

## **INDUSTRIAL HYGIENE REPORT**

Presented To:

Mr. Nicholas Munoz, EFM  
Assistant Director of Buildings & Grounds  
West Orange Public Schools  
West Orange, NJ 07052

Regarding:

All West Orange Board of Education Facilities  
West Orange, NJ 07052

Report Prepared By:

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Date of Report:

August 31, 2021

## **I. INTRODUCTION**

The West Orange Board of Education (BOE) has proactively retained Garden State Environmental, Inc. (GSE), an independent Industrial Hygiene, Public Health and Environmental Health and Safety firm, to provide recommendations to maximize the effectiveness of the heating, ventilation and air conditioning (HVAC) systems in reducing the risk of airborne transmission of the COVID-19 virus and other bioaerosols throughout all West Orange BOE facilities.

GSE's assessments were conducted on August 16 and 17, 2021, by Matthew C. DiLorenzo, B.S., Industrial Hygienist from GSE.

## **II. BACKGROUND AND DESCRIPTION OF HVAC SYSTEMS**

Mr. Nicholas Munoz, Assistant Director of Facilities for the West Orange BOE provided a background of each building's HVAC systems prior each GSE assessment.

Mr. Munoz stated that all facilities in the district aside from Liberty Middle School and Betty Maddalena Early Learning Center contain a combination of ducted rooftop unit (RTU) systems, individual room installed univents and window air conditioning units. Liberty Middle School and Betty Maddalena Early Learning Center only contain ducted RTU HVAC systems. MERV-8 filters have been installed in all HVAC systems throughout the district's facilities. All HVAC systems are inspected, cleaned and have their filters changed roughly three (3) times per year.

The majority of rooms in the BOE facilities contain openable windows. Mr. Munoz stated that HEPA equipped air filtration units have been installed in any occupied room that does not contain openable windows in all BOE facilities.

We were informed that the air intake damper settings were established on a school by school basis with no overall District parameters established.

## **III. VISUAL SURVEY FINDINGS**

The following findings were identified during our assessment of the West Orange BOE facilities:

- The majority of classrooms contained openable windows and functioning HVAC systems. Some areas, such as personal offices and hallways did not contain any windows. As previously mentioned by Mr. Munoz, the majority of occupied interior spaces without windows did contain HEPA equipped air filtration units.
- The majority of rooms in all facilities contained student/employee seating immediately adjacent to HVAC supply registers.
- Based on limited visual inspection, all HVAC system registers and other accessible areas of the systems appear to be in good sanitary condition and were operating normally during our assessments. Specific air intake damper settings were not available but it

appeared that the univent units were only drawing fresh air with no air conditioning. Only about 20% of inspected rooms had air conditioning operating during our inspection.

- Limited faculty and students were present in the school at the time of GSE's assessments.

#### **IV. IAQ SAMPLING METHODS**

##### **Temperature, Relative Humidity, Carbon Monoxide & Carbon Dioxide**

During this inspection, measurements were taken using a *TSI Q-Trak Meter Model 7565 IAQ Monitor* (Serial #1737006) equipped with a four function IAQ probe. This device measures temperature, relative humidity (RH), carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>) simultaneously. Temperature is displayed in degrees Fahrenheit (°F) and RH as a percent (%). Concentrations for CO and CO<sub>2</sub> are displayed in parts per million (PPM). Measurements were taken after allowing the device to become acclimated to the ambient temperature and relative humidity for a minimum of two (2) minutes.

#### **V. IAQ SAMPLING RESULTS**

The Indoor Air Quality (IAQ) measurements of temperature, RH, CO and CO<sub>2</sub> revealed the following average readings. Ten (10) outdoor measurements were collected during our inspection at each facility. The outdoor measurements listed in the tables below are an average of the outdoor measurements collected at each location.

