May 10, 2018

To: Waverly Elementary School

From: Christopher Madden, CIH
Indoor Environmental Quality Manager

Re: Indoor Air Quality Testing During Renovations - April

As Waverly Elementary School is currently undergoing renovations, the Howard County Public School System's Office of the Environment is conducting weekly Indoor Air Quality (IAQ) Testing to determine if renovation activities are adversely impacting the IAQ in areas located in close proximity to the renovation. The Office of the Environment visited Waverly Elementary on April 5, 13, 17 and 27, 2018. The Office of the Environment observed if engineering controls were in place to limit construction related constituents from migrating into occupied areas of the school and collected measurements of temperature, relative humidity, carbon dioxide (CO_2), carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter.

General Observations

April 5, 13, 17, and 27 2018

Construction activities varied during the assessment and included electrical work, duct installation, and finishing work. The construction containment was in place and negative air machines were operational.

Visible emissions were not observed in the school in the vicinity of the construction containment.

General Indoor Air Quality Measurements

Temperature, Relative Humidity, CO_2, CO, and VOC readings were collected as part of the IAQ assessment.

The American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) recommends a temperature range of 68.5 to 75 degrees Fahrenheit (F) in the winter and 75 to 80.5 degrees F in the summer (assuming 50% relative humidity) (Indoor Environmental Quality 2015). The recommended temperature ranges vary slightly depending on relative humidity. There are no recommendations for the spring and fall due to the variabilities in outdoor temperatures.

To prevent mold growth, The Environmental Protection Agency (EPA) recommends relative humidity should be maintained below 60%, ideally between 30-50%. Humidity readings below 30% are often encountered in buildings where humidity is not introduced through the Heating Ventilation and Air Conditioning (HVAC) system.

Carbon Dioxide measurements can provide a general sense of the adequacy of the ventilation system. It is recommended that CO_2 readings be less than 700 parts per million (ppm) plus the outside concentration of CO_2.

Carbon Monoxide can be introduced through incomplete combustion (car exhaust, improperly ventilated boilers, etc.) and should not exceed 9 ppm.

"Low levels of VOCs are ubiquitous in indoor and outdoor air from both natural and man-made sources (The IAQ 2016). VOCs can be introduced by a variety of indoor (paints, perfumes, art products, building materials, carpet, furnisher, etc.) and outdoor sources (vehicles, manufacturing emissions, etc.). A "spike" is identified when indoor readings are significantly higher than the outdoor readings.

Temperature, Relative Humidity, CO_2, and CO data was collected using a TSI IAQ Calc (Model #7545). VOC data was collected using a Rae ToxiRae Pro Photoionization Detector (PID) (Model #PGM-1800). Below are the results of the temperature, relative humidity, CO_2, and CO measurements collected.

Table I - General IAQ Measurements – April 5, 2018

Location	Temperature (F)	Relative Humidity (%)	CO_2 (ppm)	CO (ppm)	Total VOCs (ppm)
Outside	40.0	14.8	388	1.7	0.2
Construction Containment	55.6	32.7	575	0.0	0.2
Lobby	55.7	36.6	651	0.0	-
Hallway Outside of Health Suite	63.2	27.0	686	0.0	-
A125	64.2	20.8	466	0.0	-
Hallway Outside of A123	64.8	22.8	564	0.0	-
Conference Room	67.4	24.8	762	0.0	-
Media	68.0	22.0	717	0.1	-
1st Floor Addition	69.3	17.0	559	0.0	-
Outside	41.7	15.6	347	1.4	-

Note: Bolded values were not within recommended limits.

Table II - General IAQ Measurements – April 13, 2018

Location	Temperature (F)	Relative Humidity (%)	CO_2 (ppm)	CO (ppm)	Total VOCs (ppm)
Outside	66.1	39.3	362	0.1	0.0
Construction Containment	67.7	38.9	552	0.1	0.0
Lobby	69.5	38.5	450	0.1	0.0
Hallway Outside of Health Suite	69.7	36.7	503	0.0	0.0
A123	69.7	35.9	475	0.0	0.0
A125	71.1	35.2	450	0.0	0.0
Gymnasium Hallway	71.3	36.1	606	0.0	0.0
Health Suite	72.3	40.3	691	0.0	0.0
Media	72.2	34.0	558	0.0	0.0
1st Floor Addition	71.8	34.9	594	0.0	0.0

