

Evaluating Indoor Air Quality in Southwestern Pennsylvania Schools: A Case Study of Avonworth Middle and High School

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BACKGROUND

Women for a Healthy Environment (WHE) collaborates with schools like Avonworth Middle and High School to monitor indoor air quality (IAQ) using real-time sensors. This initiative began after staff raised concerns following a construction project, prompting the superintendent to secure a grant. Sensors track pollutants such as CO₂, VOCs, PM2.5, temperature, and humidity, providing actionable data to school officials.

IAQ is a critical factor in student health and academic performance. According to the U.S. EPA, indoor air can be 2–5 times more polluted than outdoor air, posing significant risks—especially for children, who spend over 1,000 hours annually in school. Poor IAQ is linked to asthma (affecting 1 in 13 children), respiratory issues, fatigue, and reduced cognitive function. Improving IAQ supports student well-being, reduces absenteeism, and enhances learning outcomes.

OBJECTIVES

Data Collection:

- Gain knowledge of indoor air quality monitoring tools, particularly the use of Attune IAQ sensors and their associated dashboard
- Collect baseline IAQ data from a school district during the summer months when there are no occupants in the building

Support School Partners:

- Support the setup, installation, and maintenance of IAQ monitoring equipment in selected schools

Community Engagement:

- Collaborate with WHE staff to interpret data and translate findings into actionable recommendations
- Enhance school community awareness by sharing results and best practices for improving indoor air quality

METHODS

Attune IAQ Equipment:

- One Gateway (connected to school server, collects data in a cloud)
- Five Sensors (measures temperature, humidity, VOCs, CO₂, and PM2.5)
- Three Relay Nodes (strengthen the connection between sensors and gateway)
- WHE is loaning out air monitoring equipment for the district for a total of three months, one month in each five-set of classrooms
- Data goes to an online dashboard in real-time
- Aggregate data weekly, send reports to superintendent with an email that summarizes the findings

Community Engagement:

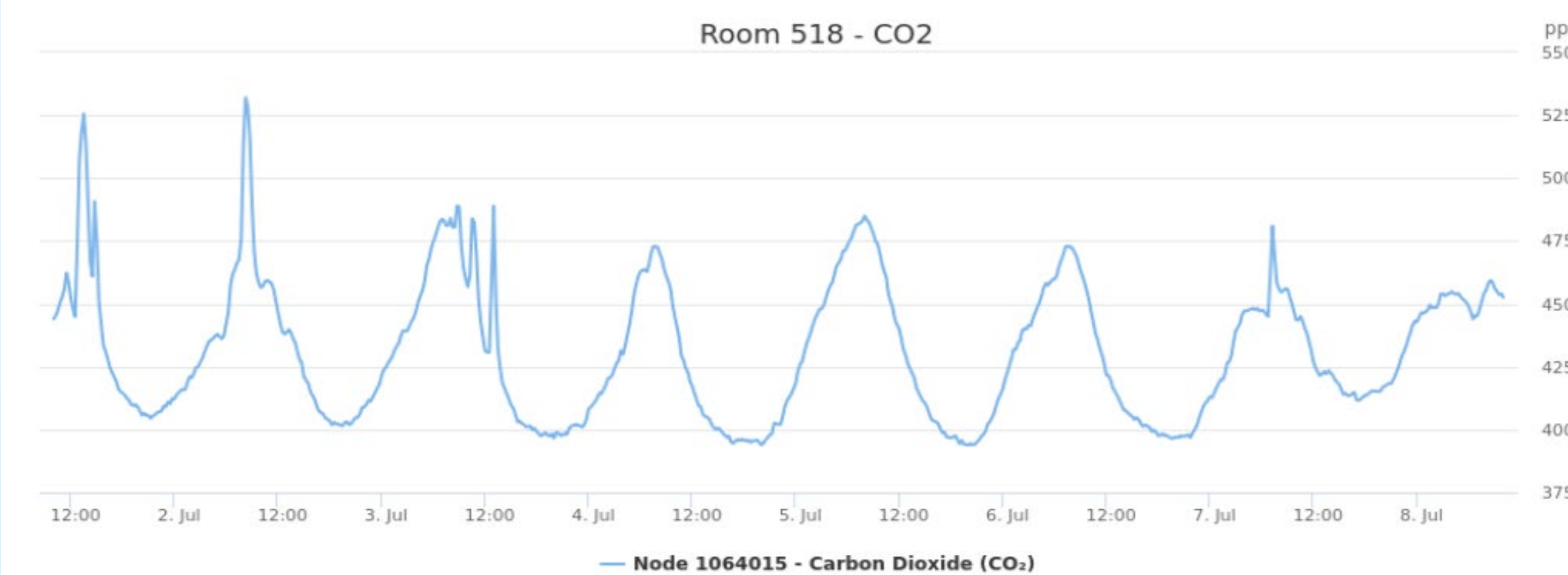
- Presentation to students at the Boys & Girls Club of Western PA on air quality, followed by a hands-on activity where students built a DIY air purifier