<b>West Orange High School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	78.9	53.5	1.4	404
Room 1173	71.1	50.1	1.4	448
Room 1174	70.0	55.4	1.4	466
Room 1134	73.8	52.3	1.4	481
Room 1128	76.3	55.9	1.4	455
Room 2104	76.5	52.2	1.5	451
Room 2111	77.5	49.4	1.4	429
Room 2130	77.1	45.3	1.4	443
Room 2124	74.8	40.4	1.4	450
Room 2128	74.6	48.5	1.4	434
Room 2222	77.2	47.3	1.5	422
Room 2219	77.1	48.0	1.4	480
Room 2206	75.2	50.0	1.4	438
Room 2200	71.5	49.3	1.4	432
Room 3212	74.0	46.4	1.5	457
Room 3229	76.8	45.3	1.4	474
Room 2343	75.8	54.2	1.4	426
Room 2336	76.5	48.7	1.5	474
Room 2316	76.6	49.2	1.4	411
Room 2317	77.7	48.7	1.5	455
Room 2310	76.4	47.3	1.6	428
Room 2301	76.2	37.0	1.4	491
Room 3307	72.6	42.5	1.5	488
Room 3310	73.7	53.2	1.4	457
Room 3311	76.7	52.7	1.6	446
Room 3309	77.4	51.1	1.5	476
Room 3323	77.5	47.8	1.4	463

<b>Kelly Elementary School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	78.2	52.4	1.4	417
Library	74.5	41.9	1.5	475
Room 204	78.3	46.3	1.4	436
Room 206	79.1	45.4	1.4	448
Room 208	79.7	45.0	1.4	480
Room 210	81.6	45.5	1.4	461
Room 106	78.0	45.6	1.5	443
Room 106A	80.7	48.5	1.5	444
Room 104	77.5	38.8	1.5	606
Room 114	77.3	52.2	1.4	462
Room 112	76.9	50.5	1.4	469
Room 108	75.4	41.8	1.4	686
Room 116	72.5	38.7	1.5	507

<b>Redwood Elementary School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	<i>81.1</i>	<i>50.8</i>	<i>1.6</i>	<i>391</i>
Room 603	80.4	47.6	1.4	389
Room 606	80.5	50.0	1.5	394
Room 602	80.3	48.4	1.3	401
Room 502	80.6	47.1	1.4	398
Room 503	80.7	46.6	1.4	411
Room 504	80.7	46.4	1.4	406
Room 101	81.2	46.2	1.4	468
Room 107	80.5	46.3	1.4	445
Room 109	78.1	43.7	1.4	426
Room 300	80.0	47.6	1.4	444
Room 302	80.0	47.4	1.4	440
Room 305	80.3	47.7	1.4	434
Room 201	79.8	50.7	1.3	402
Gym	79.1	48.9	1.4	487

<b>Thomas Edison Middle School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	82.8	54.1	1.7	392
Main Office	79.0	37.5	1.4	430
Room 109	78.0	50.4	1.4	408
Room 103B	75.7	46.0	1.4	420
Room 112	75.1	51.7	1.3	409
Room 117	75.1	53.4	1.4	408
Room 102	73.7	54.4	1.5	441
Room 205	73.0	46.2	1.3	409
Room 206	72.9	46.8	1.3	412
Room 208	77.3	52.7	1.3	408
Room 210	78.5	50.6	1.4	421
Room 214	79.2	49.5	1.4	407
Room 216	76.8	42.2	1.4	412
Room 200	74.2	45.1	1.4	408
Room 204	77.7	46.2	1.3	413
Room 203	73.9	44.7	1.3	417
Auditorium	72.1	48.8	1.4	411
1 <sup>st</sup> Floor Hallway	78.1	45.2	1.4	419
2 <sup>nd</sup> Floor Hallway	77.9	44.4	1.4	429
Lower Level L3	78.4	47.1	1.4	414
Lower Level L5	73.7	38.1	1.5	420
Cafeteria	76.3	50.3	1.5	418

<b>Mount Pleasant Elementary School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	82.1	48.9	1.8	398
Room 215	79.2	40.0	1.5	414
Room 211	78.8	42.7	1.4	417
Cafeteria	77.5	50.9	1.4	404
Room 224	77.1	51.8	1.4	456
Room 225	77.1	50.8	1.5	429
Room 223	76.9	50.4	1.4	427
Room 228	72.3	44.9	1.4	424
Room 222	75.8	49.4	1.3	426
Room 300	75.1	57.4	1.4	413
Room 103	75.0	52.5	1.4	406
Room 105	75.5	55.6	1.4	413
Room 107	76.4	56.4	1.4	418
Room 110	76.7	56.1	1.4	425
Room 113	76.3	57.2	1.4	415