Table II - General IAQ Measurements (Continued) – April 13, 2018

Location	Temperature (F)	Relative Humidity (%)	CO_2 (ppm)	CO (ppm)	Total VOCs (ppm)
Music	71.3	37.1	648	0.0	0.0
Cafeteria	71.4	36.2	642	0.0	0.0
Outside	66.8	35.2	403	0.0	0.0

Table III - General IAQ Measurements – April 17, 2018

Location	Temperature (F)	Relative Humidity (%)	CO_2 (ppm)	CO (ppm)	Total VOCs (ppm)
Outside	49.8	24.7	384	1.6	0.0
Construction Containment	56.5	37.0	483	0.0	0.0
Lobby	63.0	32.4	637	0.0	0.0
Cafeteria	65.1	31.5	634	0.0	0.0
Music	66.1	29.9	771	0.1	0.0
Hallway Outside of Health Suite	68.1	28.7	742	0.0	0.0
A125	68.2	25.5	445	0.1	0.0
A123	69.6	24.9	509	0.0	0.0
Health Suite	70.0	25.9	758	0.0	0.0
Media	69.6	31.3	1,036	0.0	0.0
1sr Floor Addition	70.3	23.0	625	0.0	0.0
Outside	48.7	24.2	404	0.3	0.0

Table IV - General IAQ Measurements – April 27, 2018

Location	Temperature (F)	Relative Humidity (%)	CO_2 (ppm)	CO (ppm)	Total VOCs (ppm)
Outside	76.3	35.7	409	0.4	0.0
Construction Containment	71.8	39.5	724	0.0	0.2
Lobby	70.8	45.6	770	0.0	0.1
Music	71.4	45.1	715	0.0	0.0
Hallway Outside of Health	71.9	44.5	681	0.0	0.1
A124	72.1	44.2	628	0.0	0.0
A125	72.6	46.7	588	0.0	0.0
Health Suite	72.4	38.7	847	0.0	0.1
Media	73.7	40.7	872	0.0	0.0
1st Floor Addition	71.2	43.6	660	0.0	0.0
Cafeteria	72.8	47.7	**1,161**	0.0	**3.8**
Outside	62.2	49.2	416	0.2	0.0

Particulate Matter Measurements

Particulate matter "is a complex mixture of extremely small particles and liquid droplets that get into the air (Particulate 2017). The data collected does not distinguish between types of particles in the air which can include pollen, skin cells, soil, human/animal hairs, etc. Particles designated as "respirable" are less than 10 micrometers (µm) in diameter and typically fall into two categories, coarse and fine particles. Coarse particles are those that are less than 10 um (PM_{10}) and fine particles are those less than 2.5 µm ($PM_{2.5}$). ANSI/ASHRAE standard 62.1-2016 suggests target indoor concentration for $PM_{2.5}$ and PM_{10} of 12 and 50 µg/m3 respectively.

Particulate matter data was collected with a TSI AeroTrak Particle Counter (Model #9306-V2). Note that the particle counter is not capable of collecting $PM_{2.5}$ data. Due to this limitation, $PM_{3.0}$ data is used. This would provide a more conservative, overestimate of $PM_{2.5}$.

Table V - Particulate Matter Measurements – April 5, 2018

Location	$PM_{0.5}$ (µ/m^3)	$PM_{1.0}$ (µ/m^3)	$PM_{3.0}$ (µ/m^3)	$PM_{5.0}$ (µ/m^3)	$PM_{10.0}$ (µ/m^3)
Outside	1	2	4	9	32
Construction Containment	2	12	**126**	520	**2,084**
Lobby	0	1	10	31	**81**
Cafeteria	0	1	12	38	**101**
Hallway Outside of Health Suite	0	0	4	18	**54**
A125	0	0	1	2	7
Hallway Outside of A123	0	0	4	17	50
Conference Room	0	1	8	21	**68**
Media	0	0	3	12	34
1st Floor Addition	0	0	2	7	31
Outside	1	2	3	4	5

