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INDOOR AIR QUALITY ASSESSMENT REPORT
FOR
RIVER RIDGE SCHOOL DISTRICT

11165 COUNTY HIGHWAY P
PATCH GROVE, WI 53817
FEBRUARY 21 AND 22, 2013

PREPARED FOR:
LEE PRITZL
SUPERINTENDENT

PROJECT NO. RR1301
MARCH 15, 2013

PREPARED BY:
THOMAS L. KAPFER, CIH
PRINCIPAL
ST. CROIX ENVIRONMENTAL & SAFETY, LLC

March 5, 2013

Lee Pritzl
River Ridge School District
11165 County Highway P
Patch Grove, WI 53817

REFERENCE:
Bloomington and Patch Grove IAQ Assessment Report
Project No. RR1301

Dear Mr. Pritzl:

St. Croix Environmental & Safety performed limited Indoor Air Quality (IAQ) Assessments at Bloomington Middle School and Patch Grove Elementary and High Schools. The assessments were performed on February 21 and 22, 2013. Prior to the February 21st and 22nd assessments, we made a site visit to both schools on February 11th to become familiar with the buildings and collect information on IAQ-related concerns.

The goals of the assessments were to identify conditions that could be contributing to health-related symptoms reported by a few staff or other conditions that have the potential to impact good indoor air quality. Our assessments were limited to evaluating conditions that are associated with poor indoor air quality in schools.

Based on information provided, the school district would like to implement corrective actions during planned facility upgrades to address IAQ-related problems discovered by out assessments. We hope that our findings along with our recommendations to improve the indoor environment contained in the attached report will help to achieve your goals.

In closing, we would like to thank you for selecting St. Croix Environmental & Safety to perform the indoor air quality assessment. If you have any questions, please do not hesitate to contact us.

Sincerely,

ST. CROIX ENVIRONMENTAL & SAFETY, LLC

Thomas L. Kapfer, CIH
Principal

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1. Background Information

River Ridge School District facilities consist of an elementary school, middle school, and high school. The middle school is located in Bloomington, WI. The high school and elementary school are located on one contiguous property in Patch Grove, WI.

Based on information provided to us during the February 11th site visit, approximately 4 to 5 staff and one student has experienced various health-related symptoms. The symptoms reported to us included sinus congestion and infections, headaches, nausea, chronic cough, and in one case, stomachaches. Most of the staff we interviewed reported that the symptoms tended to subside during school breaks.

The goals of the assessments were to determine if indoor environmental conditions in the schools could be contributing to the reported health-related symptoms, and identify other conditions that might degrade indoor air quality. If the assessments reveal problems with the indoor environment, the school district would like to implement corrective actions to improve indoor air quality.

Our assessments were limited to evaluating conditions that are associated with poor indoor air quality in schools. The investigative work we performed during the assessments is summarized below:

- Collected additional information on the history of the building envelope including water intrusion events and locations, ventilation system operation, and reports of health-related symptoms.

- Inspected accessible areas for signs of the moisture intrusion, fungal growth, and other conditions that could degrade good indoor air quality. The inspection included interior compartments of air handling equipment.

  The moisture assessment included measuring the moisture level of surfaces where moisture may exist. The moisture measurements were performed with a Protimeter Surveymaster. For this instrument, moisture levels 20% and higher are considered high.

- Measured carbon dioxide, carbon monoxide, temperature and relative humidity levels in representative occupied classrooms and other areas including boiler rooms.

- Collected settled dust samples in rooms where health-related symptoms were reported and other areas. The dust samples were analyzed for any components that are known eye, skin, and respiratory irritants.

- Collected fungal samples to determine if significant fungal contamination was present. The types of fungal samples included air, surface, and/or bulk samples depending on our inspection.

  Fungal and dust samples were analyzed by QLab Environmental Microbiology. QLab's reports are provided with this report.

2. Summary of Findings

This section of the report provides an overview of conditions that might degrade good indoor air quality, and/or may be contributing to one or more of the health-related symptoms reported by staff. Further details concerning these findings and other findings that are considered normal are provided in subsequent sections of this report.

2.1. Bloomington Middle School

2.1.1. Boiler Room

A relatively high carbon dioxide level of approximately 1,830 parts-per-million (ppm) was measured in the boiler room. Although the carbon monoxide level was low (<1 ppm), the high carbon dioxide level indicates that back drafting of exhaust gases may be occurring from the boiler or hot water heater. The high carbon dioxide level in the boiler room appeared to be impacting air quality in the adjoining classroom (131).

Although the concentration of carbon dioxide measured is not considered health threat, back drafting of exhaust gases is a potentially hazardous condition and should be addressed as soon as possible.

Recommendation:

A professional mechanical engineering experienced in boiler room design and operation should evaluate the outdoor air makeup and hot water heater exhaust flue. Whether or not the double door in the wall that separates classroom and boiler room is a code violation should be determined.

2.1.2. Fungal Samples

- High fungal levels ranging from 7,800,000 fungal counts per gram of dust (counts/gram) to 20,000,000 counts/gram were detected in settled dust samples collected from the Principal's Office, Library, and Science Room. The high fungal counts and the types of fungal organisms detected indicate that fungal growth has occurred.

  Since no visible signs of fungal growth or moisture intrusion were observed, a source of the fungal organisms is not known at this time. Possible causes of the suspect fungal growth include high humidity levels in the building during warm weather. Low filter efficiencies in the unit ventilators could also increase the amount of outdoor fungi organisms that enter through the outdoor air intakes.

  Recommendation:

  To determine a source of the fungal organisms, further assessment is required. The assessment should include a review of past ventilation system operation and building's history.

- A high fungal level of 20,000,000 counts/gram was detected by the sample collected from the carpet surface under the mat by the door to the Library. Based on the types of fungal organisms detected, fungal growth has occurred in the carpet. The moisture of the carpet under the mat ranged from 20% to 22%, which may indicate moisture transmission through the concrete slab. The high moisture level under the mat is the likely cause of the fungal growth.

Recommendations:

Remove carpet mat and clean carpet below the mat. The carpet should be dried within 24 hours after cleaning. Further assessment of possible moisture transmission up through the concrete slab should be considered.

- Fungal air samples in the Principal's Office, Library, and Science Room detected relatively low airborne fungal counts.

2.1.3. Ventilation

No source of ventilation was observed in the Principal's and Counselor's offices, and Room 100. Classroom ventilation is provided by unit ventilators. However, several of unit ventilators were not operating at the time of our assessment. Lack of ventilation allows contaminants generated indoors to accumulate, which can lead to respiratory irritation in sensitive individuals.

