COMMITMENT & INTEGRITY
DRIVE RESULTS

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Via Electronic Mail

January 8, 2020

Erin Michaud
Project Manager
Kenneth Boroson Architects
315 Peck Street
Building 3, Suite 2-B
New Haven, CT 06513

Re: Post Construction Indoor Air Quality Screening and Consulting Support Services
Holland Hill Elementary School

Dear Ms. Michaud:

Woodard & Curran has prepared this summary report of indoor air quality (IAQ) screening results following construction activities at the Holland Hill School located at 105 Meadowcroft Road in Fairfield, Connecticut.

On December 23, 2019, Woodard & Curran representative, Mr. William Henderson performed the IAQ screening. The site visit occurred during school vacation when school was not in session; however, contractors were working at the school installing new classroom doors.

The assessment was performed in response to a request to evaluate the general air quality within the school building and to evaluate the space for the presence of unwanted sources of air contamination following renovations to the school. The site visit included the following tasks:

1. Real-time direct-reading measurements for temperature, relative humidity, carbon monoxide, carbon dioxide, total volatile organic compounds (VOCs), and particulate matter (dust) throughout the school.
2. A visual inspection of areas throughout the school to determine if there were obvious construction-related dusts or odors remaining in the school.
3. A visual inspection of the school's readily accessible portions of the heating ventilation and air conditioning (HVAC) system including three rooftop air handling units and supply air diffusers in the classrooms.

Observations

Holland Hill School consists of a one-story building with a partial basement. The first floor of the school houses classrooms, administrative offices, library, gymnasium, multipurpose rooms, and kitchen. The boiler room is located in the basement.

During the previous year the school underwent renovations. The construction included a large building addition on the south elevation of the building while a smaller building addition was constructed on the north elevation. Within the existing school footprint, mechanical ventilation was added to the classrooms. The south addition is connected to the school near the corridor outside the gymnasium on the west side and the vestibule outside the library on the east elevation. The north elevation addition is adjacent to the kitchen and the boiler room.

On the day of the site visit, carpenters were observed installing classroom doors and were working near the K2 and K1 rooms during the indoor air quality assessment. A ventilation contractor was also observed performing balancing of the HVAC system. Neither of these contractor's work would be expected to adversely impact the indoor environment. No other subcontractors were observed conducting construction-related activities during the site visit.

Visual Inspection

The occupied areas of the building including classrooms and corridors, generally appeared clean and no excessive accumulation of settled dust was observed. The area above the suspended ceilings in select classrooms were also visually inspected and there was no evidence of construction related debris or materials that would be expected to adversely impact the indoor environment. Photos of the corridor outside Classroom 140 and the ceiling cavity above Classroom 10 are included as Photos 1 and 2 in Attachment A.

During the inspection stained ceiling tiles were present in the Music Room (Room 148) along the exterior wall. A photo of the stained ceiling tiles is included as Photo 3 in Attachment A. An inspection above the suspended ceiling did not reveal the source of the staining.

Heating Ventilation and Air Conditioning Inspection

Three of the observed six rooftop air handing units were visually inspected including DOAS-2, DOAS-1, and RTU-3. Photos of these units are included as Photos 4 through 9 in Attachment A. The rooftop dedicated outdoor air systems (DOAS) and rooftop units (RTU) were in good condition. Filters and pre-filters were seated tightly in their tracks, the compartments were clean with no accumulated dust, rust, water or suspect mold growth. The bird screens were also in good condition. DOAS-1 and 2 were operating at the time of the survey; however, RTU-3 was not operating.

The supply air diffuser fins observed were in good condition and settled dust was not observed. A photo of the supply air diffuser located in Classroom 10 is included as Photo 10 in Attachment A. The observable interior portion of the ductwork also appeared to be in good condition.

Indoor Air Quality

Temperature and Relative Humidity

Indoor temperature levels for occupied areas should be maintained within the thermal comfort envelope suggested by the American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE). ASHRAE specifies conditions in which 80% or more of building occupants should find the thermal environment acceptable. ASHRAE suggests temperatures of 68 to 75 degrees Fahrenheit (°F), during winter months, for people in typical seasonal clothing during light sedentary activity. For summer, the temperature should be in the range of 73 to 79 °F.

On the day of the survey, temperature and relative humidity readings throughout the school were made with a calibrated TSI Q-Trak direct-reading instrument. The temperature readings in areas intended for occupancy ranged between 58.3 and 72.2°F indicating that the temperature in the areas measured were generally below the guideline of 68 to 75 °F recommended by ASHRAE for thermal comfort for winter months. The building was not occupied at the time of the survey and it would be expected to be warmer when the school is occupied by staff and students.