<b>Gregory Elementary School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	75.4	69.8	1.6	401
Room 120	77.6	58.9	1.4	457
Room 122	78.0	<b>62.9</b>	1.4	411
Cafeteria	78.3	<b>61.1</b>	1.4	432
Room 117	69.5	43.4	1.5	410
Room 114	74.7	<b>67.6</b>	1.4	416
Room 105	76.6	<b>65.5</b>	1.4	419
Room 102	76.1	<b>65.2</b>	1.4	408
Room 106	76.6	<b>65.1</b>	1.4	403
Room 202	78.8	59.9	1.4	444
Room 203	79.7	59.8	1.4	464
Room 207	80.2	57.5	1.4	433
Room 208	80.6	52.7	1.5	503
Room 213	81.0	55.5	1.5	443
Room 214	81.0	55.9	1.5	416
2 <sup>nd</sup> Floor Hallway	81.3	54.8	1.5	446
1 <sup>st</sup> Floor Hallway	78.5	58.9	1.5	413
Room 210	76.8	40.8	1.4	467

<b>Roosevelt Middle School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	73.9	74.0	1.5	409
Main Office	74.5	<b>65.3</b>	1.4	435
Room 108	76.3	<b>65.0</b>	1.4	419
Room 107	76.2	<b>63.5</b>	1.4	409
Room 104	76.4	<b>68.0</b>	1.4	407
Basement Art Shop	75.4	<b>63.9</b>	1.5	408
Basement Art Room	75.4	<b>68.1</b>	1.4	416
Room 201	76.2	<b>62.4</b>	1.4	404
Room 202	74.4	<b>60.4</b>	1.4	418
Room 206	75.1	<b>69.1</b>	1.4	401
Room 207	76.4	<b>66.9</b>	1.4	403
Room 210	74.3	<b>62.3</b>	1.4	400
Room 209	76.0	<b>64.5</b>	1.4	406
Room 216	76.4	<b>65.0</b>	1.4	404
Room 314	77.5	<b>63.8</b>	1.4	417
Room 312	77.7	<b>63.7</b>	1.4	433
Room 310	73.9	<b>61.9</b>	1.7	436
Room 308A	74.3	<b>67.4</b>	1.7	406
Room 302	75.6	<b>64.4</b>	1.5	415
Room 303	75.0	<b>67.6</b>	1.7	416
Room 301	75.7	<b>65.0</b>	1.7	413

<b>Hazel Elementary School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	78.4	60.7	1.4	404
Gym	78.6	58.7	1.4	428
B1	77.4	59.8	1.4	414
B4	77.0	61.2	1.4	431
B12	77.2	60.8	1.4	432
B6	77.5	59.7	1.4	449
B9	78.1	<b>60.9</b>	1.4	453
Room 106	78.6	59.7	1.4	416
Room 104	79.2	58.4	1.4	426
Room 103	78.4	58.6	1.4	407
Room 107	78.5	58.1	1.4	405
Room 109	78.6	58.9	1.4	419
Room 201	78.5	58.9	1.4	416
Room 209	78.9	58.8	1.4	413
Room 202	79.6	57.8	1.4	412
Room 205	80.0	56.9	1.4	415
Room 206	79.2	56.7	1.4	411
3 <sup>rd</sup> Floor Main Room	80.6	54.1	1.4	433
3 <sup>rd</sup> Floor Library	76.7	49.9	1.4	427

<b>Washington Elementary School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	79.2	57.9	1.8	408
Room 114	82.5	53.8	1.6	427
Room 116	81.1	55.8	1.4	434
Room 111	80.9	53.9	1.4	414
Room 112	79.8	54.1	1.4	438
Room 107	77.2	55.5	1.4	422
Room 101	81.1	57.1	1.4	481
Room 98	78.6	58.0	1.6	448
Cafeteria	79.2	56.5	1.4	405
B4	78.8	60.1	1.4	428
B2	78.5	58.7	1.4	452
B9	75.4	53.1	1.4	438
B7	78.1	<b>60.9</b>	1.4	501
Room 207	80.2	57.9	1.4	481
Room 209	79.1	58.1	1.4	455
Room 206	81.0	55.2	1.4	420
Room 204	80.1	56.4	1.4	426
Trailer 1	79.3	57.2	1.4	420
Trailer 2	79.1	56.0	1.4	411