Recommendation:

The school district should consider upgrading the ventilation system. Ventilation should be added to rooms currently without any sources of mechanical ventilation.

2.2. Patch Grove High School

2.2.1. Principal's Office

The IAQ Assessment included the Principal's Office because of previously reported health-related symptoms. The following provides a summary of findings of conditions that have a negative impact on indoor air quality and are possible causes of the symptoms.

- The fungal air sample collected in the Principal's Office detected 1,200 airborne fungal counts per cubic meter (counts/m^3) which is considered a high count. The dominant fungal organisms were *Aspergillus/Penicillium*-like. These organisms are commonly associated with damp conditions and fungal growth in buildings. Based on our observations and other sample results, the most likely source is the high school's air handling unit (discussed below).

- The floor level air supply vents were blocked with pieces of cloth in an attempt to stop suspected contaminants in the tunnel air distribution system from entering the room. Although the cloths reduce air supply, the cloths are ineffective in blocking *Aspergillus/Penicillium* spores because of their small size (<5 µm).

2.2.2. High School Air Handling Unit

- A high fungal count of 36,000,000 counts/gram was found in the insulation sample collected from the HVAC supply duct. The dominant fungal organisms were *Cladosporium* and *Aspergillus/Penicillium*-like. The sample result reveals that significant fungal growth is present in the insulation, which is a likely source of the high airborne fungal counts in the Principal's office.

  The possible causes of the fungal growth in the insulation include excess moisture from the humidification system that does not appear to be well controlled, outdoor moisture drawn into the

outdoor air intake, and damp conditions in the air conveyance tunnels. At the time of our assessment, areas of visible moisture from the humidification system were observed on the floor inside the air handling unit.

- The HVAC system distributes heated, mixed, and return air through below-grade tunnels. Below grade tunnels are frequently damp, which leads to microbial growth. In the past, ground water seepage into the tunnels at Patch Grove has occurred.

- Although classroom temperatures were warm (73º F to 76º F), the HVAC unit continued to supply hot air. This finding indicates that temperature control is poor and that energy consumption is likely higher than necessary.

Recommendations:

Due to the age of the equipment and poor condition of components, replacement of existing equipment should be considered. A HVAC upgrade should include installation of air supply and return ductwork to rooms in the high school. The current method of air distribution through below-grade tunnels should be discontinued.

Depending on available incentive programs, Wisconsin's Focus on Energy Program may help reduce the school district expenditures to upgrade heating plants and HVAC Equipment.

Since a HVAC upgrade will require an extended period of time to complete, the following recommendations are provided to help improve indoor air quality in the short-term:

a. To remove the fungal growth, the insulation should be removed and extensive cleaning of the entire HVAC system including air supply tunnels performed.

b. Further assessment of the humidification system and outdoor air intake should be performed.

c. A study of HVAC operation and temperature control should be performed to determine if adjustments or relatively minor repairs can improve temperature control.

2.3. Patch Grove Elementary School

2.3.1. Counselor's Room

The IAQ Assessment included the Counselor's Office because of previously reported health-related symptoms. The following provides a summary of findings of conditions that have a negative impact on indoor air quality and are possible causes of the symptoms.

- No ventilation is currently being provided to the room. This room is used for small group meetings. The lack of ventilation allows contaminants generated indoors to accumulate. Some of these contaminants are known upper respiratory and eye irritants.

- The carbon dioxide level in the room was approximately 1,096 ppm, which is at the upper end of the recommended limit. Although the level of carbon dioxide measured is not a threat to health, it does show that ventilation is not adequate.

Recommendation: Provide air supply and return to the room. However, prior to adding ventilation to the room, work is needed to correct a problem with the elementary school air handler (see below).

2.3.2. Elementary Air Handling Unit

The elementary school air handling unit (AHU) provides mechanical ventilation to classrooms. This unit is not equipped with a heating coil. Heat is provided by coils in the air supply to each room.

- The fiberglass insulation inside the AHU appeared eroded (worn) and had been lightly coated with a white paint-like product. A sample of the insulation was collected for fungal analysis. A high fungal count of 1,500,000 counts/gram was detected. The dominant fungal organisms were *Cladosporium*, Basidiospores (an outdoor fungi), and *Aspergillus/Penicillium*-like. The sample result indicates that fungal growth is likely in the insulation, which might be a source of the high fungal counts detected in settled dust collected from Room 22 (see *Section 2.3.3* below).

  Recommendation:

  Remove internal fiberglass insulation from the AHU, and clean all internal surfaces of the AHU and duct work. Replace the fiberglass insulation with closed-cell foam insulation.

- The air supply to each classroom is delivered through a linear diffuser that extends across the center portion of the room. Return air is through a short transfer duct into the hallways. In our opinion, the air supply and return does not provide good distribution of ventilation air in the classrooms. This opinion is supported by the higher than recommended carbon dioxide levels in classrooms that ranged from approximately 1,053 ppm to 1,125 ppm.

  Recommendation:

  An engineering study of classroom air supply and return should be performed to determine if upgrades to air distribution should be performed.

2.3.3. Room 22

A settled dust sample was collected in Room 22 and analyzed for indications of fungal contamination. Previously, an air sample had been collected by CESA 10 on August 30, 2011. CESA's sample detected a high airborne fungal count of 4,827 counts/m³. The dominant fungal organisms were *Cladosporium* and *Aspergillus/Penicillium*. The presence of a relatively large amount of *Aspergillus/Penicillium* indicates an indoor source of this organism.

The settled dust sample collected by us on 2-22-13 detected a high fungal count of 7,700,000 counts/gram. The dominant fungal organisms were *Aspergillus/Penicillium*-like and *Cladosporium*. In addition, a relative high number of fungal fragments were found. As previously indicated by the 2011 air sample, the current dust sample result reveals that fungal contamination is present indoors. Based on our observations and the sample from the AHU fiberglass insulation, a likely source of the high fungal counts is the insulation. For further information, see above *Section 2.3.2*.

Further details concerning our findings are provided in the following individual sections of this report for each school.

3. Bloomington Middle School

St. Croix Environmental and Safety performed a limited indoor air quality assessment at Bloomington Middle School. The assessment was performed on February 21, 2013. Our assessment was limited to evaluating conditions that are commonly associated with poor indoor air quality in schools, and to identify possible causes of the health related symptoms reported to us.