The indoor relative humidity readings in occupied portions of the building, also measured with the TSI Q-Trak, ranged from 26.0 to 36.8%. All of the of relative humidity readings were within the guideline of less than 65% recommended by ASHRAE for occupant comfort and for the prevention of microbial growth. It should be noted that these recommended ranges are guidelines and can vary depending on building occupancy, heating system, and seasonal temperature differential.

A summary of the direct-reading measurements for temperature and relative humidity is provided in Attachment B.

Carbon Dioxide

Carbon dioxide is a normal constituent of the atmosphere and ranges from about 350 to 500 parts per million (ppm) in outdoor air. The major source of excess carbon dioxide in the indoor environment is human respiration. Other sources can include open-flame heaters, fermentation processes, and motor vehicles. Carbon dioxide itself is not normally a cause of indoor air quality problems but is typically used as an indicator of the adequacy of fresh air ventilation. As the concentration of carbon dioxide increases, so do the background levels of other air contaminants.

Carbon dioxide readings in the areas tested were made with a direct-reading instrument, a TSI Q-Trak. The interior carbon dioxide concentration for occupied areas was observed to be between 489 and 655 ppm. Interior carbon dioxide levels will fluctuate according to building occupancy.

To minimize air quality complaints, ASHRAE has proposed that the carbon dioxide concentration within an occupied workspace be maintained at or below 700 ppm above ambient exterior (outdoor) levels. For example, on the day of the survey the average outside carbon dioxide level was determined to be 468 ppm. Therefore, ASHRAE would recommend that interior carbon dioxide concentrations be at or below 1,168 ppm. All the carbon dioxide levels measured in occupied areas of the building were found to be within ASHRAE's guideline.

A summary of the direct-reading measurements for carbon dioxide is provided is provided in Attachment B.

Carbon Monoxide

Common sources of carbon monoxide within indoor environments include internal combustion engines such as motor vehicle and forklift exhaust. Other sources may include tobacco smoke, space heaters, improperly adjusted oil or gas burners and other processes that result in incomplete combustion. The Environmental Protection Agency (EPA) has established a National Ambient Air Quality Standard of 9 ppm for carbon monoxide averaged over an 8-hour period. Typical average concentrations found in a commercial building range from 0 to 6 ppm.

Carbon monoxide readings throughout the school were made with the TSI-Q-Trak direct-reading instrument. Carbon monoxide readings were all less than the instrument limit of detection of 3 ppm in the occupied interior locations and therefore, were within the EPA's guideline for carbon monoxide.

A summary of the direct-reading measurements for carbon monoxide is provided in Attachment B.

Airborne Particulate

Airborne particulate is a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope and can be irritating to the respiratory system. Various size particles were measured throughout the areas intended for occupancy. The U.S. EPA National Ambient Air Quality Standards (NAAQS) standard for airborne particulate PM-2.5 and PM-10 (airborne particulate matter with size diameters 2.5 and 10 micrometers) is 0.035 milligrams per cubic meter of air (mg/m^3) and 0.150 mg/m^3 respectively, measured over a 24-hour period.

Airborne particulate was measured using a calibrated DustTrak DRX (model 8533) manufactured by TSI which can measure mass and size fraction of airborne particulate. The DustTrak DRX can measure airborne particulate with different size ranges including particles that are 1, 2.5, and 10 micrometers in diameter size as well as respirable sized particulate and total particulate. PM-2.5 was measured between 0.003 and 0.013 mg/m^3 and PM-10 was measured between 0.005 to 0.019 mg/m^3 on the day of the survey, which is below the EPA reference values. Outdoor concentrations of PM-2.5 and PM-10 were measured to be 0.018 and 0.023 mg/m^3, respectively on the day of the survey.

A summary of the direct-reading measurements for airborne particulate is provided in Attachment B.

Total Volatile Organic Compounds

VOCs comprise a broad category of chemicals that include components of many common office supplies and products such as paints, solvents, mothballs, some janitorial supplies, photocopiers, insecticides, and building materials such as construction adhesives. Although U. S. Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) have been established for many of these individual chemicals, concentrations in typical non-industrial indoor air seldom exceed these limits.

VOC measurements were made using a calibrated photo ionization detector (PID) MiniRae 2000 to indicate the levels of total VOCs that have an ionization potential below 10.6 electron volts. The PID is useful for detecting VOCs to a lower limit of one to two ppm calibration gas equivalent. No concentrations above the instrument limit of detection for Total VOCs were measured on the day of the survey. There are currently no indoor air quality limits recommended by the EPA, however, indoor air concentrations are typically 2 – 5 times greater than the measured outdoor concentrations and can be over a thousand times higher during certain activities, such as painting.

