Aria Environmental, Inc.
INDUSTRIAL HYGIENE & SAFETY CONSULTANTS

February 23, 2017

Mr. Jeff Klenk
Howard County Public School System (HCPSS)
10910 Route 108
Ellicott City, MD 21043

RE: Indoor Air Quality Assessments during Renovations at Swansfield Elementary School
Project #J16-971

Dear Mr. Klenk,

Aria Environmental, Inc. (AE) is pleased to present this report of findings for indoor air quality assessments conducted at Swansfield Elementary School (SWES). Jeff Klenk of HCPSS requested AE start making frequent visits to SWES in order to monitor indoor air quality that may be affected by the current major renovation of the school. The visit discussed in this report was performed on November 10, 2016 and included work site observations, and real time measurements for particles and indoor air quality parameters (temperature, humidity, carbon monoxide (CO) and carbon dioxide (CO_2)). These assessments were performed by Julie Barth, CIH, CSP, LEED Green Associate and Tony Schwegmann, Industrial Hygienist, of AE. Presented below are observations and recommendations made based upon conditions readily observed on the reported date.

Particles

Particulate matter or PM is the term for a mixture of solid particles and liquid droplets found in the air. It does not distinguish between the types of particles in the air (e.g., pollen, skin cells, soil, etc.). Particulate matter includes "inhalable coarse particles," with diameters larger than 2.5 micrometers and smaller than 10 micrometers (PM10) and "fine particles," with diameters that are 2.5 micrometers and smaller (PM2.5). A micrometer is also called a micron and is one millionth of a meter. To put these particle diameters in perspective, the average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle. Particle loads expected to be a part of the school environment include carpet and clothing fiber, soil tracked from outside, paper dust and dust and fibers from building materials.

ASHRAE Standard 62.1–2010 suggests target indoor concentrations for PM2.5 and PM10 of 15 µg/m^3 and 50 µg/m^3, respectively. These concentrations are taken from the EPA's National Ambient Air Quality Standards (NAAQS) based on annual arithmetic means deemed acceptable for outdoor air quality. Occupational standards and guidelines for particles are nearly an order of magnitude higher than concentrations typically found in non-occupational settings and are not appropriate for comparison. Particle measurements were taken with an Aerocet 531 particulate monitor. The particle monitor takes a two minute averaged sample of particle concentrations in 5 size fractions (PM1, PM 2.5, PM 7, PM10 and total suspended particles (TSP)). Results of particulate monitoring are presented in Tables 1.

Table 1 – Results of Particulate Monitoring Swansfield Elementary School on November 10, 2016

Location	Time	PM1 (µg/m^3)	PM2.5 (µg/m^3)	PM7 (µg/m^3)	PM10 (µg/m^3)	TSP (µg/m^3)
Outside	2:43 PM	0	0	3	4	7
Hallway Near Construction Wall 1	2:54 PM	0	4	127	**179**	277
Hallway Near Construction Wall 2	2:57 PM	0	4	60	**87**	141

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Location	Time	PM1 (µg/m³)	PM2.5 (µg/m³)	PM7 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)
Non-construction Zone – Near Gym Entrance	3:00 PM	0	0	59	**108**	198
Non-construction Zone – Hallway Between Construction Walls	3:03 PM	0	0	63	**109**	206
Inside Construction Zone1	3:08 PM	0	14	90	**169**	281

Bold-faced results indicate results above target concentrations.

The PM2.5 particle concentrations were both 4 µg/m³ in the hallways outside the construction zones on November 10, 2016. PM10 particle concentrations ranged from 87 to 179 µg/m³ on November 10, 2016 in the hallways outside of the construction zone. PM 10 particle concentrations were above the target concentrations in both locations directly outside the construction zone, as well as in the non-construction zones with student activity that were surveyed which ranged from 108 to 109 µg/m³. The building was occupied with students during the monitoring on November 10, 2016. The measurement collected inside the construction zone at the end of the day with little to no construction activity had a higher PM2.5 concentration (14 µg/m³) and about the same PM10 concentration as the areas measured in the occupied areas (169 µg/m³).

