# INDOOR AIR QUALITY ASSESSMENT

**Richard Sugden Library**
**8 Pleasant Street**
**Spencer, Massachusetts 01562**

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
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## Background/Introduction

At the request of Mary Baker-Wood, Library Director, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at Richard Sugden Library (RSL), 8 Pleasant Street, Spencer, Massachusetts. The request was prompted by recent water damage within the building. On March 18, 2009, a visit to conduct an assessment was made to the RSL by Lisa Hébert, Regional Indoor Air Inspector in BEH's Indoor Air Quality (IAQ) Program.

The Richard Sugden Library is a rectangular brick building that was constructed in 1889. An addition to the building was constructed in 1997 on the north side of RSL including an elevator. The addition provided a children's library on the ground floor, the teen reading area and small conference room on the first floor, fiction stacks on the second floor and a small loft area utilized for storage of archives above the second floor. RSL staff informed BEH staff that new carpeting was installed throughout the building when the addition was constructed.

## Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. BEH staff also performed visual inspection of building materials for water damage and/or microbial growth. Moisture content of porous building materials was measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe.

## Results

The RSL has an employee population of approximately 9 and serves a minimum of 150 patrons daily. Air tests were taken under normal operating conditions and results appear in Table 1. Air sampling results are listed in the table by location that the air sample was taken. Moisture readings are listed in Table 2. For the most part, windows were closed at the time of the assessment.

## Discussion

### Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in all areas at the time of the assessment, indicating adequate air exchange in all of the areas surveyed on March 18, 2009. It is important to note, however, that several rooms were empty/sparsely populated at the time of the assessment, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to increase with full occupancy.

Ventilation is provided by means of six air handling units (AHUs) located throughout the interior of the building. Fresh air is supplied to rooms by ducted air supply diffusers. Stale air and contaminants are removed by means of ducted exhaust vents. The AHU located in the bell tower (Unit # SA6) has reportedly leaked over time, resulting in damage to the ceilings in the staff room the first floor and the children's library. Damage to the interior liner of this AHU was evident, as was the resulting exposed fiberglass insulation (Picture 1). A tear was observed in the exterior liner of the same unit. A breach was also evident where the liner attaches to the AHU (Pictures 2 and 3). Filters in this unit as well as others lacked spacers between them, creating a gap between the filters. The existence of these gaps allows for air to by-pass the installed filters, resulting in aerosolization of dust and particulates. In addition to the AHUs, supplemental temperature/humidity control and filtration is provided in the staff room and archives by wall mounted air handling units.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The systems at RSL were reportedly balanced upon installation in 1997 and most recently in 2001.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult Appendix A.

Temperature measurements in the RSL ranged from 69° F to 76° F, which were within the MDPH recommended range in all but one of the areas surveyed (Table 1). The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 20 to 25 percent at the time of the assessment, which was below the MDPH recommended comfort range (Table 1). The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

**Microbial/Moisture Concerns**

Several potential sources of water damage and/or mold growth were observed during the assessment. Sealant on the flashing of the slate roof appeared to be deteriorated in some areas (Pictures 4 and 5). Water damage to the ceiling adjacent to the fireplace in the seating area on the first floor as well as to the ceiling in the stairway to the bell tower was observed. Water damaged ceiling and walls were also observed in the staff room (Picture 6). This damage was attributed by RSL staff to the repeated leaks from the AHU located above the ceiling. Water damaged ceiling was observed in the entry to the children's library as well. On the ground floor in the children's library, numerous areas exhibited water damage (Picture 7). Ceilings exhibited substantial water damage as did the base of cabinets in the children's work room (Picture 8). Evidence of water penetration was evident on painted brick surfaces on the ground floor. Mold colonization was observed on portions of the brick as well (Picture 9).

Water fountains were located over unprotected carpet areas. The carpet below the water dispensing nozzles can become moistened by use of the water fountain, although was not observed to be wet at the time of the assessment. In addition, BEH staff was informed of carpets previously becoming saturated on the first floor as well as on the ground floor. Porous materials that are wet repeatedly can serve as media for mold growth. Identification and elimination of the source of water moistening building materials is necessary to control mold growth. Materials with increased moisture content *over normal* concentrations may indicate the possible presence of mold growth. All porous materials tested during the assessment were found to have low (i.e., normal) moisture content (Table 2).