<b>Liberty Middle School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	82.8	56.0	1.8	432
Auditorium	76.8	50.8	1.3	408
Room 108	73.2	52.4	1.3	406
Room 107	72.8	53.4	1.5	402
Room 110	71.6	55.2	1.4	408
Room 121	71.2	55.9	1.4	415
Media Center	69.9	55.0	1.5	414
Gym	70.8	54.9	1.5	406
Room 122	70.5	<b>60.2</b>	1.4	409
Room 116	70.3	59.7	1.5	404
Room 218	71.6	57.9	1.3	418
Room 213	70.8	57.3	1.3	406
Room 209	73.9	53.7	1.4	414
Room 200	73.2	54.4	1.5	412
Room 203	72.8	55.1	1.5	415
Room 204	73.1	54.8	1.4	418
2 <sup>nd</sup> Floor Hallway	72.7	55.7	1.4	409
1 <sup>st</sup> Floor Hallway	72.9	55.4	1.4	411
Room 222	73.0	54.8	1.5	418

<b>St. Cloud Elementary School - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	80.4	61.9	1.6	398
Room 306	73.4	52.0	1.5	395
Room 305	81.0	55.0	1.6	388
Room 308	77.1	49.5	1.5	408
Room 310	80.0	57.1	1.5	409
Room 312	80.5	56.1	1.5	402
Room 313	79.1	46.7	1.5	405
Room 214	80.0	57.6	1.6	416
Library	79.1	<b>60.4</b>	1.5	408
Room 210	80.5	<b>60.6</b>	1.6	418
Room 206	79.1	<b>61.5</b>	1.5	404
Room 207	78.9	<b>60.4</b>	1.5	409
Room 103	79.2	<b>61.7</b>	1.5	412
Room 101	79.0	<b>62.1</b>	1.5	420
Room 102	79.1	<b>61.8</b>	1.6	411
1 <sup>st</sup> Floor Hallway	78.4	<b>60.6</b>	1.5	428
2 <sup>nd</sup> Floor Hallway	78.7	<b>60.8</b>	1.5	436
3 <sup>rd</sup> Floor Hallway	78.5	<b>60.2</b>	1.5	414

<b>Betty Maddalena Early Learning Center - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	82.4	60.1	1.3	374
Room 6	74.7	52.6	1.3	425
Room 5	74.5	50.3	1.3	419
Room 4	74.6	52.9	1.3	436
Room 3	74.2	51.8	1.3	444
Room 2	74.1	51.4	1.3	421
Room 1	74.1	52.2	1.3	427
Front Desk Area	73.4	56.6	1.3	454
Principal's Office	72.8	58.4	1.3	472
Middle Hallway Office	72.6	57.1	1.3	484
Main Hallway	72.6	<b>61.0</b>	1.3	472

<b>West Orange Administration Building - General IAQ Parameters</b>				
<b>Location</b>	<b>Temperature (°F)</b>	<b>Relative Humidity (%)</b>	<b>Carbon Monoxide (PPM)</b>	<b>Carbon Dioxide (PPM)</b>
<i>Outdoors</i>	84.2	61.3	1.6	403
Room 106	75.3	38.1	1.6	444
Registration Office	75.6	38.2	1.6	456
Buildings & Grounds Office	74.1	39.7	1.6	473
Room 105	77.0	48.3	1.6	405
Room 201	75.5	44.4	1.6	451
Room 203	75.9	43.8	1.6	453
Room 206	74.2	46.6	1.6	481
Room 212	74.9	51.3	1.6	489
Room B2	75.6	<b>60.7</b>	1.6	458
Basement Hallway	74.9	60.0	1.7	442
1 <sup>st</sup> Floor Hallway	76.1	49.9	1.6	437
2 <sup>nd</sup> Floor Hallway	75.3	53.4	1.6	461
Special Services Room	76.1	54.9	1.6	472

## **VI. DISCUSSION**

### **Temperature:**

Temperatures inside each facility ranged from:

- 70.0 to 77.7°F in West Orange High School
- 72.5 to 81.6°F in Kelly Elementary School
- 78.1 to 81.2°F in Redwood Elementary School
- 72.9 to 79.0°F in Thomas Edison Middle School
- 72.3 to 79.2°F in Mount Pleasant Elementary School
- 69.5 to 81.3°F in Gregory Elementary School
- 74.3 to 77.7°F in Roosevelt Middle School
- 76.7 to 80.6°F in Hazel Elementary School
- 77.2 to 82.5°F in Washington Elementary School
- 69.9 to 76.8°F in Liberty Middle School
- 73.4 to 81.0°F in St. Cloud Elementary School
- 72.6 to 74.7°F in Betty Maddalena Early Learning Center
- 74.1 to 77.0°F in the West Orange Administration Building

These indoor temperature ranges are all either within or near the summer/transitional season recommended range.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) recommends that indoor temperatures be maintained between 73°F and 79°F during the summer/transitional season.