RESULTS

Routine School Operations During Summer Can Compromise Indoor Air Quality: Construction and Cleaning Products Raise PM2.5 and VOC Concentrations

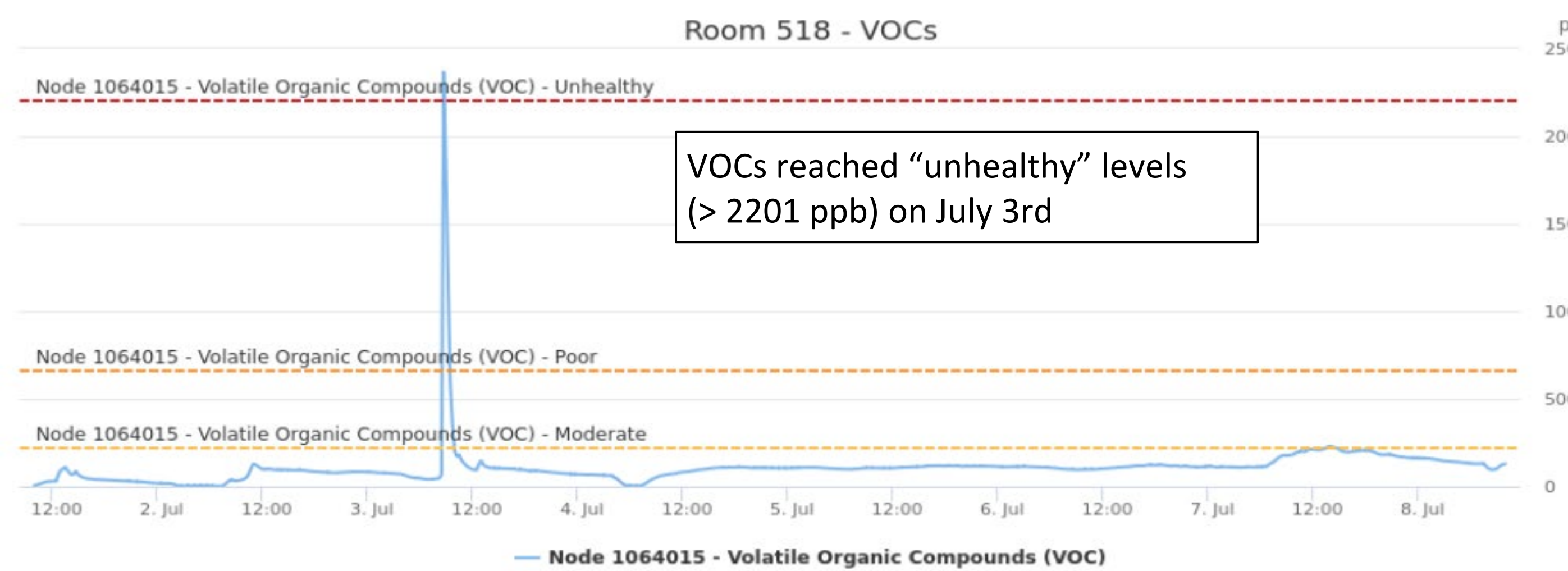
Example: CO₂ (ppm) Levels Are Stable & Below Levels of Concern

Avonworth CO₂ Levels (July 1st - July 9th)



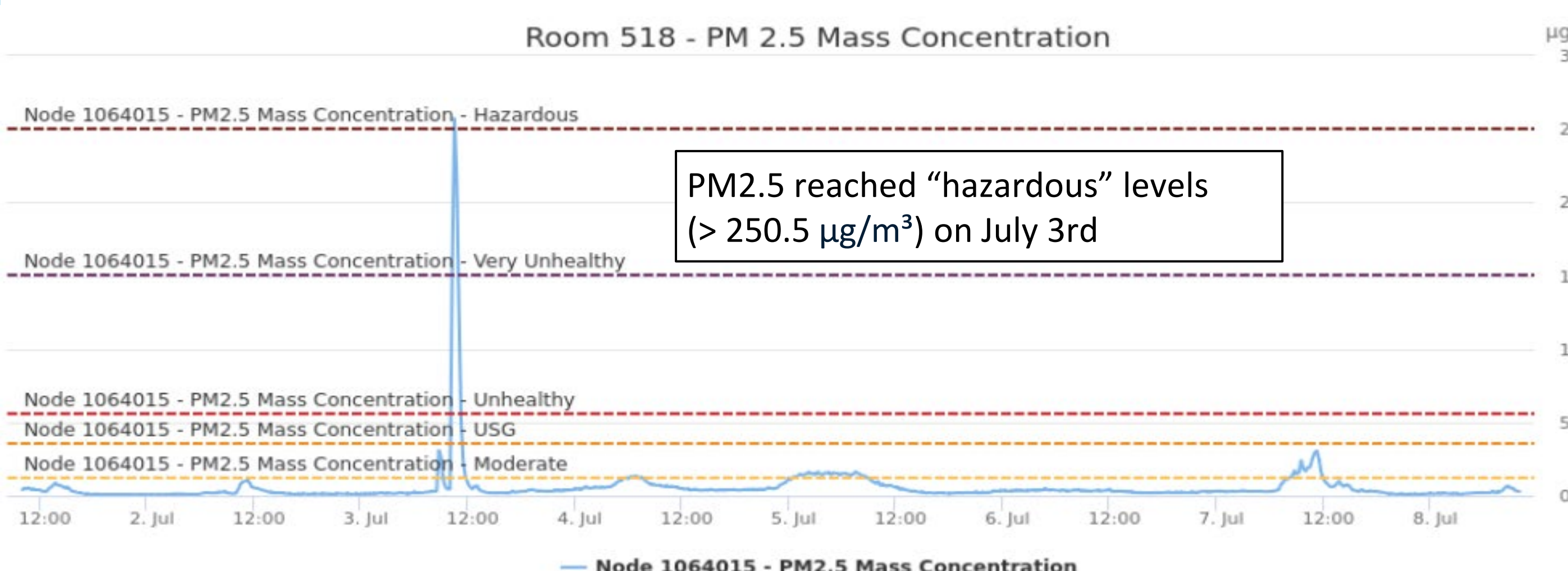
Example of VOC Spike: VOC (ppb) Levels Are Unhealthy

