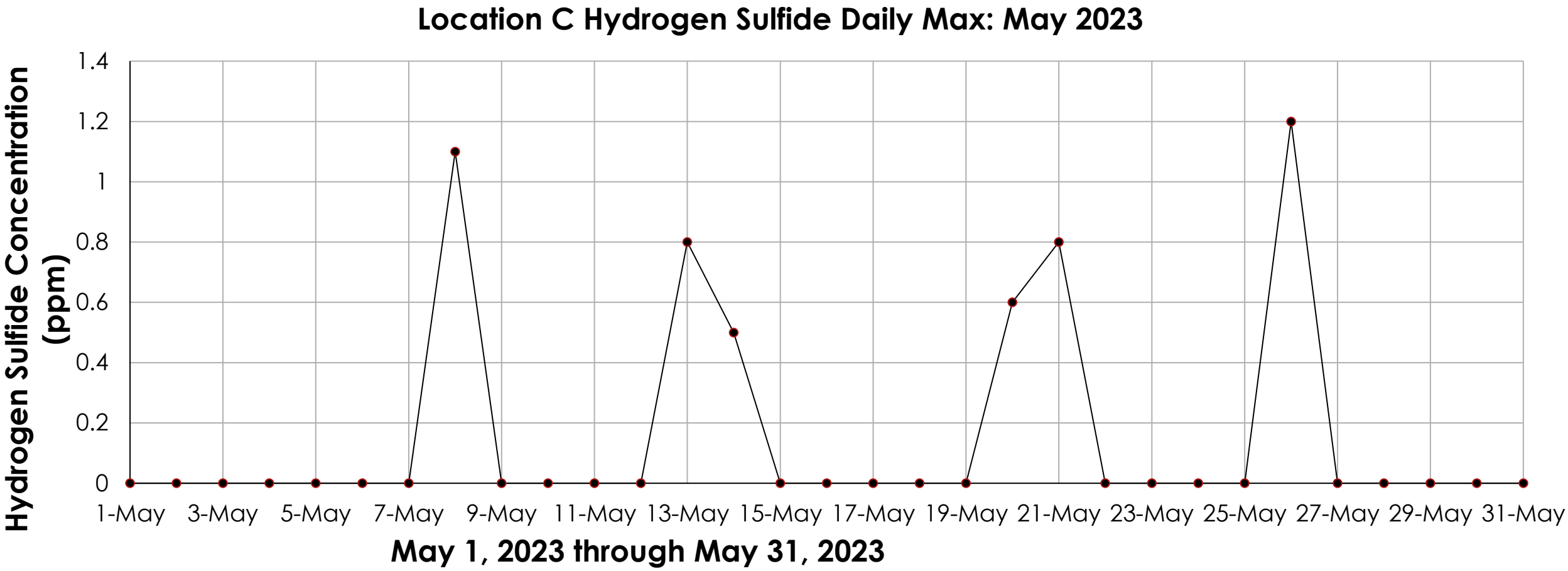


# Location C Readings

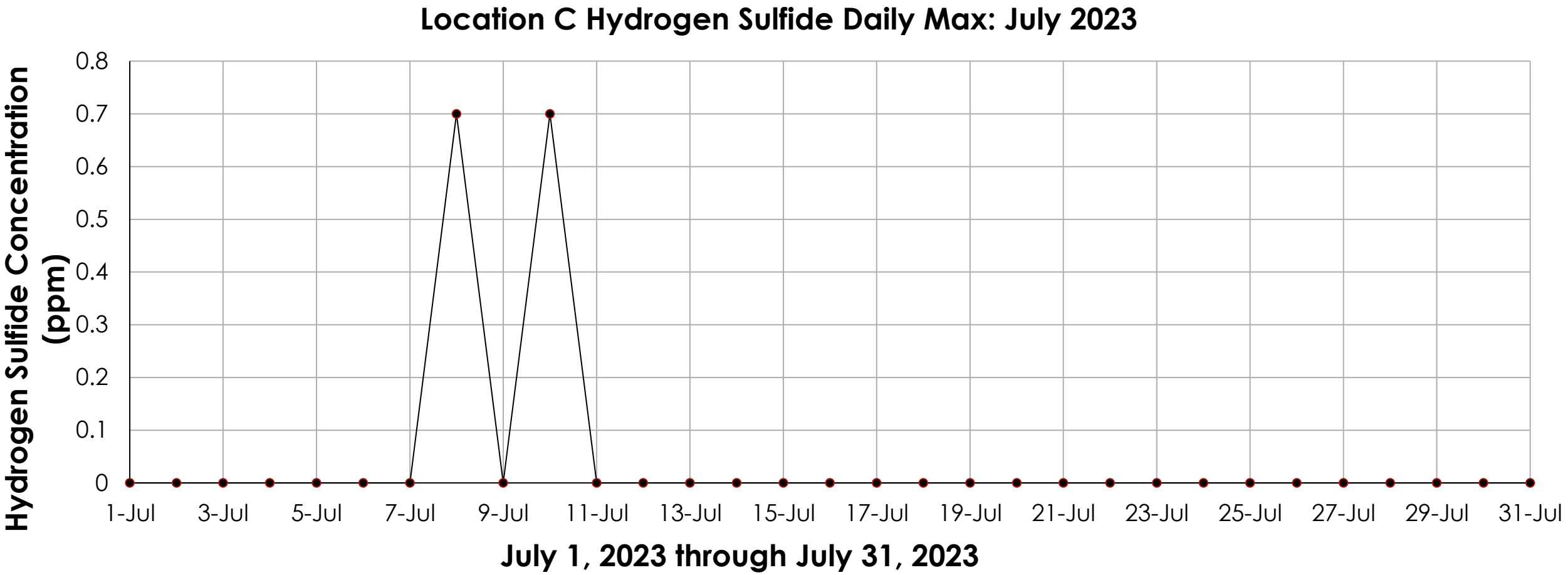
# February 2023 to February 2024