### **Relative Humidity:**

The relative humidity inside each facility ranged from:

- 37.0 to 55.9% in West Orange High School
- 38.7 to 52.2% in Kelly Elementary School
- 43.7 to 50.7% in Redwood Elementary School
- 37.5 to 54.4% in Thomas Edison Middle School
- 40.4 to 57.2% in Mount Pleasant Elementary School
- 43.4 to 67.6% in Gregory Elementary School
- 61.9 to 69.1% in Roosevelt Middle School
- 49.9 to 61.2% in Hazel Elementary School
- 53.1 to 60.9% in Washington Elementary School
- 50.8 to 60.2% in Liberty Middle School
- 46.7 to 62.1% in St. Cloud Elementary School
- 50.3 to 61.0% in Betty Maddalena Early Learning Center
- 38.1 to 60.7% in the West Orange Administration Building

These RH readings ranged from within acceptable range to elevated (>60%). ASHRAE has established a recommended range for RH of 30-60%. The ideal comfortable RH range has been reported as 40% to 60%, as long as building materials or contents are not adversely affected. The United States Department of Labor, Occupational Safety and Health Administration (OSHA) recommend humidity control within a 20% to 60% range in their technical manual for IAQ investigations. High humidity levels (over 60%) can promote the growth of microorganisms on building surfaces and furnishings, and cause or contribute to microbial IAQ problems.

#### Carbon Monoxide:

The concentration of CO ranged from 1.3 to 1.8 PPM inside all of the inspected facilities. These measurements fall well below the acceptable OSHA Permissible Exposure Limit as well as the Indoor Air Quality Association recommended maximum concentration of 9.0 PPM as an eight (8) hour time weighted average (TWA).

#### Carbon Dioxide:

The concentration of CO<sub>2</sub> inside each facility ranged from:

- 411 to 491 PPM in West Orange High School
- 436 to 686 PPM in Kelly Elementary School
- 389 to 487 PPM in Redwood Elementary School
- 407 to 441 PPM in Thomas Edison Middle School
- 404 to 456 PPM in Mount Pleasant Elementary School
- 403 to 503 PPM in Gregory Elementary School
- 400 to 436 PPM in Roosevelt Middle School
- 405 to 453 PPM in Hazel Elementary School
- 405 to 501 PPM in Washington Elementary School
- 404 to 418 PPM in Liberty Middle School
- 395 to 436 PPM in St. Cloud Elementary School
- 419 to 484 PPM in Betty Maddalena Early Learning Center
- 405 to 501 PPM in the West Orange Administration Building

ASHRAE's recommended upper CO<sub>2</sub> concentration for an occupied building is ambient levels plus 700 PPM. In this case they would recommend a limit of about 1,200 PPM. Our highest readings of 501, 503 and 686 PPM are well below this upper limit. While the majority of CO<sub>2</sub> concentrations fell below 600 PPM, the low number of occupants during testing mitigates the significance of those findings since the primary source of CO<sub>2</sub> in buildings is human respiration. While overall test results suggest an adequate amount of outdoor air delivery to the interior areas of each facility periodic re-testing during peak occupancy is highly recommended for a more definitive evaluation.

CO<sub>2</sub>, a product of combustion and human respiration is a commonly used indicator of overall IAQ and ventilation rates within an occupied building. The concentrations found in buildings are primarily a function of the rate and amount of fresh outside air delivery to the occupied space,

the effectiveness of air distribution within the space, and the occupancy (number of people and activity) of the space.

### HVAC/ COVID-19

Our visual inspection identified students desks arranged directly next to or below HVAC supply registers. This arrangement can facilitate the spread of COVID virus if the student/employee sitting next to the air supply register is infectious.

Each facility contains adequate systems to facilitate outdoor air to enter and interior air to discharge via windows and HVAC units with adjustable dampers. This is critical to prevent indoor air stagnation which significantly increases the potential for exposure to airborne viral particles.

Elevated relative humidity identified in multiple areas may be related to the lack of air conditioning in those areas. This can lead to an increased risk of microbial growth on susceptible surfaces.