Moisture content of materials measured is a real-time measurement of the conditions present at the time of the assessment. The building was evaluated on a partly cloudy day, with an outdoor temperature of $51^{o}$ F and relative humidity of 31 percent. Moisture content of materials may increase or decrease depending on building and weather conditions. For example, during the normal operation of a heating, ventilating and air-conditioning (HVAC) system, moisture is introduced into a building during weather with high relative humidity. As indoor relative humidity levels increase, porous building materials, such as GW, plywood or carpeting, can absorb moisture. The moisture content of materials can fluctuate with increases or decreases in indoor relative humidity.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed/discarded.

A broken pane of glass was observed in a window in the staff office. This condition allows unconditioned air to enter the RSL. The infiltration of outside air into the building may impede the efficiency of the air handling unit and may also provide a means by which moisture may condense on the interior window rail.

Some plants were observed lacking drip pans. Water damage was evident on the window sill beneath one plant, likely due to over-watering (Picture 10). Plant soil and drip pans can serve as a source of mold growth. Plants should be properly maintained and be equipped with drip pans. Plants should also be located away from the air stream of mechanical ventilation to prevent aerosolization of dirt, pollen or mold.

A chimney flue sealed with wood, cardboard and duct tape was observed in the fireplace in the main library (Picture 11). Signs of moisture accumulation were observed on the cardboard. Soot accumulation was noted on an area of clear plastic utilized in the fireplace as well. A similar condition was noted in the fireplace in the Director's office. The current conditions allow unconditioned air including moisture and particulates into the building as well.

There are numerous pathways by which water can currently enter the building envelope. BEH staff examined the exterior of the building to identify breaches in the building envelope that could provide a source of water penetration. Several potential sources were identified:

- A sizable gap was observed on the exterior front door.
- Holes were observed in masonry. Cracks were evident in mortar and foundation blocks.
- Mortar is cracking and lifting in areas where the new addition meets the original building.
- Light fixture above entrance to children's library is detached, exposing an open penetration into the block wall.
- Large gaps were observed between the foundation and masonry in some areas (Picture 12).
- Deteriorated sealant and decomposing wood frame was observed on the exterior of the original building.
- Downspouts do not enter piping to drainage system in some areas and therefore, deposit rainwater adjacent to the foundation. Moisture is visible at the base of the concrete foundation in one location. In addition, evidence of chronic moisture exposure was also observed in the form of heavy moss accumulation adjacent to a downspout (Pictures 13 and 14).
- Shrubs were observed growing in close proximity to the building. The growth of roots against exterior walls can bring moisture in contact with the foundation. Plant roots can eventually penetrate, leading to cracks and/or fissures in the sublevel foundation. Over time, this process can undermine the integrity of the building envelope, providing a means of water entry into the building via capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001).

- A white, powdery material known as efflorescence was noted on several sections of the exterior masonry (Picture 15). Efflorescence is a characteristic sign of water intrusion, but it is not mold. As penetrating moisture works its way through mortar around brick, it leaves behind characteristic mineral deposits.
- Of note along the exterior of the building were weep holes. BEH staff identified a series of blocked weep holes in the exterior brick and block walls of the RSL. Weep holes were plugged with debris. Without appropriate drainage, moisture can build up inside the wall's drainage plane, resulting in increased water/moisture problems in the exterior wall. Exterior wall systems should be designed to prevent moisture penetration into the building interior. An exterior wall system should consist of an exterior curtain wall. Behind the curtain wall is an air space that allows for water to drain downward and for the exterior cladding system to dry. In order to allow for water to drain from the exterior brick system, a series of weep holes is customarily installed in the exterior wall, at or near the foundation slab/exterior wall system junction. Weep holes allow for accumulated water to drain from a wall system (Dalzell, 1955). Opposite the exterior wall and across the air space is a continuous, water-resistant material adhered to the back up wall that forms the drainage plane. The purpose of the drainage plane is to prevent moisture that crosses the air space from penetrating the interior of the building. The plane also directs moisture downwards toward the weep holes. The drainage plane can consist of a number of water-resistant materials, such as tarpaper or, in newer buildings, plastic wraps. The drainage plane should be continuous. Where breaks exist in the drainage plane (e.g., window systems, door systems, air intakes), additional materials (e.g., flashing) are installed as transitional surfaces to direct water to weep holes. If the drainage plane is