# Location C Spring 2023



# Location C Summer 2023



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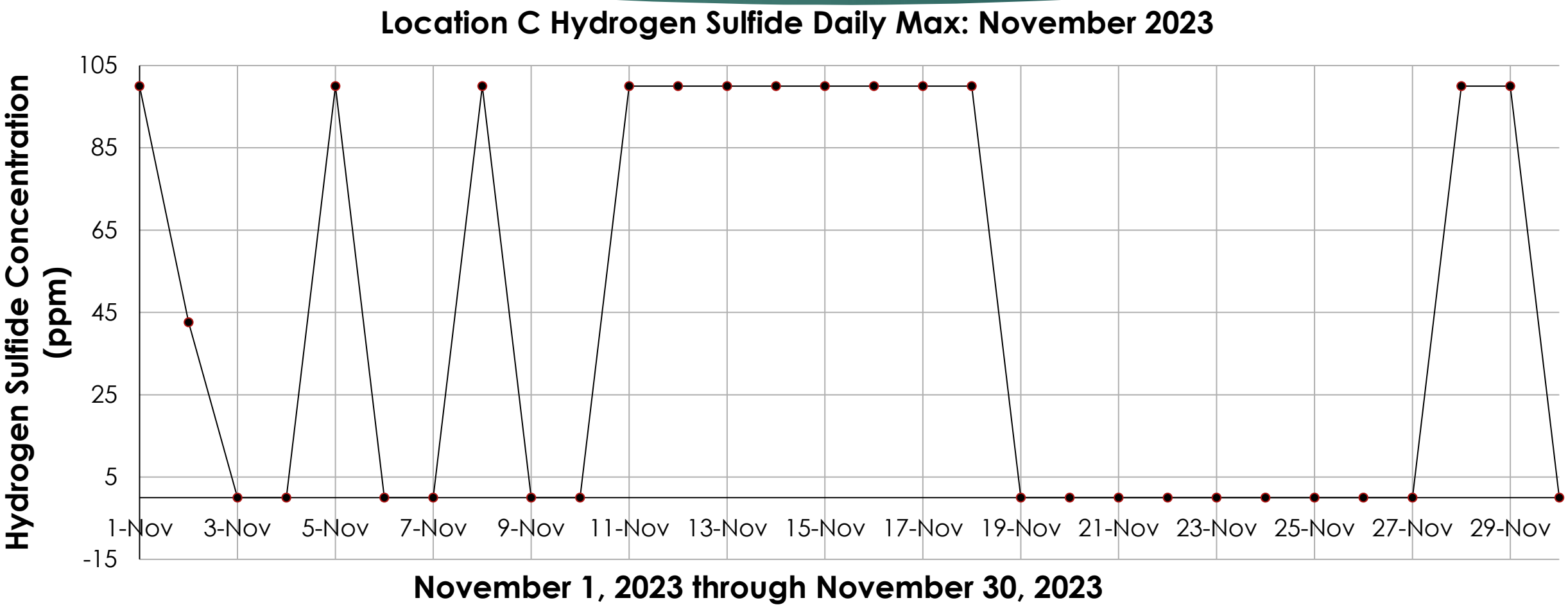

