INDOOR AIR QUALITY ASSESSMENT

Department of Children and Families
J.B. Blood Building
20 Wheeler Street
Lynn, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
November 2010

Background/Introduction

In response to a request from Doug Shatkin, Human Resources Director, Office of Children, Youth & Families, Executive Office of Health and Human Resources (EOHHS), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at the Massachusetts Department of Children and Families' (DCF) Lynn Area Office located at in the J.B. Blood Building at 20 Wheeler Street, Lynn, Massachusetts. The request was prompted by occupant concerns of water damage and mold growth on building materials relating to water infiltration through exterior walls during heavy, wind-driven rains experienced during the winter/spring of 2010. On April 9, 2010, a visit to conduct an indoor air quality assessment was made by Michael Feeney, Director of BEH's Indoor Air Quality (IAQ) Program.

The DCF is located in the J.B. Blood Building, which is a four-story red brick building constructed in the early 1900s. The building has undergone a variety of interior renovations since that time. It currently serves as office space for a number of businesses. The DCF space consists of offices, open work areas and conference rooms. Windows are openable throughout the building.

BEH staff have previously evaluated this DCF office. During a heavy rain in May 2006, DCF offices were reportedly damaged as a result of water infiltrating through an exterior brick wall. This resulted in BEH staff evaluating the building and issuing a report of findings/recommendations (MDPH, 2007). Repairs were made to this area following the 2006 storm. At the time of the IAQ assessment, it appeared that similar water penetration issues are reoccurred in this location.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor. BEH staff also performed a visual inspection of building materials for water damage and/or microbial growth. Moisture content of porous building materials was measured with a Tramex Encounter Plus, Non-Destructive Moisture Meter.

Results

The DCF has an employee population of approximately 115 and is visited by up to 30 individuals daily. Tests were taken during normal operations. Results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in 19 of 35 areas surveyed, indicating less than optimal air exchange in the majority of areas surveyed during the assessment. It is probably important to note that 18 of the 19 areas with carbon dioxide levels greater than 800 ppm were in the range of 805 to 883 ppm suggesting a need to adjust the ventilation system. Mechanical ventilation is provided by ceiling-mounted air-handling units (AHUs) located throughout the DCF. Fresh air is drawn into the AHUs through air intakes located on the exterior of the building (Picture 1) and delivered to occupied areas via ceiling-mounted air diffusers. Return air is drawn into ceiling-mounted vents and ducted back to the AHUs.

Thermostats that control each heating, ventilating and air conditioning (HVAC) system have fan settings of “on” and “automatic”. Thermostats were set to the “automatic” setting in most of the areas surveyed during the assessment. The automatic setting on the thermostat activates the HVAC system at a preset temperature. Once a preset temperature is measured by the thermostat, the HVAC system is deactivated. Therefore no mechanical ventilation is provided until the thermostat re-activates the system. Without dilution and removal by the mechanical ventilation system, commonly occurring indoor air pollutants can build up and lead to indoor air quality/comfort complaints and result in carbon dioxide levels in excess of 800 ppm.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of 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). In response to recommendations by axiom (axiom 2006a; axiom 2006b), the building’s HVAC vendor has reportedly visited several times over the summer of 2006 to conduct balancing, make adjustments and increase the introduction of outside air.

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, please see Appendix A.

Temperature readings ranged from 71^{o} F to 75^{o} F, which were within the MDPH recommended comfort guidelines in all areas surveyed during the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. Temperature control and poor airflow complaints were expressed in several areas. 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 45 to 57 percent, which was within the MDPH recommended comfort range the day of the assessment. 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 common during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As with the previous MDPH assessment (MDPH, 2007), a distinct musty odor was detected in the hallway for rooms 1 to 14. The odors are attributed to water penetration through the exterior brick wall of rooms 1 and 2 (Picture 2). Water penetration through brick was identified in the area director's conference room and private office in the previous DPH IAQ assessment (MDPH, 2006). On April 9, 2010, the greater Lynn area was subjected to a wind driven rainstorm with 3 to 12 mile per hour (mph) wind speed (Weather Underground, 2010). At the time of the 2010 MDPH assessment, the walls in room 1 and 2 appeared to be moist (Pictures 3 and 4), and was confirmed by moisture sampling. It appears that moisture readily penetrates through the brick exterior wall and accumulates beneath the raised tile floor. This moisture accumulation wets building material and likely causes mold colonization of flooring materials. Odors are also drawn into the HVAC system into the hallway, resulting in odors migrating to other areas. BEH conducted moisture sampling in offices with exterior walls and found the plaster walls of Rooms 20 to 24 to have detectable moisture concentrations (Picture 5), whereas all other offices had no measurable moisture levels. The walls of rooms 1, 2 and 20 to 24 all appeared to be on the windward side of the building during this rainstorm and were subjected to perpendicular wind impingement, subjecting them to direct and driving rain.