3.1. Indoor Air Quality Assessment Findings

3.1.1. Carbon Dioxide, Carbon Monoxide, Temperature, and Relative Humidity Measurements

Carbon dioxide, carbon monoxide, temperature, and relative humidity levels were measured is selected classrooms that were occupied and the boiler room. The measurement results are provided in the following table:

Room/Location	Occupants	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temperature (ºF)	Relative Humidity (%)
Outdoors	NA	390	1	10	85
Principal's Office	1	935	0.2	70	15
Counselor' Office	1	906	0.5	73	16
Lunch room	~100	1,040	0.3	73	17
Gym	~50	780	0.3	69	13
Library	4	630	0.8	73	12
Computer room	11	785	0.4	73	15
100	1	870	0.3	68	17
108	4	755	0	70	15
109	18	1,255	0.4	74	19
110	21	730	0.4	73	12
111	14	1,110	0.1	72	20
117	15	1,324	0.2	73	17
Band	1	904	0.2	76	13
134A	24	1,110	0.2	75	14
131	16	1,417	0.1	76	18
Boiler room	NA	1,830	0.5	83	15

Ppm = parts-per-million

Discussion:

Based on the carbon dioxide level measured outdoors, indoor levels should be less than approximately 1,090 ppm[1]. Therefore, carbon dioxide levels exceeded the ASHRAE recommendation in Rooms 109, 111, 117, 134A, and 131. Since the primary source of carbon dioxide in classrooms is exhaled breath of occupants, higher than recommended carbon dioxide levels indicate that ventilation is not adequate for the number of room occupants.

Classroom ventilation is provided by older unit ventilators, which are not considered adequate by current ventilation codes. Unit ventilators in room 117 and the computer room were not operating. No ventilation is provided to the Principal's and Counselor's offices, and room 100.

[1] ASHRAE's 62-2001(Section 6.1.3) guideline of adding 700 parts-per-million (ppm) to the outdoor carbon dioxide level

Since the boiler room is not an occupied area, the carbon dioxide level of 1,830 ppm is higher than expected. Although the carbon monoxide level was low (<1 ppm), the high carbon dioxide level indicates that back drafting of exhaust gases may be occurring from the boiler or hot water heater.

The high carbon dioxide levels in the boiler room appeared to be impacting air quality in the adjoining classroom (131) where the carbon dioxide level was 1,417 ppm. The double door in the masonry block wall that separates the classroom from the boiler room may be a pathway.

Although the concentration of carbon dioxide measured is not considered health threat, back drafting of exhaust gases is a potentially hazardous condition and should be addressed as soon as possible. Possible causes of suspected back drafting include:

- Damaged outdoor air makeup damper for the boiler burner that prevents adequate outdoor make up air for the burner,
- The hot water heater exhaust flue which appears to be too long (see *Photo 1*).

Recommendations:

a. A professional mechanical engineering experienced in boiler room design and operation should evaluate the outdoor air makeup and hot water heater exhaust flue. Whether or not the double door in the wall that separates classroom and boiler room is a code violation should be determined.

b. To improve classroom air quality and provide ventilation to rooms currently without proper ventilation, the school district should consider upgrading the school's ventilation system.

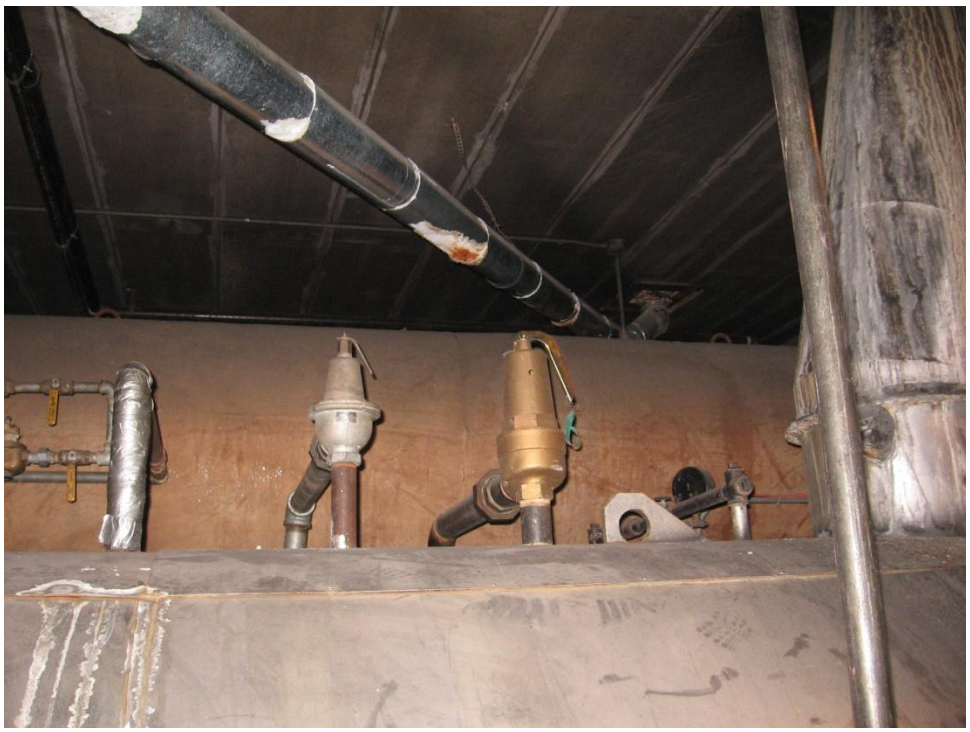

Photo 1: Long Horizontal Hot Water Heater Exhaust Flue Pipe

3.1.2. Principal's Office

The IAQ Assessment included the Principal's Office because of previously report health-related symptoms. Investigative activities performed in the office included inspecting for signs of fungal growth and moisture intrusion, collecting dust and fungal samples, and measuring carbon dioxide, carbon monoxide, temperature and relative humidity levels. The carbon dioxide, carbon monoxide, temperature, and relative humidity measurement results are provided above in *Section 3.1.1*.

- Small areas of high moisture ranging from 20% to 40% were measured of the carpet around the Principal's desk. As a result, a microvac sample (# RR1301-02) was collected from the carpet surface to check for fungal growth. The total fungal count was 140,000 counts per gram of dust (counts/gram), which is considered low to moderate. The dominant fungal organism was Cladosporium at 120,000 counts/gram. The sample result does not indicate that significant fungal growth is present in the carpet.

- A settled dust sample (# RR1301-01) was collected from horizontal surfaces in the office and analyzed for fungal structures. The number of fungal structures detected in the dust sample was 12,000,000 counts/gram, which is considered high. The dominant fungal organisms detected were *Cladosporium* and *Aspergillus/Penicillium*-like. The sample results reveal that a source of fungal growth is present either in the office or in the building.

  Since the air sample (# RR1301-03) detected low of airborne fungal counts (see below), the fungal structures detected in the settled dust may by from past fungal growth or growth that occurs seasonally.