VOC measurements were all less than the instrument limit of detection of 0.1 ppm in the interior locations intended for occupancy and therefore, were within acceptable limits.

A summary of the direct-reading measurements for VOCs is provided in Attachment B.

Conclusions and Recommendations

The areas of the building intended for occupancy including classrooms and corridors, generally appeared clean and no excessive accumulation of settled dust was observed. Two stained ceiling tiles were observed in the Music Room (Room 148). The stained ceiling tiles in the Music Room (Room 148) should be replaced. The source of the staining should be identified and remediated.

The accessible portions of the HVAC system were clean and appeared free of anything that could adversely impact the indoor air quality.

The direct reading IAQ measurements were within the recommended IAQ levels.

Limitations

The services performed by Woodard & Curran were conducted in a manner consistent with standard industry practices for indoor air quality screening assessments and Woodard & Curran's proposal dated June 17, 2019.

If you have any questions, or require additional information, please contact us via email or at the number listed above.

Sincerely,

WOODARD & CURRAN

William Henderson, CIH
Project Scientist II

George J. Franklin, CHMM
Technical Manager

Attachment A: Photo Log
Attachment B: Table of Direct Reading Measurements

ATTACHMENT A: PHOTO LOG

Photo Number: 1	Location: Corridor outside Classroom 140	Date: December 23, 2019
Description: Interior corridor		

Photo Number: 2	Location: Above ceiling, Classroom 10	Date: December 23, 2019
Description: Clean ceiling cavity		

Photo Number: 3	Location: Music Room (Room 148)	Date: December 23, 2019
Description: Stained ceiling tiles		

Photo Number: 4	Location: RTU-3	Date: December 23, 2019
Description: Filter compartment		

Photo Number: 5	Location: RTU-3	Date: December 23, 2019
Description: Fan compartment		

Photo Number: 6	Location: DOAS-2	Date: December 23, 2019
Description: Prefilters and fresh air dampers		

Photo Number: 7	Location: DOAS-1	Date: December 23, 2019
Description: Condensate drain line		

Photo Number: 8	Location: DOAS-2	Date: December 23, 2019
Description: Bird screens		

Photo Number: 9	Location: DOAS-2	Date: December 23, 2019
Description: Filter compartment		

Photo Number: 10	Location: Classroom 10	Date: December 23, 2019
Description: Supply air diffuser		

ATTACHMENT B: TABLE OF DIRECT-READING IAQ MEASUREMENTS

Indoor Air Quality Direct-Reading Measurements

Holland Hill School

105 Meadowcroft Road, Fairfield, CT 06824

December 23, 2019

Location	Time	CO (ppm)	CO_2 (ppm)	VOC (ppm)	Temp (ºF)	Relative Humidity (%rh)	Dust Particulate (mg/m^3)				
							PM 1	PM 2.5	Respirable	PM 10	Total
Corridor Outside Facility Room	9:28a	ND[1] < 3	542	ND < 0.1	62.3	32.2	0.010	0.010	0.011	0.019	0.021
110 Main Office	9:30a	ND < 3	554	ND < 0.1	64.9	33.7	0.005	0.005	0.005	0.007	0.007
106A Health Suite	9:32a	ND < 3	556	ND < 0.1	65.9	31.8	0.005	0.005	0.005	0.009	0.009
Classroom 10	9:34a	ND < 3	553	ND < 0.1	66.6	30.6	0.005	0.005	0.005	0.009	0.010
Classroom 7	9:36a	ND < 3	591	ND < 0.1	67.9	29.0	0.005	0.006	0.006	0.006	0.006
Classroom 4	9:39a	ND < 3	541	ND < 0.1	68.1	27.7	0.006	0.007	0.008	0.008	0.018
Classroom K2	9:41a	ND < 3	522	ND < 0.1	67.5	29.0	0.006	0.006	0.008	0.007	0.007
Room 120 All Purpose Room	9:43a	ND < 3	494	ND < 0.1	58.3	30.9	0.013	0.013	0.013	0.014	0.014
Library	9:45a	ND < 3	655	ND < 0.1	61.0	36.8	0.005	0.005	0.006	0.006	0.007
Classroom 14	9:49a	ND < 3	541	ND < 0.1	64.3	31.4	0.008	0.008	0.008	0.008	0.009
Classroom 13	9:50a	ND < 3	514	ND < 0.1	66.0	31.1	0.008	0.008	0.008	0.011	0.011
Classroom 18	9:52a	ND < 3	501	ND < 0.1	66.2	29.3	0.007	0.007	0.007	0.018	0.018
Classroom 17	9:54a	ND < 3	520	ND < 0.1	66.4	30.6	0.007	0.007	0.007	0.007	0.007
Gym	9:56a	ND < 3	527	ND < 0.1	64.5	29.7	0.010	0.010	0.010	0.011	0.011