Missing/damaged mortar and efflorescence were also observed in Rooms 1 and 2 (Picture 6). Efflorescence is a characteristic sign of water damage to brick and mortar, but it is not mold growth. As moisture penetrates and works its way through mortar and brick, water-soluble compounds in mortar and brick dissolve, creating a solution. As the solution moves to the surface of the mortar or brick, the water evaporates, leaving behind white, powdery mineral deposits. Of note is a framed wall hanging with rippling paper, which is a telltale sign of moisture exposure (Picture 7). Water damage observed on a bulletin board hanging on a wall in room 1 is also likely the result of moisture exposure (Picture 3).

Water-damaged carpeting was noted in an unconditioned hallway adjacent to the DCF offices (Picture 8), this water damage is likely the result of leaks from roof drain pipes in the hallway. Water stained ceiling tiles were observed in some rooms, notably in the reception area. This building was constructed in a manner to have successively receding stories, creating a series of short roofs over occupied areas. Water damage in the reception is in line with a roof/wall junction that is above the reception area (Picture 9). Under certain wind conditions, it is likely that rain penetrates though the junction as well as exterior wall openings above room 26.

Repeated water damage to porous building materials (e.g., carpeting, ceiling tiles, wood and plywood) can result in microbial growth. 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.

Plants were observed in several areas. Plants should be properly maintained and equipped with drip pans. Plants should be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold. Plants should not be placed on porous materials, since water damage to porous materials may lead to microbial growth.

Other Concerns

A number of supply and return/exhaust vents throughout the DCF office space were accumulated dust (Pictures 10 and 11). If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. Dust can also become aerosolized from supply vents when HVAC units are activated.

Conclusions/Recommendations

At the time of the BEH assessment, the building appeared to be readily susceptible to water penetration through its exterior walls. It is recommended that a building engineer be consulted to examine and make recommendations to identify remedial measures to arrest of water penetration through the exterior walls. However, if water-proofing measures are to be conducted, these activities should be considered a renovation project, therefore several recommendations are provided below to prevent/reduce the migration of materials into occupied areas. In view of findings at the time of the visit, the following recommendations are made to improve indoor air quality:

1. Consider removing carpeting from areas 1 and 2 until water leakage through exterior walls is remedied.
2. Remove carpeting approximately 1 to 2 feet from exterior walls. Disinfect floor beneath carpet with an appropriate antimicrobial agent, clean and dry. Consider replacing carpet with tile or other non-porous floor material. Carpeting should be removed in a manner consistent with recommendations in "Mold Remediation in Schools and Commercial Buildings" published by the US EPA (2001), which is available from their website: http://www.epa.gov/iaq/molds/mold_remediation.html.
3. Refrain from hanging pictures or placing materials capable of supporting mold growth (e.g., paper, cardboard, etc.) in contact with the exterior walls in all offices.
4. Move furniture and book shelves away from exterior walls to allow airflow/drying.
5. Remove water-damaged carpet from hallway in Picture 9. Repair drainpipes.
6. Examine the exterior wall/roof junction above the reception area and repair as needed.
7. Consult a building engineer concerning the best method for rendering window frames and windowsill water-tight to prevent moisture penetration.
8. Consult a building engineer concerning the best method for reducing water penetration through exterior walls, particularly in areas with bricked-in windows.
9. Operate ventilation systems continuously during periods of occupancy.
10. Supplement airflow by using openable windows to control for comfort (with the exception of during the cooling season when AC is activated). Care should be taken to ensure windows are properly closed at night and weekends to avoid freezing of pipes and potential flooding.