  The settled dust sample was also analyzed by microscopic examination to identify the components of the dust. The primary components of the dust were cellulose fibers (23%), skin cells (15%), mineral dusts (20%), combustion particles (10%), and synthetic fibers (10%). The dust components identified are typical of settled dust in school and office environments.

- As mentioned above, a fungal air sample (RR1301-03) was collected in the office. The total airborne fungal count was 50 fungal per cubic meter (counts/m^3), which was close to the outdoor comparison sample result of 40 counts/m^3. The dominant fungal organism was Basidiospores, which is associated with the outdoors.

  The fungal air sample result did not detect a source of fungal growth, which is not consistent with the settled dust sample. Since the settled dust sample generally encompasses a much longer period of time, fungal growth has likely occurred in the past or occurs seasonally during warm weather.

- An adequate source of ventilation is not provided for the office. The lack of good ventilation tends to allow indoor contaminants or contaminants generated by indoor activities to accumulate.

3.1.3. Counselor's Office

- A small area of high moisture of approximately 20% was measured of the carpet around the office desk. As a result, a microvac sample (# RR1301-05) of the carpet surface was collected to check for fungal growth. The total fungal count was 26,000 counts per gram of dust (counts/gram), which is considered low. The dominant fungal organism was Cladosporium at 13,000 counts/gram. The sample result does not indicate that significant fungal growth is present in the carpet.

- An adequate source of ventilation is not provided for the office. The lack of good ventilation tends to allow indoor contaminants or contaminants generated by indoor activities to accumulate.

3.1.4. Library

Fungal air, settled dust, and carpet microvac samples were collected in the Library. Carbon dioxide, carbon monoxide, temperature and relative humidity levels were also measured, which are provided above in *Section 3.1.1*.

- An area of high moisture of approximately 22% was measured of the carpet surface under the mat by the door. As a result, a microvac sample (# RR1301-07) of the carpet surface was collected to check for fungal growth. The total fungal count was 20,000,000 counts per gram of dust (counts/gram), which is considered a high count. The dominant fungal organism was *Aspergillus/Penicillium*-like. The sample result reveals that fungal growth in carpet at the sample location has occurred.

  The high moisture found below the carpet mat indicates that moisture transmission may be occurring up through the concrete slab or placement of the carpet mat shortly after carpet cleaning. In either case, the high moisture has led to fungal growth in the carpet.

- A settled dust sample (# RR1301-08) was collected from surfaces in the Library and analyzed for fungal structures. The number of fungal structures detected in the dust sample was 7,800,000 counts/gram, which is considered high. The dominant fungal organisms were Myxomycetes/smuts/Periconia, *Cladosporium*, *Epicoccum*, Pithomyces, and *Alternaria*. A significant amount of hyphal fragments were also detected. The sample results reveal that a source of fungal growth is present either in the library or in the building.

  Some of the fungal organisms detected are associated with the outdoors. Most of these organisms likely entered through the low efficient filters in the unit ventilators.

  Since the air sample (# RR1301-09) detected low levels of airborne fungal structures at 20 counts/m^3, the fungal structures detected in the settled dust may be from past fungal growth or growth that occurs seasonally.

  The settled dust sample was also analyzed by microscopic examination to identify the components of the dust. The primary components of the dust were cellulose fibers (20%), skin cells (10%), mineral dusts (18%), combustion particles (11%), and synthetic fibers (15%). The dust components identified are typical of settled dust in school and office environments.

- As mentioned above, a fungal air sample was collected in the Library. The total airborne fungal count was 20 counts/m^3, which was less than the outdoor comparison sample result of 40 counts/m^3. The dominant fungal organism was *Aspergillus/Penicillium*-like, which may be from the fungal growth in carpet by the door.

3.1.5. Science Room

Fungal air and settled dust samples were collected in the Science Room (117). The samples were collected in this room to compare with the other indoor samples.

- A settled dust sample (# RR1301-11) was collected from horizontal surfaces in the Science Room and analyzed for fungal structures. The number of fungal structures detected in the dust sample was 10,000,000 counts/gram, which is considered high. The dominant fungal organisms were Myxomycetes/smuts/Periconia, *Cladosporium*, *Epicoccum*, Pithomyces, and *Alternaria*. A significant amount of hyphal fragments were also detected. The sample results reveal that a source of fungal growth is present either in the library or in the building.

  Some of the fungal organisms detected are associated with the outdoors. Many of these organisms likely entered through the low efficient filters in the unit ventilators.

  Since the air sample detected low levels of airborne fungal counts (see below), the fungal structures detected in the settled dust may by from past fungal growth or growth that occurs seasonally.

  The settled dust sample was also analyzed by microscopic examination to identify the components of the dust. The primary components of the dust were cellulose fibers (22%), skin cells (11%), mineral dusts (16%), combustion particles (10%), and synthetic fibers (15%). The dust components identified are typical of settled dust in school and office environments.

- As mentioned above, a fungal air sample (RR1301-10) was collected in the Science Room. The total airborne fungal count was 20 counts/m^3, which was less than the outdoor comparison sample result of 40 counts/m^3. The dominant fungal organisms were *Aspergillus/Penicillium*-like.

3.2. Bloomington Middle School Summary of Conclusions and Recommendations

3.2.1. A high carbon dioxide level was measured in the boiler room. The source of the carbon dioxide might be from back drafting of exhaust flues.

Recommendation:

A professional mechanical engineering experienced in boiler room design and operation should evaluate the outdoor air makeup and hot water heater exhaust flue. Whether or not the double door in the wall that separates the adjoining classroom and boiler room is a code violation should be determined.

3.2.2 Relatively high carbon dioxide levels were measured in several classrooms, which indicate that air exchange is not adequate for the number of room occupants. No ventilation is provided to several occupied rooms in the school.

Recommendation:

The school district should consider upgrading the school's ventilation system to current codes.

3.2.3. High fungal counts were found in the settled dust samples collected in the Principal's Office, Library, and Science Room. The high fungal counts along with some of the dominant fungal organisms indicate a past history of fungal growth. In the rooms with unit ventilators, the dominant organisms are considered to be outdoor fungi. This indicates that these organisms may be entering through unit ventilator filters.

Recommendations:

a. Further assessment of the building's history focusing on past moisture problems, ventilation system operation, cleaning practices, and visible fungal growth is needed to identify the most likely source(s) of the high fungal counts in settled dust.

b. Upgrades to the ventilation system as recommended above should include filter upgrades. MERV 8 or higher efficiency filters are recommended.

3.2.4. High fungal counts were found in the carpet by the door to the Library. The cause of the fungal growth is likely due to excess moisture trapped below the mat.