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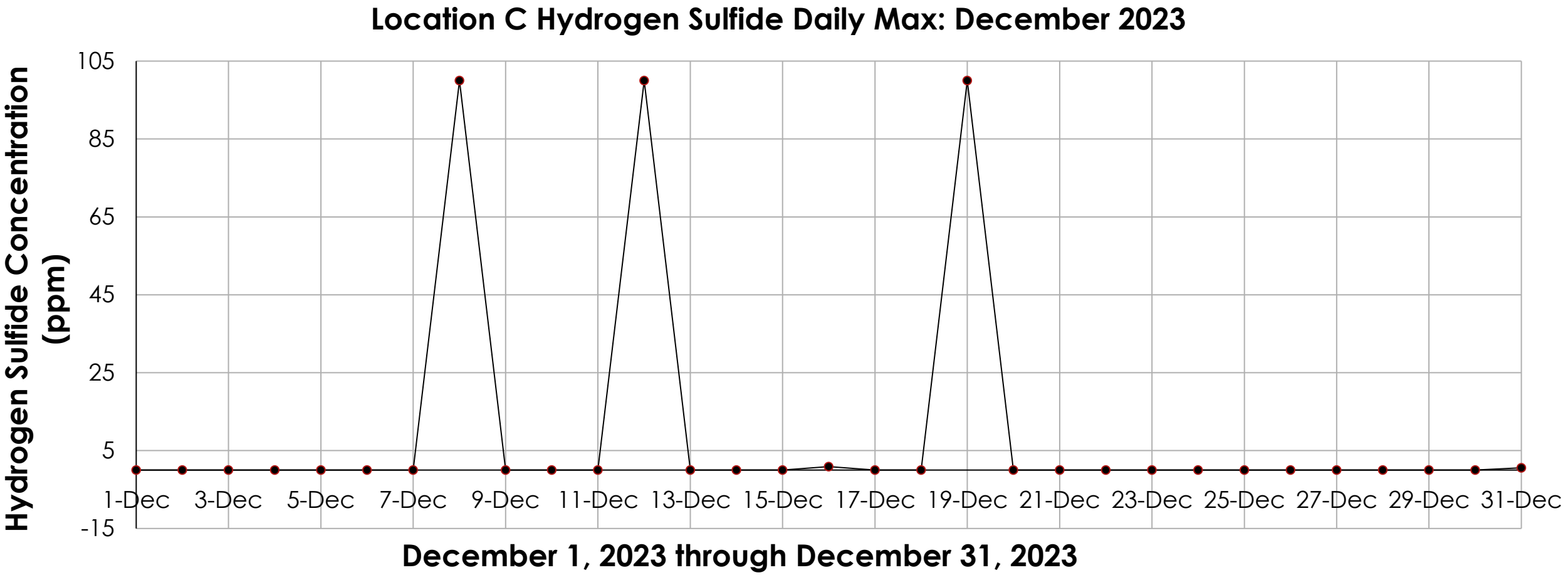
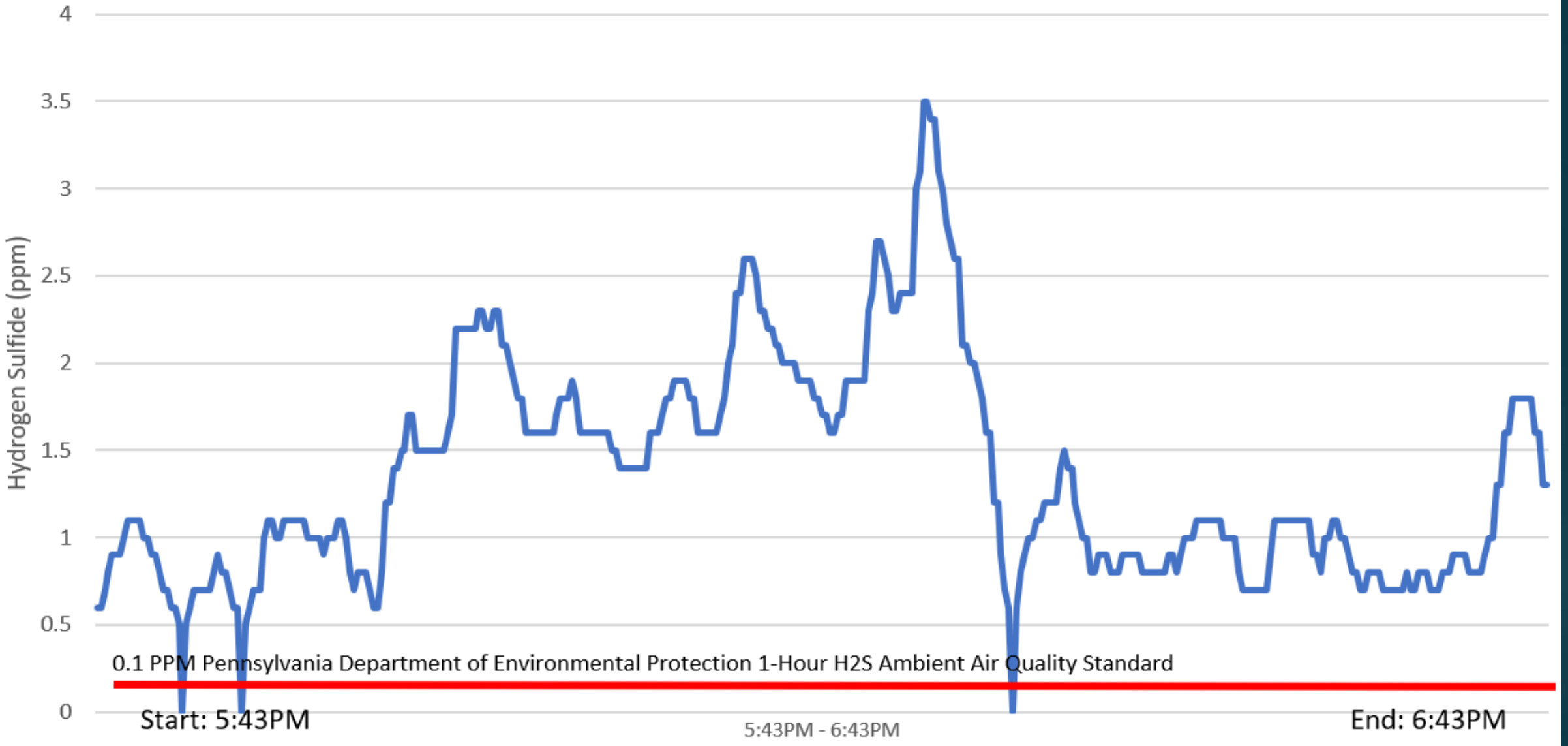