Avonworth VOC Levels (July 1st - July 9th)



Example of PM2.5 Spike: PM2.5 (µg/m³) Levels Are Hazardous

Avonworth PM2.5 Levels (July 1st - July 9th)



Sensor



Gateway



Node



DISCUSSION

Overall, there were no persistent IAQ concerns identified in the tested rooms during typical classroom conditions. However, with school out of session and building maintenance being done during that time, Avonworth Middle and High School experienced periods of poor indoor air quality.

Elevated VOCs and PM2.5: Deep cleaning by custodians in classrooms led to significant spikes in VOC levels. This is likely due to the use of aerosol sprays, harsh chemicals like bleach, and fragranced cleaning products (Temkin et al., 2023). PM2.5 levels were elevated during roof construction directly above classrooms, possibly due to dust (Sekhavati & Yengejeh, 2023).

Temperature and Humidity Concerns: The school experienced warm, hot, and humid conditions, primarily due to a broken chiller. These conditions are typical of unoccupied summer classrooms with limited airflow and closed windows.

Stable CO₂ Levels: Throughout the data collection period, CO₂ levels remained stable and consistent, indicating no immediate concerns regarding ventilation related to CO₂.

External Factors: Our monitoring efforts were impacted by uncontrollable external factors, including a broken chiller, ongoing roof construction, and extensive deep cleaning in classrooms.

Strengths:

- Optimal Monitoring Conditions: We leveraged the building's summer vacancy for baseline readings, helping identify HVAC issues
 - No occupants meant easier pinpoint of pollution sources
- Collaborative Partnership: Our direct collaboration with a cooperative superintendent streamlined the monitoring process and data interpretation

Limitations:

- Unoccupied Building: Regular participant use was not recorded since students and teachers were not in the building
- Testing Pause: These unexpected events forced us to pause the second round of air quality testing

PUBLIC HEALTH SIGNIFICANCE

Poor IAQ can trigger or worsen health issues like asthma, allergies, headaches, and irritation of the eyes and throat, as well as fatigue. Inadequate IAQ leads to increased absenteeism for both students and staff, especially due to asthma, reduced comfort and concentration, lower academic performance, and decreased productivity. (Bozzola et al., 2024). Children are particularly vulnerable to poor IAQ because they have a higher intake of air per body weight, are more sensitive to temperature and humidity, and are still undergoing physical and cognitive development (Sadrizadeh et al., 2022). Monitoring and maintaining a good IAQ is essential not just for the immediate health of students and staff, but also for long-term safety and sustainability of school facilities and overall well-being.

CONCLUSION

Our findings highlighted the impact of temperature, humidity, deep cleaning practices, and ongoing construction. Specifically, VOC levels rose significantly due to classroom cleaning, while PM2.5 was elevated during construction directly above monitored areas. Overall, monitoring and maintaining good indoor air quality in schools is crucial. Poor IAQ can significantly affect the health and cognitive function of students and staff, potentially leading to serious issues such as increased absenteeism, reduced academic performance, impaired concentration, and heightened susceptibility to respiratory illnesses like asthma.

Actionable Recommendations to Improve School IAQ:

- Promote the use of third-party certified cleaning products with low VOC content, such as those with the EPA Safer Choice label
- Encourage direct-surface application of sanitizers and disinfectants (e.g., wipes) instead of aerosol sprays, which can linger in the air
- Consider implementing air purifiers to effectively reduce indoor pollutants like PM2.5 and VOCs
- Construction periods should not be recommended during school hours and IAQ monitoring should be done before students return to the building to prevent exposure to hazardous pollutants

REFERENCES



Scan here for full references!

ACKNOWLEDGMENTS

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