Recommendations:

a. Thoroughly clean the carpet by the door to the library. Assure that the carpet is dry before placing the mat.

b. Perform testing to determine if significant moisture transmission is occurring up through the concrete slab.

End of Bloomington Middle School Report

4. Patch Grove High School

St. Croix Environmental and Safety performed a limited indoor air quality assessment at Patch Grove High School. The assessment was performed on February 22, 2013. Our assessment was limited to evaluating conditions that are commonly associated with poor indoor air quality in schools and to identify possible causes of the health related symptoms reported to us.

4.1. Indoor Air Quality Assessment Findings

4.1.1. Carbon Dioxide, Carbon Monoxide, Temperature, and Relative Humidity Measurements

Carbon dioxide, carbon monoxide, temperature, and relative humidity levels were measured is selected classrooms that were occupied. The measurement results are provided in the following table:

Room/Location	Occupants	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temperature (ºF)	Relative Humidity (%)
Outdoors	NA	390	1	25	86
Admin Office	3	748	0.4	77	21
Principal's Office	1	760	0.3	76	22
22	18	824	0.2	76	22
23	1	742	0.1	76	22
25	18	1,215	0.4	75	26
27	6	802	0.1	74	22
26	12	780	0.2	74	23
29	18	850	0.2	73	23
Ag Shop Classroom	16	860	0.3	73	23
20	7	743	0.1	73	23
19	1	657	0.1	74	22
Lunch room	~100	985	0.2	74	28
120	1	621	0.3	71	20
Library	3	628	0.2	73	19

ppm = parts-per-million

Discussion:

Based on the carbon dioxide level measured outdoors, indoor levels should be less than approximately 1,090 ppm[2]. Therefore, the carbon dioxide level exceeded the ASHRAE recommendation in Room 25. Since the primary source of carbon dioxide in classrooms is exhaled breath of occupants, the higher than recommended carbon dioxide level indicates that ventilation is not adequate for the number of room occupants.

The temperature in most of the classrooms was warm. During our assessment, we noticed that the AHU continued to supply warm air to the rooms even though room temperature requirements should have been satisfied. Continued heating indicates that temperature controls are not operating properly.

[2] ASHRAE's 62-2001(Section 6.1.3) guideline of adding 700 parts-per-million (ppm) to the outdoor carbon dioxide level

4.1.2. HVAC System

Ventilation and heating of the rooms in the high school is provided by a gas-fired furnace surrounded on the sides and top by a galvanized sheet metal plenum. Air in the plenum is heated by heat transfer through the furnace wall and then forced through the tunnel system to the classrooms by fans.

From the plenum surrounding the furnace, three ducts connect to the tunnel to convey heated and mixed air to rooms, and return air back to the plenum. The tunnel system is divided into three sections to accommodate the three air streams.

Three conditions were observed that have the potential of impacting indoor air quality in the high school:

- Areas of moisture were observed on the floor of the plenum (see *Photo 2*). The source of the moisture appeared to be from the humidification nozzles located inside the plenum (see *Photo 3*). Humidification did not appear well controlled, which is the likely cause of the excess moisture inside the plenum. Excess moisture in the plenum could lead to fungal growth.

- The HVAC system distributes heated, mixed, and return air through below-grade tunnels. Below grade tunnels are frequently damp, which leads to microbial growth. In the past, ground water seepage into the tunnels at Patch Grove has occurred.

- Fiberglass insulation was observed on ductwork that conveyed air to and from the tunnel system in the return air compartment. The insulation appeared to be in poor condition and discolored (see *Photo 4*). To determine if significant fungal growth had occurred in the insulation, a bulk sample of the insulation (sample # RR1301-13) was collected and submitted for fungal analysis.

  A high fungal count of 36,000,000 counts/gram was detected in the sample. The dominant fungal organisms were *Cladosporium* and *Aspergillus/Penicillium*-like. A large amount of hyphal fragments were also found in the sample. The sample result reveals heavy fungal growth in the insulation.

  The fungal growth in the insulation may be a source of the high airborne fungal count detected in the Principal's Office. See the following section of this report for further details.

- A dust sample (# RR1301-17) was collected in the mixed air dust and analyzed by microscopic examination to identify the components of the dust. The primary components of the dust were cellulose fibers (15%), skin cells (22%), mineral dusts (30%), combustion particles (10%), and synthetic fibers (5%). The dust components identified are typical of dust in school and office environments.

Recommendations:

Due to the age of the equipment and poor condition of components, replacement of existing equipment should be considered. A HVAC upgrade should include installation of air supply and return ductwork to rooms in the high school. The current method of air distribution through below-grade tunnels should be discontinued. Since a HVAC upgrade will require an extended period of time to complete, the following recommendations are provided to help improve indoor air quality in the short-term:

a. To remove the fungal growth, the insulation should be removed and extensive cleaning of the entire HVAC system including air supply tunnels performed.

b. Further assessment of the humidification system and outdoor air intake should be performed.

c. A study of HVAC operation and temperature control should be performed to determine if adjustments or relatively minor repairs can improve temperature control.