# RESULTS

# Location A Hourly Graphs

# Location A: July 7, 2023 Hydrogen Sulfide Readings

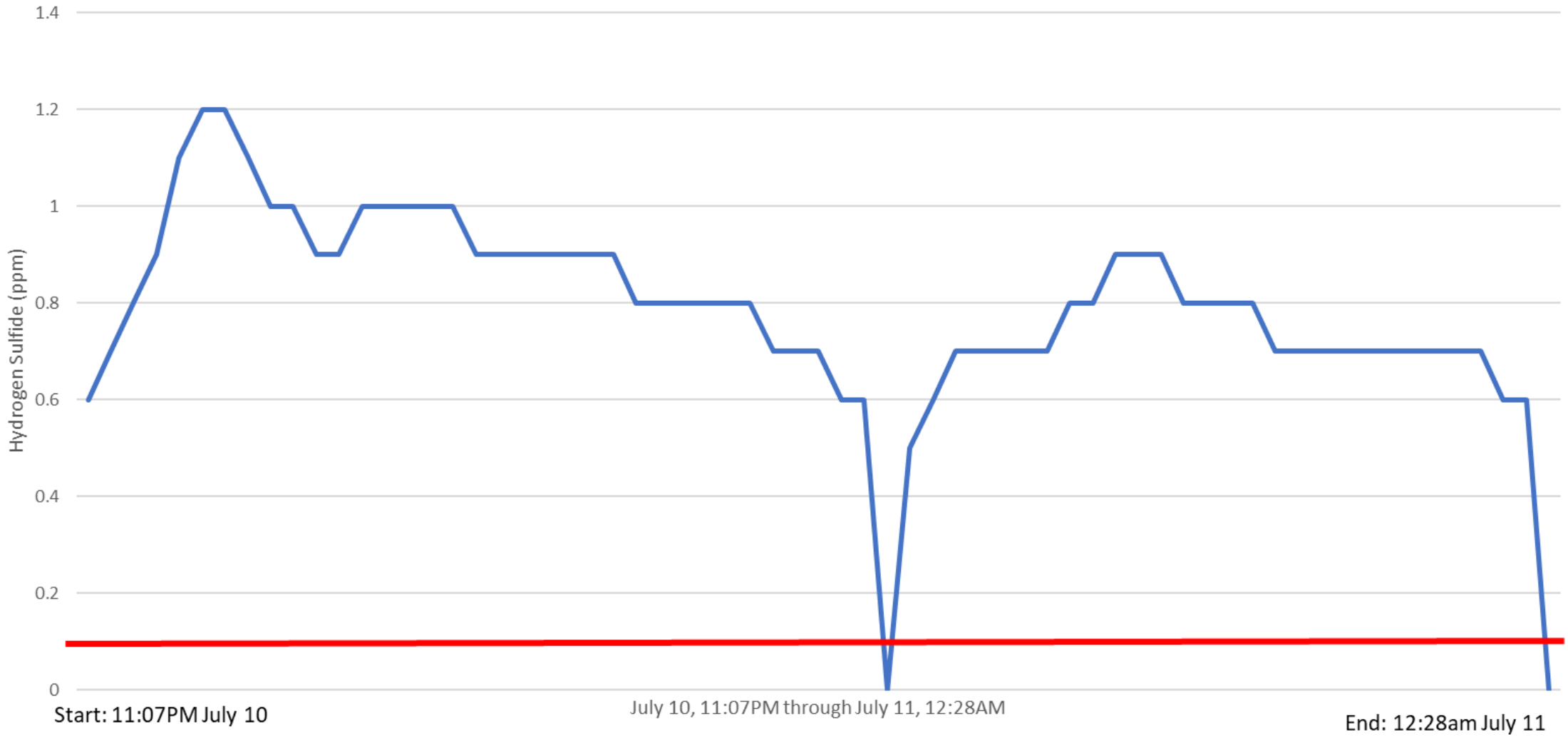
# Location A: December 10, 2023 Hydrogen Sulfide Readings