Table VI - Particulate Matter Measurements – April 13, 2018

Location	$PM_{0.5}$ (µ/m^3)	$PM_{1.0}$ (µ/m^3)	$PM_{3.0}$ (µ/m^3)	$PM_{5.0}$ (µ/m^3)	$PM_{10.0}$ (µ/m^3)
Outside	2	3	8	15	29
Construction Containment	2	8	**85**	350	**1,240**
Lobby	1	2	8	24	**59**
Hallway Outside of Health Suite	1	2	6	28	**98**
A123	1	1	5	12	40
A125	1	0	2	3	12
Gymnasium Hallway	2	3	9	27	**75**
Health Suite	1	2	10	24	**85**
Media	1	2	4	8	31
1st Floor Addition	1	2	4	8	23
Music	1	2	14	54	**189**
Cafeteria	1	2	12	39	**133**
Outside	2	3	7	12	26

Table VII - Particulate Matter Measurements – April 17, 2018

Location	$PM_{0.5}$ (µ/m^3)	$PM_{1.0}$ (µ/m^3)	$PM_{3.0}$ (µ/m^3)	$PM_{5.0}$ (µ/m^3)	$PM_{10.0}$ (µ/m^3)
Outside	0	0	1	3	6
Construction Containment	1	7	**101**	444	**1,818**
Lobby	0	1	8	23	**65**
Cafeteria	0	1	9	24	**76**
Music	0	1	7	19	48
Hallway Outside of Health Suite	0	0	4	18	**73**
A125	0	0	1	3	9
A123	0	0	1	5	19
Health Suite	0	1	8	22	60
Media	0	2	19	57	**176**
1st Floor Addition	0	0	2	7	21
Outside	0	0	0	1	11

Table VIII - Particulate Matter Measurements – April 27, 2018

Location	$PM_{0.5}$ (µ/m^3)	$PM_{1.0}$ (µ/m^3)	$PM_{3.0}$ (µ/m^3)	$PM_{5.0}$ (µ/m^3)	$PM_{10.0}$ (µ/m^3)
Outside	1	0	2	3	12
Construction Containment	1	2	**22**	87	**298**
Lobby	0	0	3	14	**54**
Music	0	0	3	11	49
Hallway Outside of Health Suite	0	0	3	13	**56**
A124	0	0	1	4	16
A125	0	0	1	3	8
1st Floor Addition	0	0	4	18	44
Health Suite	0	0	3	11	39
Media	0	0	1	7	25
Cafeteria	0	0	5	22	**101**
Outside	2	3	4	6	13

Discussion

No concerns were identified on April 5th. The PID malfunctioned due to a charging issue and VOC data was not able to be collected. No VOCs odors were detected within the school during the visit.

Elevated particulate ($PM_{10.0}$) was detected in various locations on each day of the sampling. Elevated concentrations are expected and would not necessarily be associated with construction activities. Dust levels are expected to vary overtime based on student and staff activities.

Elevated CO2 and slightly elevated VOCs were detected in the cafeteria on April 27th. These measurements were likely associated with the large volume of occupants in the cafeteria at the time of sampling (CO_2) and the opening of these individuals lunches (pre-packaged food items, sandwich bags, etc.). Construction activities did not appear to be associated with these measurements.

Conclusion

The sampling activities conducted in April indicate measures are being taken to prevent construction odors/VOCs from entering the occupied areas of the school.

Regarding dust, it should be noted that elevated concentrations are expected and may not necessarily be associated with construction activities. Dust levels are expected to vary overtime based on student and staff activities. Additionally, dust levels are far from the enforceable OSHA Occupational Exposure Limit for respirable nuisance dust of 5,000 $\mu g/m^3$.

Housekeeping practices are also pivotal for dust control. Increased frequency of vacuuming and cleaning could also help reduce dust levels in areas around the construction containment such as the lobby, hallway outside of health, and the health suite. Sticky mats could also be added in areas where trades enter/exit the construction areas through the school. This will likely alleviate the tracking of construction dusts into occupied areas of the school.

It should be noted that the sampling is not being conducted for Occupational Safety and Health Administration (OSHA) compliance, in association with the renovation/construction contractors.

References

Indoor Environmental Quality, the National Institute for Occupational Safety and Health/Centers for Disease Control and Prevention, September 1, 2015. Retrieved from: https://www.cdc.gov/niosh/topics/indoorenv/temperature.html

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Volatile Organic Compounds (VOC) Criteria for New Construction White Paper, American Industrial Hygiene Association, March 15, 2017.