Aria Environmental, Inc.
INDUSTRIAL HYGIENE & SAFETY CONSULTANTS

June 16, 2016

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

RE: Indoor Air Quality Assessments during Renovations at Deep Run Elementary School
Project #J15-867

Dear Mr. Klenk,

Aria Environmental, Inc. (AE) is pleased to present this report of findings for indoor air quality assessments conducted at Deep Run Elementary School (DRES). In response to faculty complaints Jeff Klenk of HCPSS requested that AE start making frequent visits to DRES in order to monitor indoor air quality that may be affected by the current major renovation of the school. Previous visits have been conducted on May 16, 2016 and May 19, 2016 and reported separately. The follow up visit discussed in this report was performed on May 25, 2016 and included work site observations and real time measurements for particles, volatile organic compounds (VOCs) and indoor air quality parameters (temperature, humidity, carbon monoxide (CO) and carbon dioxide ($CO_2$)). This assessment was performed by Julie Fafard of AE. The observations and recommendations made during this visit to DRES are presented below. These observations and recommendations are 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 (PM 10) and "fine particles," with diameters that are 2.5 micrometers and smaller (PM 2.5). 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 PM 2.5 and PM 10 of 15 $\mu g/m^3$ and 50 $\mu g/m^3$, 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 (PM 1, PM 2.5, PM 7, PM 10 and total suspended particles (TSP)). Results of particulate monitoring are presented in Tables 1.



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**Table 1 – Results of Particulate Monitoring Deep Run Elementary School on May 25, 2016**

| Location | Time | PM1 (µg/m³) | PM2.5 (µg/m³) | PM7 (µg/m³) | PM10 (µg/m³) | TSP (µg/m³) |
|---|---|---|---|---|---|---|
| At Sealed Double Door to Construction Area | 11:24 AM | 0 | 0 | 19 | 24 | 58 |
| 2nd Grade Common Area | 11:29 AM | 0 | 0 | 13 | 17 | 29 |
| Middle 2nd Grade Classroom Closest to Construction | 11:34 AM | 0 | 0 | 2 | 3 | 8 |
| Rear 2nd Grade Classroom Closest to Construction | 11:37 AM | 0 | 1 | 10 | 15 | 28 |
| Front 2nd Grade Classroom near Wall to Construction | 11:41 AM | 0 | 0 | 5 | 7 | 11 |
| Rear 2nd Grade Classroom on Opposite Side from Construction | 11:44 AM | 0 | 1 | 4 | 4 | 23 |
| Media Center (Near Construction Barrier) | 11:49 AM | 0 | 0 | 8 | 17 | 41 |
| Media Center (Away from Construction Barrier Near Opening to Main Hallway) | 11:52 AM | 0 | 2 | 22 | 33 | 56 |
| In Cafeteria Lobby | 11:57 AM | 0 | 0 | 5 | 10 | 26 |
| Outdoors at Front Entrance | 12:04 PM | 0 | 1 | 5 | 5 | 21 |

The PM 2.5 particle concentrations ranged from 0 to 2 µg/m³ and PM10 particle concentrations ranged from 3 to 33 µg/m³. Particle concentrations were below the target concentrations in all areas monitored.

**Volatile Organic Compounds Monitoring**

Instantaneous measurements for volatile organic compounds (VOCs) were collected using a ppbRae 3000 monitor. This instrument is used as a screening tool for VOCs in general; for short or long periods of time. The limit of detection for VOCs is 1 ppb. VOCs include a variety of chemicals, some of which may cause adverse health effects. Concentrations of many VOCs are generally higher indoors than outdoors. VOCs are emitted by many common products including paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, fuels, office equipment and supplies, glues and adhesives, and permanent markers, as well as cosmetics, perfumes, hand sanitizers and other personal hygiene products. All of these products can release organic compounds while being used or stored. It is important to note that the measurements taken with the ppbRAE monitor are instantaneous and are intended only as a quick reference in this particular case. VOC measurements are presented in Table 2.