11. Consider balancing mechanical ventilation systems every 5 years, as recommended by ventilation industrial standards (SMACNA, 1994).
12. Consider reducing the number of plants in the building.
13. 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).
14. For additional information on mold refer to "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001). This document is available from the US EPA website: http://www.epa.gov/iaq/molds/mold_remediation.html.
15. Ensure leaks are repaired, and replace any remaining water-damaged ceiling tiles.
16. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
17. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://mass.gov/dph/iaq.

Recommendations for Buildings under Renovation

1. Establish communications between all parties involved with remediation efforts to prevent potential IAQ problems. Develop a forum for occupants to express concerns about remediation efforts as well as a program to resolve IAQ issues.
2. Develop a notification system for building occupants to report remediation/construction/renovation related odors and /or dust problems to the building administrator. Have these concerns relayed to the contractor in a manner that allows for a timely remediation of the problem.
3. When possible, schedule projects which produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy.
4. Disseminate scheduling itinerary to all affected parties. This can be done in the form of meetings, newsletters or weekly bulletins.
5. Obtain Material Safety Data Sheets (MSDS) for all remediation/decontamination materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983).
6. Consult MSDS' for any material applied to the effected area during renovation(s) including any sealant, carpet adhesive, tile mastic, flooring and/or roofing materials. Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.
7. Use local exhaust ventilation and isolation techniques to control remediation pollutants. Precautions should be taken to avoid the re-entrainment of these materials into the building's HVAC system. The design of each system must be assessed to

determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated form contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).

8. Seal utility holes and spaces in temporary walls to eliminate pollutant paths of migration.

9. If possible, relocate susceptible persons and those with pre-existing medical conditions (e.g., hypersensitivity, asthma) away from the general areas of remediation until completion.

10. Implement prudent housekeeping and work site practices to minimize exposure to spores. This may include construction barriers, sealing off areas, and temporarily relocating furniture and supplies. To control for dusts, a high efficiency particulate air filter (HEPA) equipped vacuum cleaner is recommended. Non-porous materials should be disinfected with an appropriate antimicrobial agent. Non-porous surfaces should also be cleaned with soap and water after disinfection.

References

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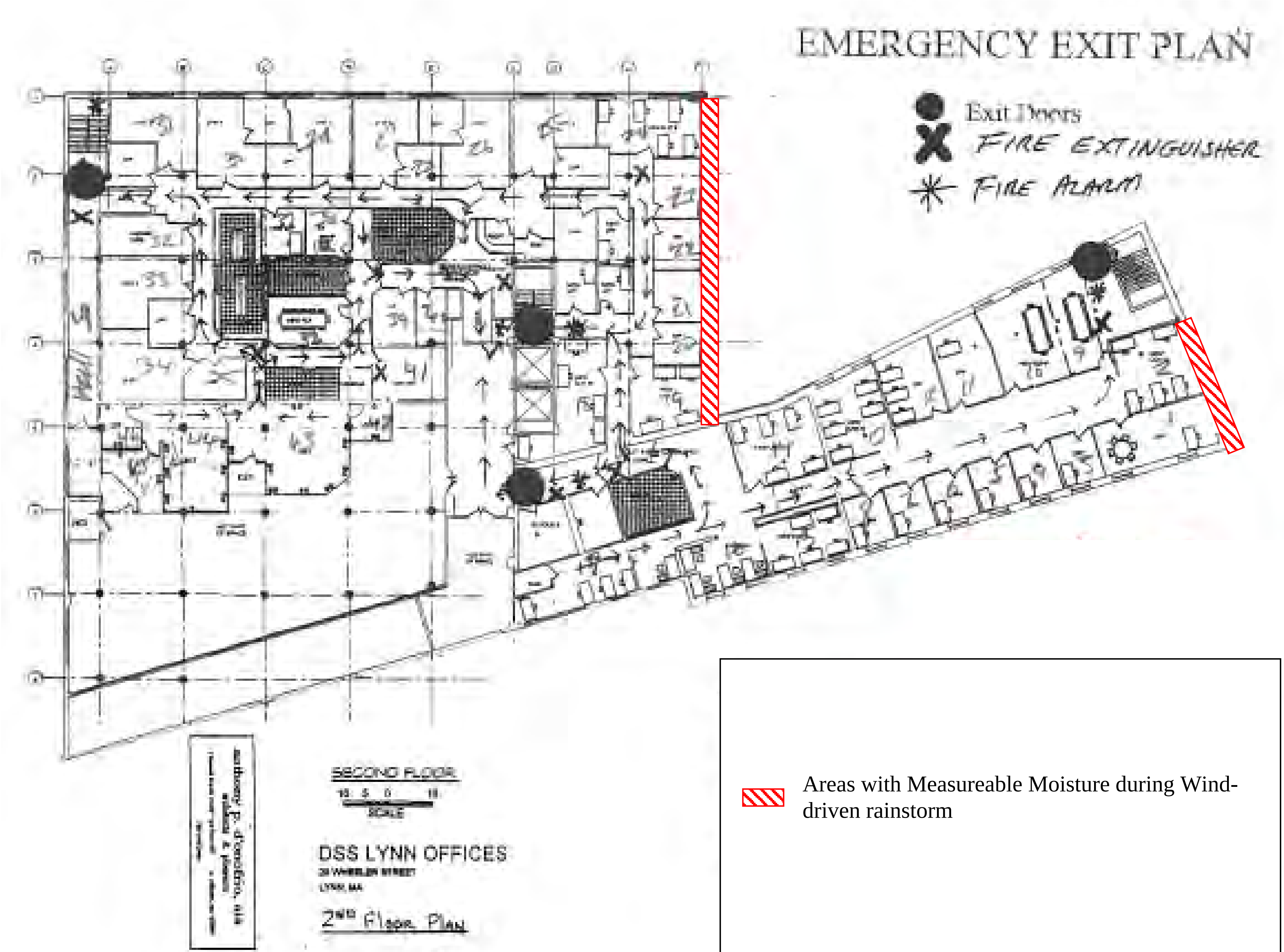
Figure 1: Areas Showing Moisture Damage to Walls