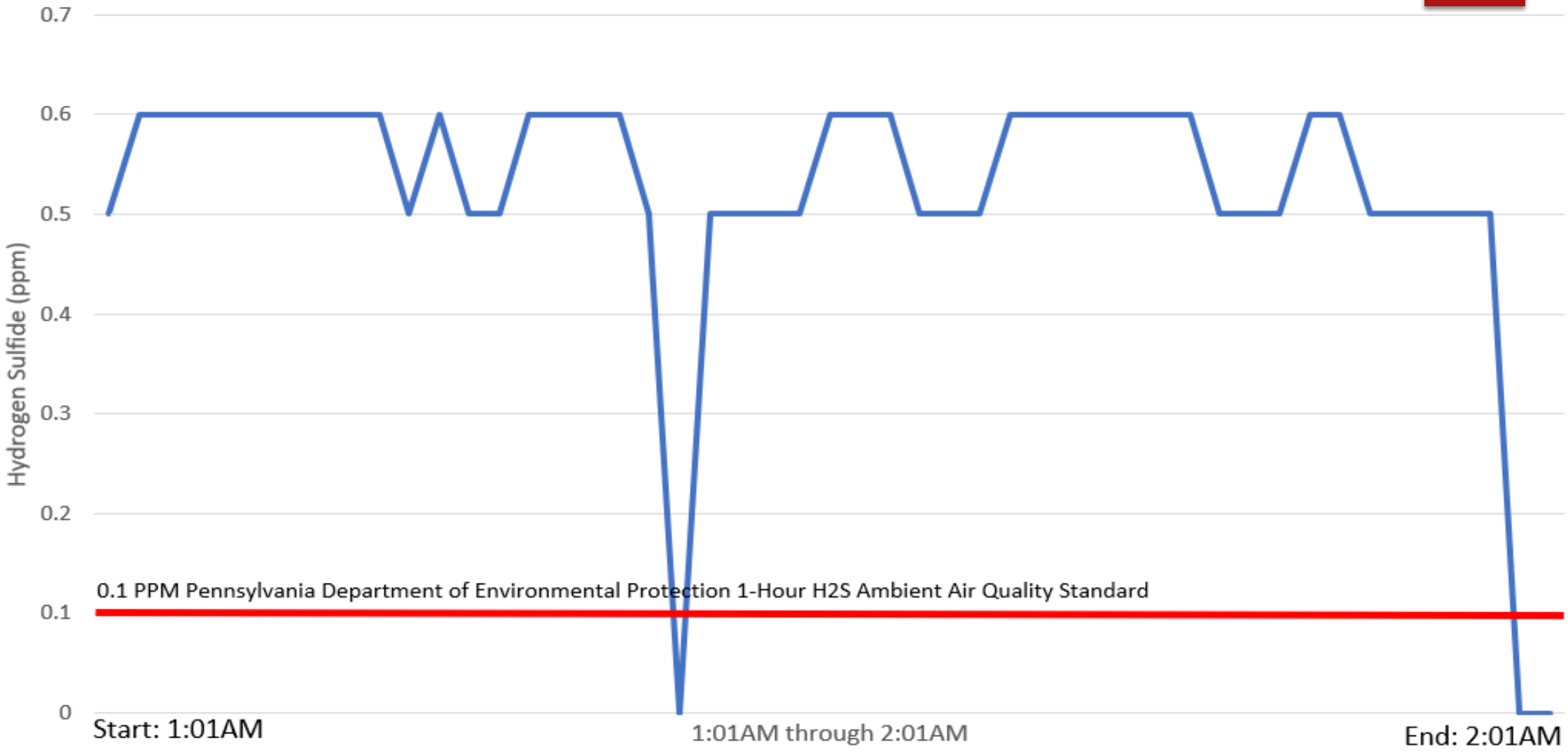
# RESULTS

# Location B Hourly Graphs

# Location B: July 10-11, 2023 Hydrogen Sulfide Readings



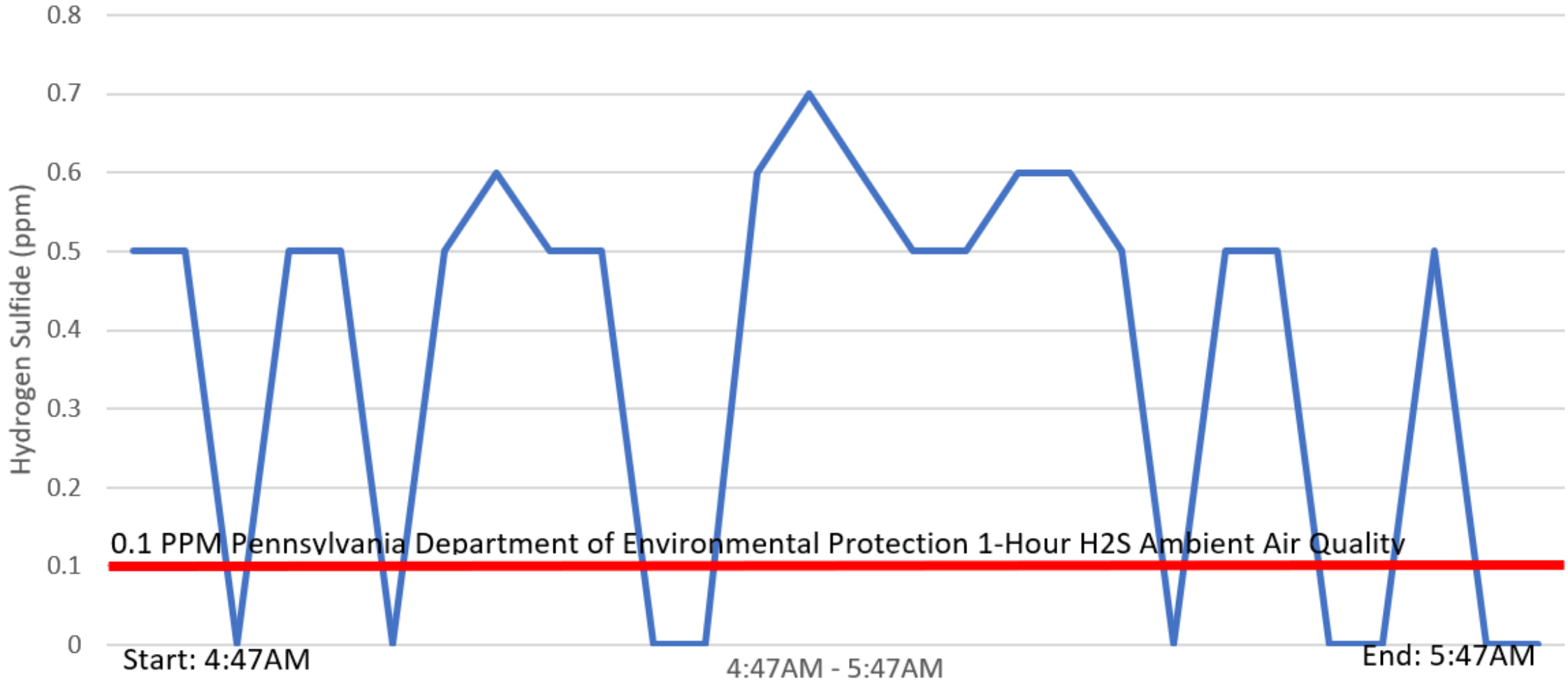