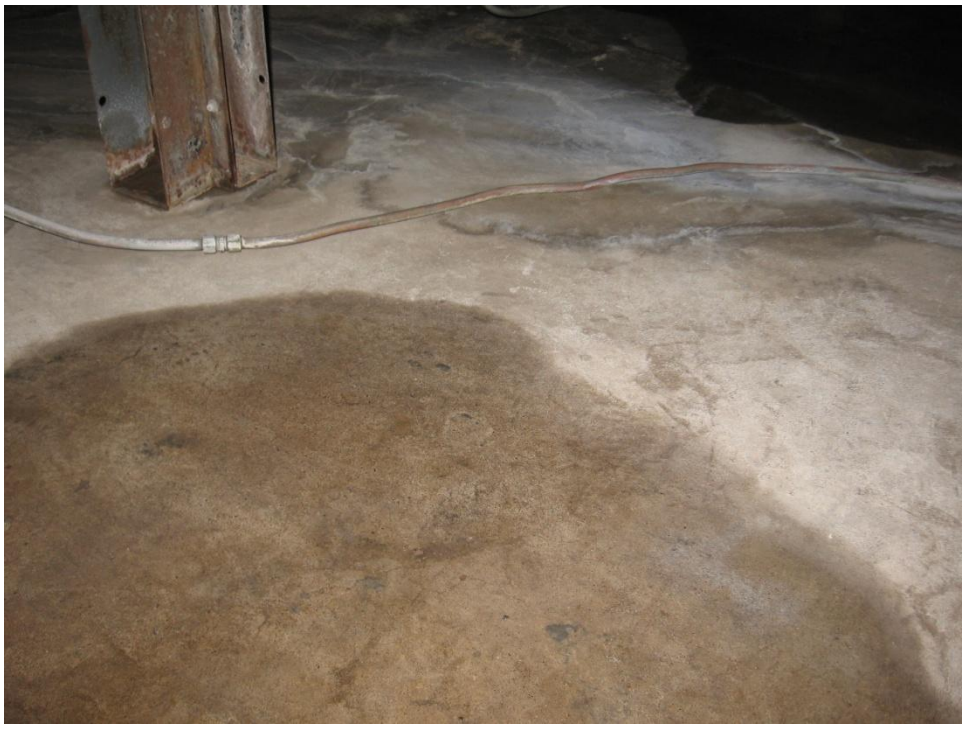

Photo 2: Areas of Moisture and Moisture Staining on Floor of Plenum

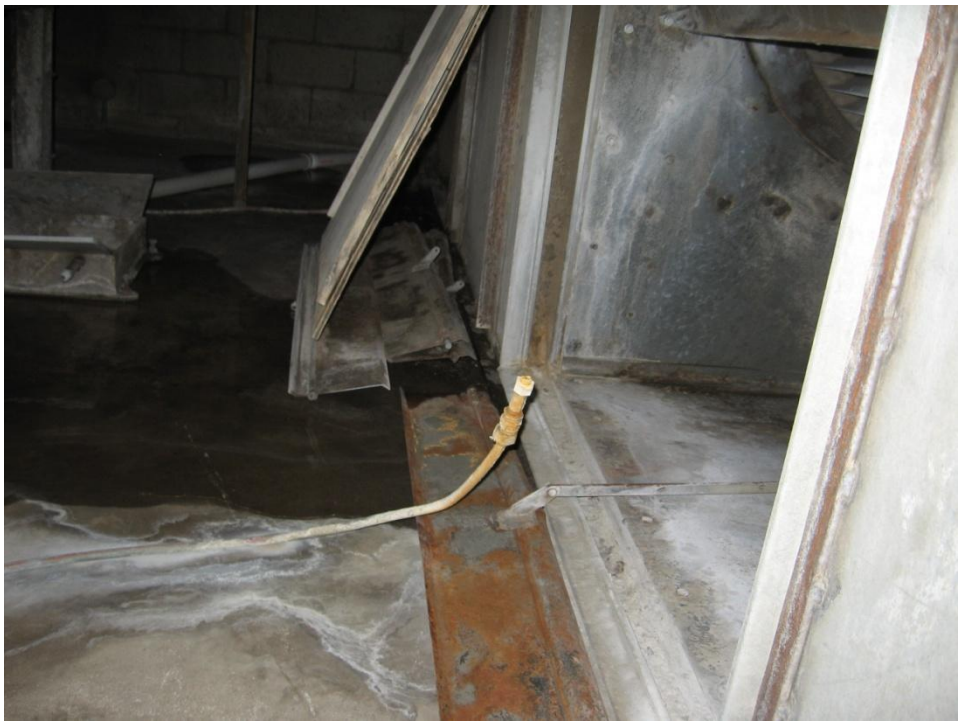

Photo 3: Spray Nozzle used to Humidify Air – Note Water on Plenum Floor in Background

Photo 4: Fiberglass Insulation in Return Air Compartment

4.1.3. Principal's Office

The IAQ Assessment included the Principal's Office because of previously reported health-related symptoms. Investigative activities performed in the office included inspecting for signs of fungal growth and moisture intrusion, collecting dust and fungal samples, and measuring carbon dioxide, carbon monoxide, temperature and relative humidity levels. The carbon dioxide, carbon monoxide, temperature, and relative humidity measurement results are provided above in *Section 4.1.1*.

- The air supply vents located on the floor next to the wall common with the corridor were blocked with cloths. The vents were blocked because of a suspected contaminant in the tunnel air supply.

- A fungal air sample was collected in the office. The total airborne fungal count was 1,200 counts/m³, which was well above the outdoor comparison sample result of less than 20 counts/m³. The dominant fungal organisms were *Aspergillus/Penicillium*-like and *Cladosporium*. A likely source of these organisms appears to be the insulation used to insulated ductwork in the HVAC return air compartment.

  The recommended corrective actions recommended above in Section 4.1.2 should reduce airborne fungal counts in the office and other areas of the high school.

- A settled dust sample (# RR1301-16) was collected from surfaces in the office and analyzed for fungal structures. The number of fungal structures detected in the dust sample was 320,000 counts/gram, which is considered relatively low. The dominant fungal organism detected was Basidiospores, which is considered an outdoor fungus. The sample result did not show significant fungal levels in the settled dust.

- The settled dust sample was also analyzed by microscopic examination to identify the components of the dust. The primary components of the dust were cellulose fibers (23%), skin cells (15%), mineral dusts (20%), combustion particles (10%), and synthetic fibers (10%). The dust components identified are typical of settled dust in school and office environments.

4.1.4. High School Classrooms

- Based on carbon dioxide levels, air exchange appears adequate in most classrooms. The only exception was Room 25 where the carbon dioxide level was 1,215 ppm. Although air exchange may be adequate in most rooms, the fungal growth found in the HVAC insulation is likely affecting air quality in the classrooms also.

- Classroom air supply and return is conveyed via below grade tunnels. The potential for microbial growth in the tunnels is relatively high due to moist conditions.

Recommendations: See *Sections 4.1 or 4.2* of this report.

4.1.5. 2000 Addition

The only condition that relates to indoor air quality found in the 2000 Addition was water stained ceiling tiles in Room 120.

Recommendation:

Determine if the stained ceiling tiles are due to current leaks and repair as necessary. Water stained ceiling tiles should be replaced.

4.2. Patch Grove High School Summary of Conclusions and Recommendations

4.2.1. High fungal counts were detected in the insulation sample collected from the return air compartment of the air handler. Based on the fungal air sample in the Principal's Office, the fungal growth in the insulation is likely impacting air quality in the high school.

Recommendation:

Remove all fiberglass insulation that is located in an air stream, and perform extensive cleaning of the entire HVAC system including air supply tunnels. If insulation replacement is required, use close cell foam insulation instead of fiberglass.

4.2.2. During our assessment, we noticed that the AHU continued to supply warm air to the rooms even though room temperature requirements should have been satisfied. Continued heating indicates that temperature controls are not operating properly.

Recommendation:

Determine if temperature controls can be repaired to operate properly.

4.2.3. The carbon dioxide level in Room 25 was relatively high based ASHRAE 62-2001.

Recommendation:

Determine if additional ventilation can be provided to Room 25.