Location	Time	CO (ppm)	CO_2 (ppm)	VOC (ppm)	Temp (°F)	Relative Humidity (%rh)	Dust Particulate (mg/m^3)				
							PM 1	PM 2.5	Respirable	PM 10	Total
148 Music	10:00a	ND < 3	568	ND < 0.1	66.1	31.1	0.006	0.006	0.007	0.011	0.017
142 Classroom	10:02a	ND < 3	514	ND < 0.1	67.6	27.7	0.007	0.007	0.007	0.008	0.010
140 Classroom	10:04a	ND < 3	527	ND < 0.1	67.8	27.9	0.00 5	0.006	0.006	0.008	0.008
139 Classroom	10:06a	ND < 3	528	ND < 0.1	67.5	27.6	0.006	0.006	0.007	0.007	0.007
135 Classroom	10:08a	ND < 3	546	ND < 0.1	67.9	28.6	0.006	0.006	0.006	0.006	0.006
Corridor Outside Facility Room	10:29a	ND < 3	527	ND < 0.1	67.9	27.7	0.006	0.006	0.006	0.007	0.007
110 Main Office	10:41a	ND < 3	519	ND < 0.1	68.1	29.6	0.005	0.006	0.006	0.007	0.0018
106A Health Suite	10:43a	ND < 3	522	ND < 0.1	68.1	29.0	0.003	0.003	0.004	0.004	0.004
Classroom 10	10:45a	ND < 3	540	ND < 0.1	69.2	28.1	0.005	0.005	0.006	0.007	0.007
Classroom 5	10:47a	ND < 3	536	ND < 0.1	68.0	26.8	0.006	0.006	0.007	0.011	0.011
Classroom K2	10:59a	ND < 3	514	ND < 0.1	67.5	30.3	0.005	0.005	0.005	0.009	0.009
Classroom 4	10:51a	ND < 3	560	ND < 0.1	67.8	29.4	0.005	0.005	0.006	0.006	0.007
Room 120 All Purpose Room	10:53a	ND < 3	518	ND < 0.1	66.7	28.6	0.005	0.005	0.006	0.006	0.006
Classroom 14	10:55a	ND < 3	524	ND < 0.1	68.0	29.9	0.005	0.005	0.005	0.005	0.005
Classroom 13	10:58a	ND < 3	573	ND < 0.1	70.3	30.1	0.006	0.006	0.006	0.006	0.006
Classroom 18	11:01a	ND < 3	500	ND < 0.1	71.9	27.8	0.007	0.007	0.007	0.007	0.007
Classroom 17	11:02a	ND < 3	503	ND < 0.1	72.2	28.0	0.005	0.005	0.005	0.005	0.005
Gym	11:04a	ND < 3	501	ND < 0.1	69.1	26.0	0.009	0.010	0.010	0.011	0.011

Location	Time	CO (ppm)	CO_2 (ppm)	VOC (ppm)	Temp (°F)	Relative Humidity (%rh)	Dust Particulate (mg/m3)				
							PM 1	PM 1	PM 1	PM 1	PM 1
Classroom 148 Music	11:06a	ND < 3	489	ND < 0.1	69.7	26.9	0.007	0.007	0.008	0.012	0.014
Classroom 142	11:04a	ND < 3	499	ND < 0.1	69.4	26.9	0.005	0.005	0.005	0.006	0.006
Corridor Outside 141	11:11a	ND < 3	587	ND < 0.1	68.8	29.1	0.005	0.005	0.005	0.005	0.014
Classroom 140	11:13a	ND < 3	504	ND < 0.1	68.5	27.6	0.006	0.006	0.007	0.018	0.019
Resource Room 135	11:15a	ND < 3	509	ND < 0.1	68.9	28.9	0.007	0.007	0.007	0.007	0.007
Classroom 139	11:17a	ND < 3	492	ND < 0.1	69.3	27.2	0.005	0.006	0.008	0.018	0.018
Outdoors	11:30a	ND < 3	468	ND < 0.1	58.0	32.6	0.018	0.018	0.019	0.023	0.023

1. ND = None detected