Indoor Air Quality Measurements

Industry guidelines or standards for seasonal temperature and humidity ranges for thermal comfort are established by the American Society for Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standard 55-2013. These ranges are presented in Table 3. The U.S. Environmental Protection Agency (EPA) recommends maintaining indoor relative humidity below 60% and ideally between 30 and 50%. Low humidity is expected in buildings that do not add humidity during the heating season. The comfort ranges are only set for the Summer and Winter seasons when temperatures are usually consistent. There are no Fall or Spring ranges because these seasons can include both heating and cooling modes of HVAC operation. Results of temperature, relative humidity, carbon dioxide and carbon monoxide monitoring on November 10 are presented in Table 4.

Table 3- Acceptable Ranges of Temperature and Relative Humidity in Summer and Winter[a]

Relative Humidity	Winter Temperature	Summer Temperature
30%	68.5°F – 76.0°F	74.0°F – 80.0°F
40%	68.5°F - 75.5°F	73.5°F – 79.5°F
50%	68.5°F - 74.5°F	73.0°F – 79.0°F
60%	68.0°F - 74.0°F	72.5°F – 78.0°F

[a]adapted from ASHRAE Standard 55-2013

Carbon dioxide and carbon monoxide measurements are used to assess ventilation system performance. The exhaled breath of building occupants is the main indoor source of carbon dioxide; therefore, the build-up of carbon dioxide indicates inadequate ventilation.

Table 4 – Results of Indoor Air Quality (IAQ) Measurements at Swansfield Elementary School on November 10, 2016

Location	Time	Temperature (°F)	Relative Humidity (Rh%)	Carbon Monoxide (CO)	Carbon Dioxide (CO_2)
Outside	2:43 PM	61.6	33.8	0.4	305
Hallway Near Construction Wall 1	2:54 PM	69.0	36.6	0.0	671
Hallway Near Construction Wall 2	2:57 PM	70.1	33.9	0.0	652
Non-construction Zone – Near Gym Entrance	3:00 PM	71.1	32.9	0.1	595
Non-construction Zone – Hallway Between Construction Walls	3:03 PM	71.7	33.2	0.0	682
Inside Construction Zone1	3:08 PM	63.8	37.4	0.0	318

Bold-faced indicates results outside of recommended comfort ranges or target concentrations.

The indoor temperatures for November 10, 2016 ranged from 69.0°F to 71.7°F. Measurements in classrooms and occupied areas of the school were within the recommended winter comfort ranges. Indoor relative humidity measurements were all between 32.9% and 36.6%, within the recommended range of 30 to 60%. Comfort ranges are set for winter and summer, not for Spring and Fall when both cooling and heating may be necessary depending on outdoor conditions.

Carbon dioxide concentrations ranged from 595 to 682 ppm within indoor occupied areas. The concentration of concern for carbon dioxide is set by ASHRAE standard 62.1 as 700 ppm above outdoor air. On the day of monitoring, the outdoor air concentration of carbon dioxide was 305 ppm; therefore, concentrations were within the comfort parameters in all areas monitored. Measurements were made during a normal school day when the building was fully occupied, which could have contributed to elevated carbon dioxide readings.

Carbon monoxide is mainly attributed to incomplete combustion. Concentrations of CO ranged from 0.0 ppm to 0.1 ppm for all indoor and outdoor locations monitored and were below the ASHRAE concentration of concern (9 ppm).

Conclusions and Recommendations

Based upon our observations and sampling results on November 10, 2016 at Swansfield Elementary School (SWES), current measures are sufficient to prevent construction dust from entering the occupied areas of the school. Although the PM10 readings were above the recommended levels, the school is fully occupied and elevated levels are expected and are not due fully to construction activities. The floors were being kept clean of visible dust. AE will continue to make visits to SWES as requested.

Thank you for choosing Aria Environmental, Inc. for your industrial hygiene consulting needs. Should you have any questions about the information contained herein, please do not hesitate to contact us at 410-549-5774.

Sincerely,
Aria Environmental, Inc.

Julie Barth, CIH, CSP, LEED Green Associate