# Location B: December 5, 2023 Hydrogen Sulfide Readings



# RESULTS

# Location C Hourly Graphs

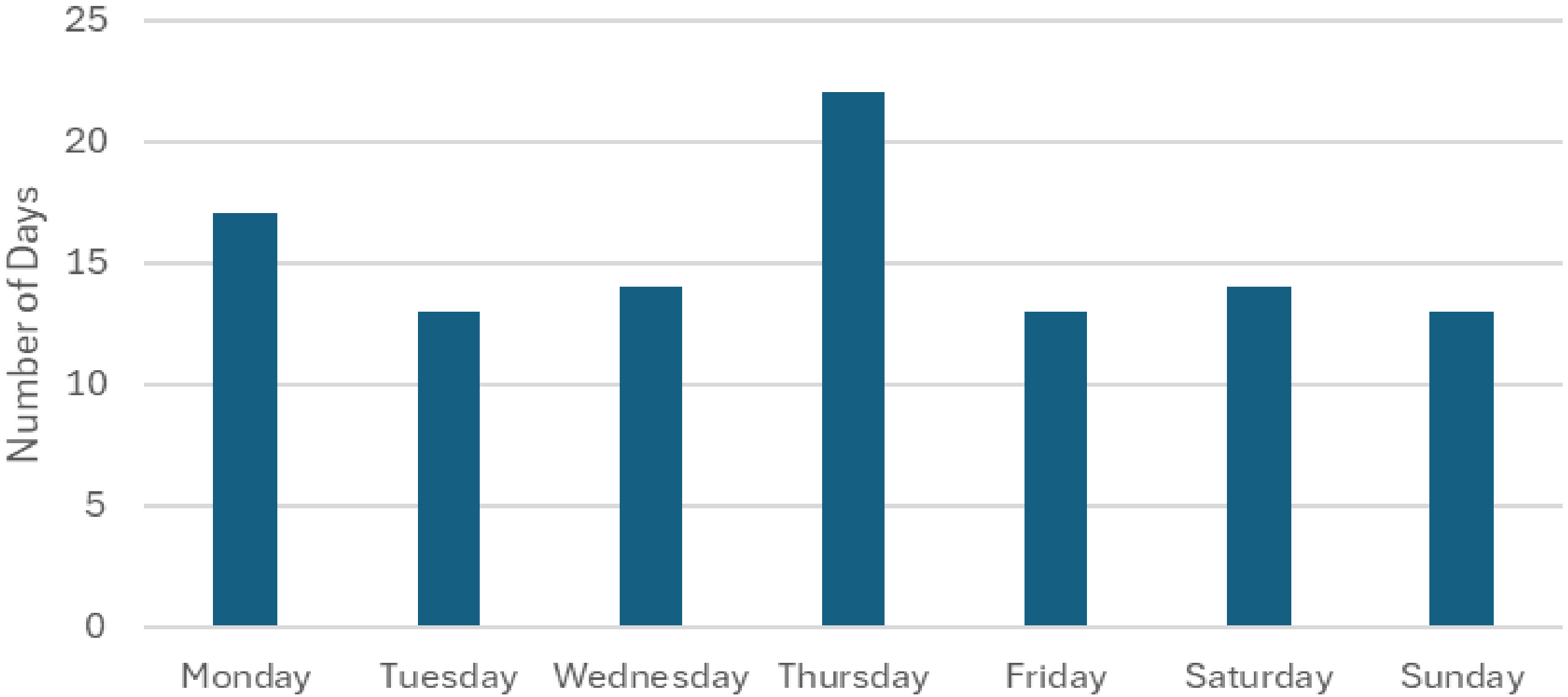
# Location C: July 10, 2023 Hydrogen Sulfide Readings