High speed hand dryers were also found in some bathrooms. These dryers can cause air disturbances and airborne dispersion of the COVID virus.

The largest clusters of students and faculty are expected to be in hallways during the upcoming school year. Some sections of hallways have limited HVAC systems serving them and a dense occupancy can increase the potential for airborne viral transmission.

Residential style HEPA air filtration devices were confirmed in multiple rooms without windows.

## **VII. RECOMMENDATIONS**

1. Wherever possible, open windows and operate all HVAC systems with a minimum of 20% fresh air intake. HVAC systems should continue to run at least two hours before and after occupancy. As weather allows (i.e. dry sunny days with low relative humidity), increase fresh air intake to as high as possible while still enabling the system to efficiently function. Each room must consider the balance between enabling outdoor air exchange and the need to control temperature and relative humidity at comfortable levels. Do NOT allow more than 20% outside air intake during periods of high ambient humidity.
2. Take all necessary steps to reduce the relative humidity in rooms identified with readings above 60% (see tables in section V) to reduce the risk of microbial growth. This may include reducing outside air intake as much as possible during humid conditions, increasing and/or supplementing air conditioning where possible and the use of portable dehumidifiers.

3. Inspect the interiors and filters of each HVAC system on at least a monthly basis for signs of dirt, discolorations, corrosion, etc., to ensure clean and dry conditions. Clean surfaces as needed with EPA listed disinfectant.
4. Where present, continually run vent fans in bathrooms and vent hoods in science laboratories to maintain low level negative air pressure in those occupied spaces.
5. Monitor CO<sub>2</sub> levels regularly, especially in high occupancy areas with limited ventilation to maintain levels below 800 PPM (below the target of 1,000 PPM set in the NJ PEOSH IAQ Regulation (NJAC 12:100-13)). High CO<sub>2</sub> levels as compared to outside concentrations are an indication of insufficient fresh air and an increased risk of airborne viral transmission. *GSE can provide periodic CO<sub>2</sub> monitoring for an additional fee, upon request.*
6. Alternatively, the school may wish to internally monitor key IAQ levels via a TSI “QTrak” or equivalent hand held IAQ meter. Most IAQ meters measure temperature, relative humidity, carbon monoxide and carbon dioxide. One source of such equipment can be found at: <https://tsi.com/products/indoor-air-quality-meters-instruments/indoor-air-quality-meters/q-trak-indoor-air-quality-monitor-7575/>. There are other sources of equivalent equipment and less expensive options.
7. Temporarily discontinue the use of high speed hand dryers in all bathrooms and replace with paper towels.
8. Arrange desks in classrooms so that students are not seated directly next to, or immediately below HVAC supply registers. If that is not possible, install temporary baffles to divert the air flow away from nearby student seating while not impeding overall functioning of the HVAC unit.
9. Continue the use of portable HEPA air filtration units in areas with limited HVAC or no openable windows. Install these units in hallways and interior rooms that are expected to have high traffic during the school year and have no openable windows. Be sure to regularly change the HEPA filters which can become clogged with dust and other airborne particulates.

## **VIII. CONCLUSION**

Based on visual findings and IAQ monitoring results, we believe that the current HVAC systems in the inspected West Orange BOE facilities are sufficient to maintain healthy indoor air quality; assuming the implementation of the above recommendations as conditions indicate. Such steps, in coordination with other protective measures such as masking, monitoring of symptoms, limited occupancy in high risk areas and consistent cleaning and disinfection, will further reduce the potential of COVID-19 transmission/exposure to each building’s occupants.

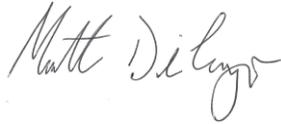
## **IX. CONDITIONS AND LIMITATIONS**

The findings described in this report are reflective of the conditions present at the time(s) of inspection and testing. In the field of environmental sampling, various environmental parameters such as temperature, humidity, air movement and winds may significantly impact measurements.

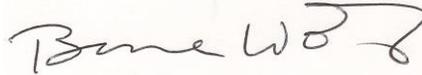
Our findings and conclusions must be considered probabilities based upon professional judgment concerning the significance of the limited data gathered during the course of investigation. The results and recommendations set forth by GSE in this report will be valid as of the date of the report and are limited to the site conditions at the time of investigation.

Please feel free to call our office with any questions about this report.

Respectfully submitted,



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