discontinuous, missing flashing or lacking air space, rainwater may accumulate inside the wall cavity and lead to moisture penetration into the building.

- Also of note was the block wall foundation which connects the original building to the 1997 addition. The construction of this component created an alcove (Picture 16). The conditions observed in this area may well contribute toward water penetration through the building envelope. A downspout drains rainwater directly onto a patio in close proximity to the original foundation of the building (Picture 17). Water penetrates between the patio stones, and can be seen with movement of water from a melting pile of snow on the patio (Picture 18). As the water penetrates the stones, much of it migrates beneath the stones and drains down the stairs and along the block wall foundation, despite efforts to prevent it that were made by placing pieces of sheet metal adjacent to the wall (Pictures 19 and 20). As Picture 20 depicts, the ground adjacent to the block wall is saturated. Additionally, since the patio area is in an alcove, the water received by it may not dry as quickly as it might in a more open area. The patio/alcove is also located on the west side of the building. This could be significant because moist weather tends to travel in a northeasterly track up the Atlantic Coast towards New England (Trewartha, G.T., 1943). Wet weather systems generally produce south/southwesterly winds, which will tend to deliver driving rain to the south/southwestern/western walls of the RSL. As a result, heavy moss accumulation was noted between the stones as well as at the juncture of the wall of the original building and the patio (Picture 21). The presence of moss in Picture 21 is indicative of repeated water exposure. And lastly, the sealant above the flashing on the original building has begun to deteriorate, which will allow moisture to potentially enter the building envelope (Picture 22).

- Exterior utility holes were not adequately sealed (Picture 23).
- Plant growth was noted throughout stone walkway adjacent to children's library.

The aforementioned conditions represent potential water penetration sources. Over time, these conditions can undermine the integrity of the building envelope and provide a means of water entry into the building via capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001). In addition, these breaches may provide a means for pests/rodents to enter the building.

**Other IAQ Evaluations**

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the indoor environment, BEH staff obtained measurements for carbon monoxide and PM2.5.

*Carbon Monoxide*

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

*Carbon monoxide should not be present in a typical, indoor environment*. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of assessment, outdoor carbon monoxide concentrations were measured at 1 ppm (Table 1). The level of automobile traffic observed on Pleasant Street at the time the measurement was taken would account for this reading. Carbon monoxide levels measured inside the RSL were ND.

*Particulate Matter (PM2.5)*

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 $\mu g/m^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations the day of the assessment were measured at 30 $\mu g/m^3$. PM2.5 levels measured inside the RSL ranged from 3 to 10 $\mu g/m^3$ (Table 1), which were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in buildings can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, use of photocopiers and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

*Volatile Organic Compounds*

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to identify materials that can potentially increase indoor VOC concentrations, BEH staff examined RSL for products containing these respiratory irritants.

Cleaning products were noted in a cabinet beneath a sink in the children's library. Cleaning compounds frequently contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals.

*Other Conditions*

Other conditions that can affect indoor air quality were observed during the assessment. The large number of items stored in a work room in the children's library provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation. Additionally, in the mechanical room on the ground floor, carpeting, cloths, cardboard boxes were stored on the AHU. They will also have a tendency to accumulate dusts and should be addressed as well.

An open utility hole was observed beneath the sink in the children's work room. Open utility holes can provide a means of egress for odors, fumes, dusts and vapors between rooms and floors. In addition, these materials can migrate into air handling units and be distributed to additional occupied areas within the building.