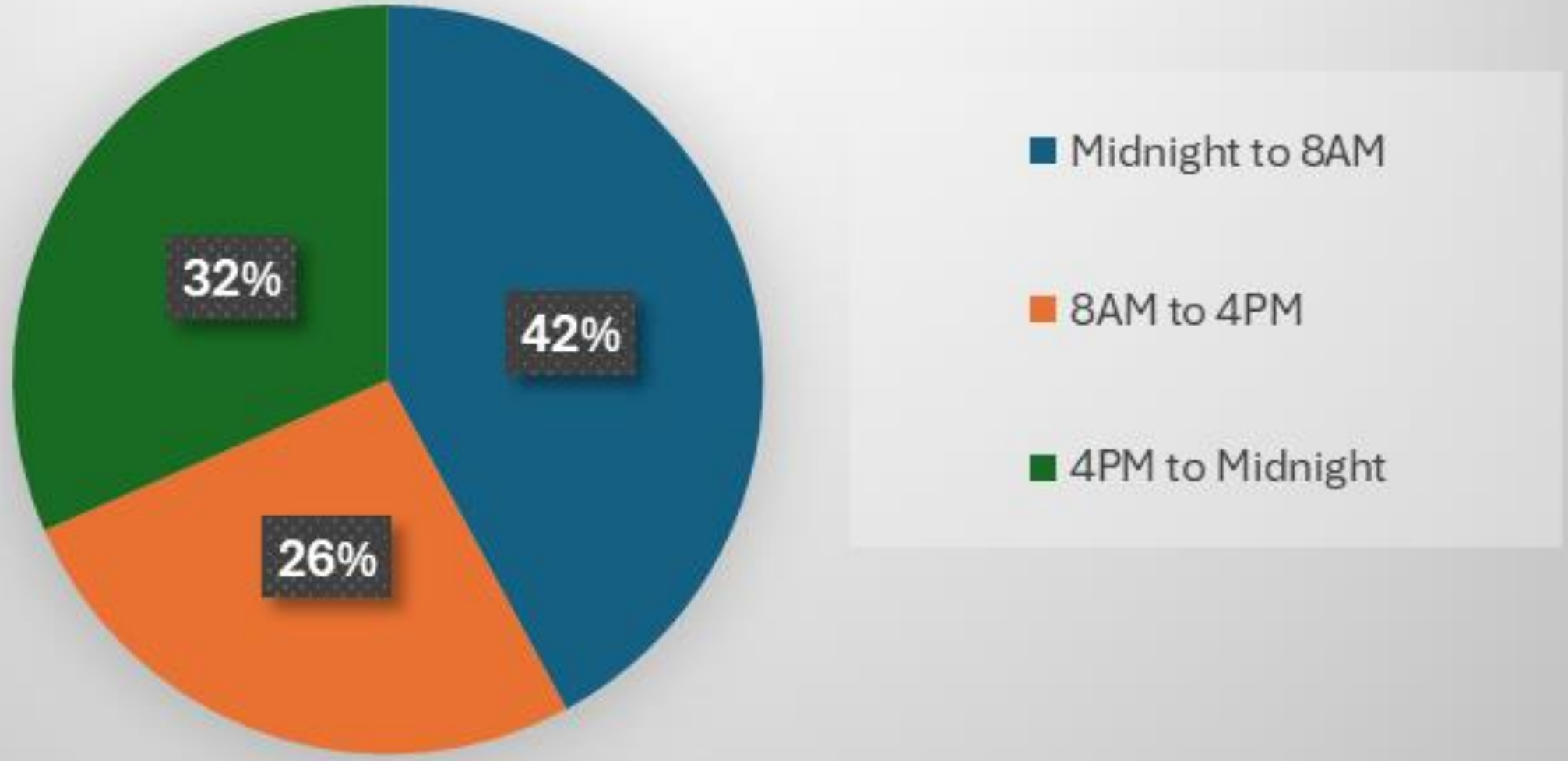
# RESULTS

# Temporal Considerations

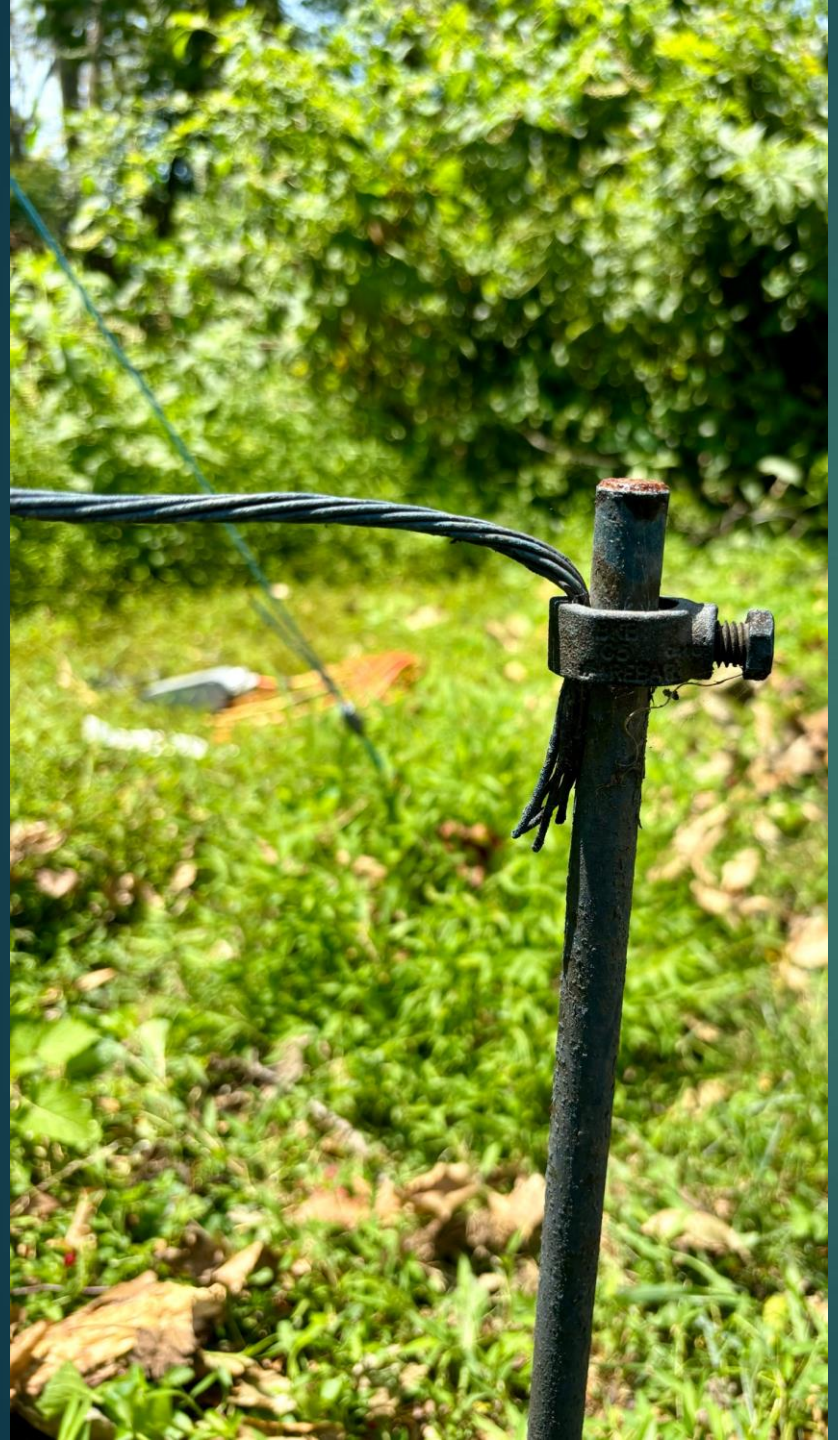
# Day of the Week When Peak $H_2S$ Readings Occur



# Time of Day When Peak $H_2S$ Readings Occur



# Metal Corrosion



# Summary

- Data indicates elevated concentrations of $H_2S$ above the DEP regulation.
  - Measurements as high as 33x DEP findings (excluding location C)
- Collaboration is needed to associate exposures to point sources and tasks in mushroom/soil production.
- The future of this study requires interdisciplinary collaboration between researchers, the American Mushroom Institute, farm operators, and local government.

# Future of the Project

## Obtained funding from the PA Dept. of Agriculture for large scale study

- Requires collaboration with farmers/soil producers
- 2-year project
- Focus exclusively on $H_2S$
- Install 10 devices with higher sensitivity sensors (LOD 0.1ppm)
- Associate operating procedures with gas releases and concentration patterns
- Contribute to revisions of *Best Practices for Environmental Protection in the Mushroom Farm Community* (PA DEP, Bureau of Waste Management, 2012)


Location A
DEP Sampling Location
Location B
Location C