4.2.4. The HVAC system distributes heated, mixed, and return air through below-grade tunnels. Below grade tunnels are frequently damp and should not be used to convey air to occupied areas.

Recommendation:

a. The school district should consider installing above grade ductwork for room air supply and return.

b. Due to the age of the equipment and poor condition of components, replacement of existing equipment should be considered.

End of Patch Grove High School Report

5. Patch Grove Elementary School

St. Croix Environmental and Safety performed a limited indoor air quality assessment at Patch Grove Elementary School. The assessment was performed on February 22, 2013. Our assessment was limited to evaluating conditions that are commonly associated with poor indoor air quality in schools, and to identify possible causes of the health related symptoms reported to us.

5.1. Indoor Air Quality Assessment Findings

5.1.1. Carbon Dioxide, Carbon Monoxide, Temperature, and Relative Humidity Measurements

Carbon dioxide, carbon monoxide, temperature, and relative humidity levels were measured is selected classrooms that were occupied. The measurement results are provided in the following table:

Room/Location	Occupants	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temperature (ºF)	Relative Humidity (%)
Outdoors	NA	390	1	25	86
Counselor's Office	5	1,096	0.5	74	22
4	12	1,125	0.4	74	23
3	18	1,053	0.5	74	21
24	22	1,076	0.1	75	20
28	20	1,125	0.4	75	20

Ppm = parts-per-million

Discussion:

Based on the carbon dioxide level measured outdoors, indoor levels should be less than approximately 1,090 ppm[3]. Therefore, the carbon dioxide level was near or above the ASHRAE recommendation in all of the rooms tested. Since the primary source of carbon dioxide in classrooms is exhaled breath of occupants, the higher than recommended carbon dioxide level indicates that ventilation is not adequate for the number of room occupants.

Based on our observations, air supplied to classrooms may not mix properly due to type and location of the air supply diffuser. A single linear air supply diffuser is installed across the middle of the rooms (see *Photo 5*). Air return is located in the hallways. In our opinion, this arrangement will not provide proper mixing of room air, which may contribute to the higher than recommended carbon dioxide levels.

The temperature in most of the classrooms was warm. During our assessment, comments were received that room temperature is typically warm; windows are frequently opened to provide fresh air.

Recommendation:

An engineering study of the ventilation system should be performed to determine if air supply and returns to each room should be modified to provide better ventilation effectiveness. The study should also include an evaluation of system operation and temperature control.

[3] ASHRAE's 62-2001(Section 6.1.3) guideline of adding 700 parts-per-million (ppm) to the outdoor carbon dioxide level

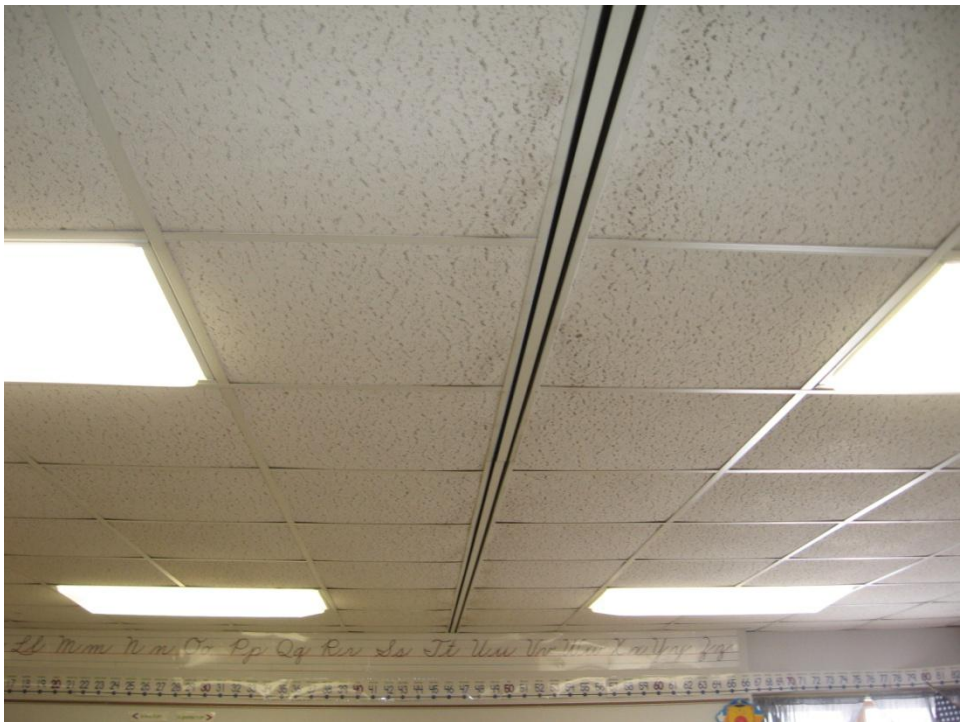

Photo 5: Single Linear Air Supply Diffuser in Elementary Classrooms

5.1.2. HVAC System

Classroom ventilation is provided by a central air handler (AHU) located in a mezzanine mechanical room. The AHU provides mechanical ventilation of classroom, but is not equipped with a heating coil. Classroom heating is provided by hot water coils located in the air supply to each room.

The internal fiberglass insulation in the AHU was in poor condition (appeared worn). According to information provided, the system had been cleaned and the insulation coated with a white paint-like material (see *Photo 6*).

A sample (# RR1301-14) of the insulation was collected to determine if significant fungal growth had occurred. The total fungal count in the insulation was 1,500,000 counts/gram. The dominant fungal organisms were *Cladosporium*, Basidiospores, and *Aspergillus/Penicillium*-like. The sample result indicates that light to moderate fungal growth has occurred in the insulation.

Recommendation:

Remove all fiberglass insulation that is located in the AHU and associated ductwork, and perform extensive cleaning of the entire HVAC system. If insulation replacement is required, use close cell foam insulation instead of fiberglass.