A number of exhaust/return vents and a personal fan were observed to have accumulated dust. The heaviest accumulation was observed to be in the children's library community room. If exhaust vents are not functioning, back-drafting can occur, which can re-aerosolize accumulated dust particles. Activated fans can also aerosolize dust accumulated on fan blades.

As previously mentioned, the painted brick areas on the ground floor exhibited evidence of water penetration (Picture 24). This has, in turn, resulted in some paint peeling/chipping off the brick. Prior to conducting any repainting of those surfaces, it would be prudent to determine if the paint is lead based.

## Conclusions/Recommendations

In view of the findings at the time of the assessment, the following short term recommendations are made for consideration:

1. Contact an HVAC engineering firm to survey AHUs to ensure equipment no longer leaks and to repair/replace damaged interior and exterior liners on AHUs as needed.
2. Ensure both supply and exhaust ventilation operate continuously during periods of building occupancy.
3. Periodically clean accumulated dust from exhaust/return vents.
4. Clean mold colonized areas in accordance with EPA guidelines. For more information, please consult "Mold Remediation in Schools and Commercial Buildings," which can be accessed at the following location: http://www.epa.gov/mold/mold_remediation.html
5. Determine whether peeling paint in basement contains lead. If so, remediate in compliance with state and federal regulations.
6. Repair/Replace water damaged materials within the RSL. Discard affected porous materials if they were not dried within 24 to 48 hours of becoming wet.
7. Repair broken pane of glass.
8. Provide nonabsorbent mats beneath water fountains.

9. Consider providing plants with drip pans and avoid over-watering. Examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.
10. If fireplaces are not used, consider sealing both ends to prevent moisture and particulates from entering the occupied space.
11. Material Safety Data Sheets for all cleaning products utilized at the RSL should be made available at a central location within the building in the event of an emergency. Cleaning product should be stored out of reach of children in the children's library.
12. Relocate or consider reducing the amount of materials stored in the children's work room to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
13. Remove extraneous materials from mechanical room. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
14. Change filters for air-handling equipment as per the manufacturer's instructions or more frequently if needed. Vacuum interior of air handling units to prevent the aerosolization of dirt, dust and particulates. Ensure filters fit flush in their racks with no spaces in between allowing bypass of unfiltered air into the unit.
15. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is

recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

16. Repair deteriorated sealant on roof of original building.
17. Seal gaps around exterior doors.
18. Repoint masonry and ensure all gaps are appropriately sealed on the exterior of the building, with particular attention to areas where the addition is joined to the original building.
19. Seal gaps where foundation meets masonry. Replace deteriorating sealant on the exterior of the building.
20. Seal all open utility holes in the building, both on the interior of the building as well as the exterior.
21. Repair gutters/downspouts to ensure rainwater is deposited away from the building foundation. Downspout that empties onto the patio should be redesigned to eliminate rainwater from being deposited in this area.
22. Cut shrubbery in a manner to maintain a space of 5 feet from the building.
23. Remove sediment from blocked weepholes.
24. Secure light fixture at entrance to children's library.
25. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: http://mass.gov/dph/iaq.

In view of the findings at the time of the assessment, the following **long term** recommendations are made for consideration:

1. Consider removal of carpeting on ground floor and replace with tile.

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**Picture 1**

**Damaged Liner in AHU**

**Picture 2**

**Exterior Liner to AHU is Damaged**

**Picture 3**

**Exterior Liner on AHU Has Also Separated from Unit**

**Picture 4**

**Deteriorated Sealant on Flashing**

**Picture 5**

**Deteriorated Sealant**

**Picture 6**

**Water Damaged Ceiling in Staff Room**

**Picture 7**


**Water Damaged Ceiling in Children's Library**

**Picture 8**

**Water Damage to Base of Cabinet**

**Picture 9**


**Evidence of Water Penetration**

**Picture 10**

**Water Damage to Window Sill**

**Picture 11**

**Seal on Interior of Chimney**

**Picture 12**

**Gap Between Foundation and Masonry**

**Picture 13**

**Downspout Draining at Base of Building**
**Note Moss Accumulation**

**Picture 14**

**Disconnected Downspout**

**Picture 15**

**Efflorescence on Masonry**

**Picture 16**

**Block Wall Foundation Connecting Addition to Original Building**

**Picture 17**

**Downspout in Alcove/Patio**

**Picture 18**

**Movement of Water on Patio**
**Note Moss Growth Between Tiles**

**Picture 19**

**Water Draining Against Foundation**

**Picture 20**

**Saturated Soil Adjacent to Block Wall**
**Note Sheet Metal**

**Picture 21**

**Heavy Moss Growth**

**Picture 22**

**Deteriorated Sealant**

**Picture 23**

**Open Utility Hole**

**Picture 24**

**Peeling Paint on Bricks**

**Location: Richard Sugden Library (Spencer Public Library)** **Indoor Air Results**

**Address: 8 Pleasant Street - Spencer** **Date: 3/18/09**

## Table 1

| Location | Occupants in Room | Carbon Dioxide (ppm) | Temp (°F) | Relative Humidity (%) | Carbon Monoxide (ppm) | PM2.5 (μg/m3) | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Supply | Exhaust | |
| Outside (Background) | - | 328 | 51 | 31 | 1 | 30 | - | - | - | |
| Director's Office | 0 | 476 | 73 | 24 | ND | 7 | Y | Y | Y | DO, FP |
| Front Entry | 0 | 537 | 73 | 24 | ND | 7 | N | N | Y | DC |
| Staff Office | 1 | 472 | 74 | 25 | ND | 9 | Y | N | N | DO, PF, Liebert Datamate used for temp/humidity control and air filtration. |
| Front desk area (First Floor) | 4 | 466 | 73 | 23 | ND | 5 | N | Y | Y | |
| Reading Room | 1 | 478 | 69 | 23 | ND | 10 | Y | Y | Y | |

ppm = parts per million

AT = ajar ceiling tile
design = proximity to door
DO = door open

DEM = dry erase materials
GW = gypsum wallboard
MT = missing ceiling tile

ND = non detect
PC = photocopier
PF = personal fan

TB = tennis balls
VL = vent location
WD = water-damaged

**Comfort Guidelines**

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

**Location: Richard Sugden Library (Spencer Public Library)** **Indoor Air Results**

**Address: 8 Pleasant Street - Spencer** **Date: 3/18/09**

## Table 1 (continued)

| Location | Occupants in Room | Carbon Dioxide (ppm) | Temp (°F) | Relative Humidity (%) | Carbon Monoxide (ppm) | PM2.5 (μg/m3) | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Supply | Exhaust | |
| Teen area | 0 | 436 | 73 | 22 | ND | 3 | Y | Y | Y | |
| Second floor Stacks | 0 | 514 | 71 | 23 | ND | 3 | Y | Y | Y | |
| Ground Floor Children's Library Front Desk | 5 | 482 | 76 | 23 | ND | 9 | Y | Y | Y | DC, Plants |
| Children's Work Room | 0 | 424 | 76 | 20 | ND | 9 | N | Y | N | DO, sink, paper accum.,WD carpet and cabinets |
| Children's Library Community Room | 0 | 409 | 74 | 22 | ND | 6 | N | Y | Y | DC |

ppm = parts per million

ND = non-detectable

**Comfort Guidelines**

| | | | |
|---|---|---|---|
| Carbon Dioxide: | < 600 ppm = preferred | Temperature: | 70 - 78 °F |
| | 600 - 800 ppm = acceptable | Relative Humidity: | 40 - 60% |
| | > 800 ppm = indicative of ventilation problems | | |

**TABLE 2**

**Moisture Test Results**

**Spencer, Richard Sugden Library**

**March 18, 2009**

| Location | Moisture Measurement (Low = Normal) | Material/Comments |
|---|---|---|
| Community Room Story Area (Ground Floor) 2” from brick wall | Low | Carpet |
| Community Room Story Area (Ground Floor) 4” from brick wall | Low | Carpet |
| Staff Room (First Floor) | Low | Carpet |
| Director’s Office (First floor) | Low | Carpet |
| Bell Tower Moisture stained plywood near AHU | Low | Carpet |