**Table 2 – Results of Volatile Organic Compound (VOC) at Deep Run Elementary School on May 25, 2016**

| Location | Time | VOCs (ppb) |
|---|---|---|
| At Sealed Double Door to Construction Area | 11:24 AM | 0.0 |
| 2nd Grade Common Area | 11:29 AM | 0.0 |
| Middle 2nd Grade Classroom Closest to Construction | 11:34 AM | 0.0 |
| Rear 2nd Grade Classroom Closest to Construction | 11:37 AM | 0.0 |
| Front 2nd Grade Classroom near Wall to Construction | 11:41 AM | 0.0 |

| Location | Time | VOCs (ppb) |
|---|---|---|
| Rear 2nd Grade Classroom on Opposite Side from Construction | 11:44 AM | 0.0 |
| Media Center (Near Construction Barrier) | 11:49 AM | 0.0 |
| Media Center (Away from Construction Barrier Near Opening to Main Hallway) | 11:52 AM | 0.0 |
| In Cafeteria Lobby | 11:57 AM | 0.0 |
| Outdoors at Front Entrance | 12:04 PM | 0.0 |

Indoor concentrations of VOCs measured on May 25, 2016 were 0.0 ppb at DRES. The outdoor measurement was 0.0 ppb.

**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 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 Deep Run Elementary School on May 25, 2016**

| Location | Time | Temperature (°F) | Relative Humidity (Rh)(%) | Carbon Monoxide (CO) | Carbon Dioxide ($CO_2$) |
|---|---|---|---|---|---|
| At Sealed Double Door to Construction Area | 11:24 AM | **81.3** | 39.5 | 0.4 | 821 |
| 2nd Grade Common Area | 11:29 AM | 77.7 | 42.1 | 0.0 | 450 |
| Middle 2nd Grade Classroom Closest to Construction | 11:34 AM | 74.7 | 44.7 | 0.0 | 467 |

| Location | Time | Temperature (°F) | Relative Humidity (Rh)(%) | Carbon Monoxide (CO) | Carbon Dioxide ($CO_2$) |
|---|---|---|---|---|---|
| Rear 2nd Grade Classroom Closest to Construction | 11:37 AM | 74.1 | 48.1 | 0.0 | 567 |
| Front 2nd Grade Classroom Near Wall to Construction | 11:41 AM | 74.1 | 46.0 | 0.0 | 413 |
| Rear 2nd Grade Classroom on Opposite Side from Construction | 11:44 AM | 75.3 | 45.9 | 0.0 | 529 |
| Media Center (Near Construction Barrier) | 11:49 AM | 75.4 | 45.2 | 0.0 | 771 |
| Media Center (Away from Construction Barrier near Opening to Main Hallway) | 11:52 AM | 74.3 | 42.8 | 0.0 | 644 |
| In Cafeteria Lobby | 11:57 AM | 73.5 | 44.7 | 0.0 | 543 |
| Outdoors at Front Entrance | 12:04 PM | 79.8 | 32.5 | 0.0 | 275 |

The indoor temperatures for May 25, 2016 ranged from 73.5°F to 81.3°F. Temperature measurements in classrooms and occupied areas of the school were mostly within the acceptable comfort ranges. No measurements were taken within the construction area. Relative humidity measurements were all between 39.5% and 48.1% which is within the recommended range of 30 to 60%.

Carbon dioxide concentrations ranged from 413 to 821 ppm indoors. The concentration of concern for carbon dioxide is set by ASHRAE standard 62.1–2013 as 700 ppm above outdoor air. On the day of monitoring, the outdoor air concentration of carbon dioxide 275 ppm; therefore, carbon dioxide concentrations were within the comfort parameters established by ASHRAE in all areas monitored.

Carbon monoxide is mainly attributed to incomplete combustion. Concentrations of CO were consistently 0.0 ppm for all indoor and outdoor locations monitored (with the exception of the reading at the construction entrance which was 0.4 ppm) and were below the ASHRAE concentration of concern of 9 ppm.

**Conclusions and Recommendations**

Based upon our observations and sampling results on May 25, 2016 at Deep Run Elementary School (DRES), measures are being taken to control dust and odors related to construction activities. AE will continue to make visits to DRES 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