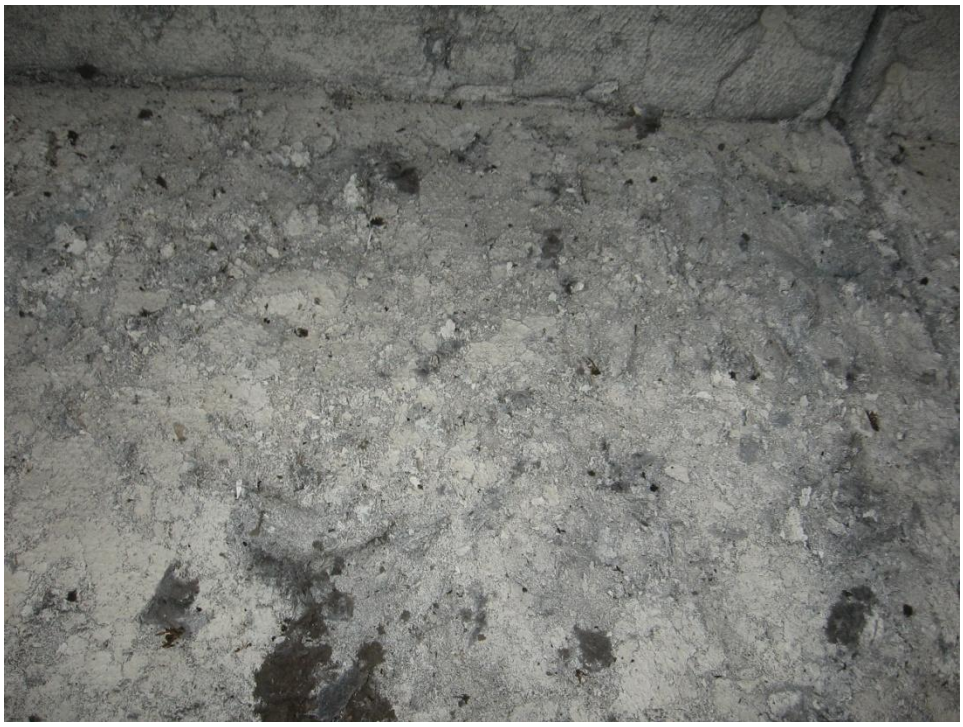

Photo 6: Worn Fiberglass Insulation inside Mixed Air Compartment of AHU

5.1.3. Room 22

a. A microvac sample (# RR1301-21) of settled dust was collected in Room 22 to determine if indications of significant fungal growth were present and to identify dust components. Previously, an air sample had been collected by CESA 10 on August 30, 2011. CESA's sample detected a high airborne fungal count of 4,827 counts/m³. The dominant fungal organisms were *Cladosporium* and *Aspergillus/Penicillium*. The presence of a relatively large number of *Aspergillus/Penicillium* indicates an indoor source of these organisms.

   The settled dust sample collected by us on 2-22-13 detected a high fungal count of 7,700,000 counts/gram. The dominant fungal organisms were *Aspergillus/Penicillium*-like and *Cladosporium*. In addition, a relative high number of fungal fragments were found. As previously indicated by the 2011 air sample, the current dust sample result reveals that fungal contamination is likely present indoors. Based on our observations and the sample from the AHU fiberglass insulation, a likely source of the high fungal counts in the settled dust is the insulation.

b. The settled dust sample was also analyzed by microscopic examination to identify the components of the dust. The primary components of the dust were cellulose fibers (20%), skin cells (16%), mineral dusts (30%), combustion particles (13%), and synthetic fibers (10%). The dust components identified are typical of settled dust in school and office environments.

Recommendation:

The recommendation for cleaning the AHU will likely correct one possible source of the high fungal counts in settled dust. However, further assessment is needed to determine if other sources are present. For example, ceiling tiles in most rooms were sagging, which means that high humidity levels are

present during warm weather months. A staff member also commented that tile floors are sometimes wet during the summer, which also indicates high humidity levels.

5.1.4. Counselor's Office

The IAQ Assessment included the Counselor's Office because of the health-related symptoms reported to us. Investigative activities performed in the office included inspecting for signs of fungal growth and moisture intrusion, collecting dust and fungal samples, and measuring carbon dioxide, carbon monoxide, temperature and relative humidity levels. The carbon dioxide, carbon monoxide, temperature, and relative humidity measurement results are provided above in *Section 5.1.1*.

- No mechanical ventilation is provided to the Counselor's Office.
- A fungal air sample (# RR1301-20) was collected in the office. The total airborne fungal count was 40 counts/m^3, which was similar the outdoor comparison sample result of less than 20 counts/m^3. Only a few fungal organisms were found on the sample. The sample does not indicate that significant fungal contamination is present in the office.
- A settled dust sample (# RR1301-18) was collected from surfaces in the office and analyzed for fungal structures. The number of fungal structures detected in the dust sample was 220,000 counts/gram, which is considered relatively low. Only a few fungal organisms were found on the sample. The sample result did not show significant fungal levels in the settled dust.

  Since no mechanical ventilation is provided to this room and the fungal counts were relatively low, these results appear to support our previous conclusion that a source of the high fungal counts detected in the dust sample from Room 22 includes the insulation inside the Elementary School AHU.
- The settled dust sample was also analyzed by microscopic examination to identify the components of the dust. The primary components of the dust were cellulose fibers (25%), skin cells (19%), mineral dusts (12%), combustion particles (7%), and synthetic fibers (15%). The dust components identified are typical of settled dust in school and office environments.

Recommendation:

Mechanical ventilation should be provided to the Counselor's Office after the AHU has been cleaned.

5.2. Patch Grove High School Summary of Conclusions and Recommendations

5.2.1. Light to moderate fungal growth was detected in the fiberglass insulation inside the AHU providing ventilation to the Elementary School. The insulation also appeared worn, which could release glass fibers into the air stream.

Recommendation:

Remove all fiberglass insulation that is located in the AHU and associated ductwork, and perform extensive cleaning of the entire HVAC system. If insulation replacement is required, use close cell foam insulation instead of fiberglass.

5.2.2. High fungal counts were found in the settled dust sample collected in Room 22. A possible source of the high fungal counts is the suspected fungal growth found in the AHU insulation.

Recommendation:

The recommendation for cleaning the AHU will likely correct one possible source of the high fungal counts in settled dust. However, further assessment is needed to determine if other sources are present. For example, ceiling tiles in most rooms were sagging, which means that high humidity levels are present during warm weather months. A staff member also commented that tile floors are sometimes wet during the summer, which also indicates high humidity levels.

5.2.3. No mechanical ventilation is provided to the Counselor's Office.

Recommendation:

Mechanical ventilation should be provided to the Counselor's Office after the AHU has been cleaned.

5.2.4. The single linear air supply diffuser in classrooms, and return air to hallways likely does not allow good mixing of air. In addition, classroom temperatures were warmer than necessary, which appears to encourage staff to open windows. Opening windows may also be due to the perception of stuffiness as a result of the higher than recommended carbon dioxide levels.

Recommendation:

An engineering study of the ventilation system should be performed to determine if air supply and returns to each room should be modified to provide better ventilation effectiveness. The study should also include an evaluation of system operation and temperature control.

End of Patch Grove Elementary School Report