Areas with Measureable Moisture during Wind-driven rainstorm

Picture 1

Fresh Air Intake

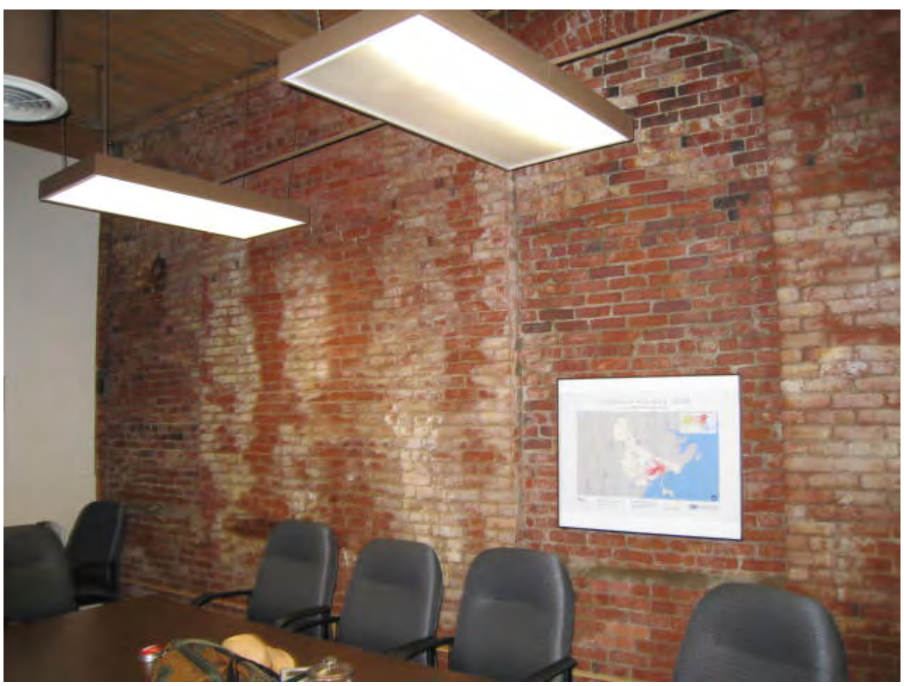
Picture 2

Brick-In Windows, Rooms 1 And 2

Picture 3

Moist Wall, Room 1, Note Efflorescence, Bricked-In Windows and Bulletin Board

Picture 4



Moist Wall, Room 2, Note Efflorescence and Bricked-In Windows

Picture 5

Moist Low Wall, Room 20

Picture 6

Efflorescence and Wet Spot in Room 2

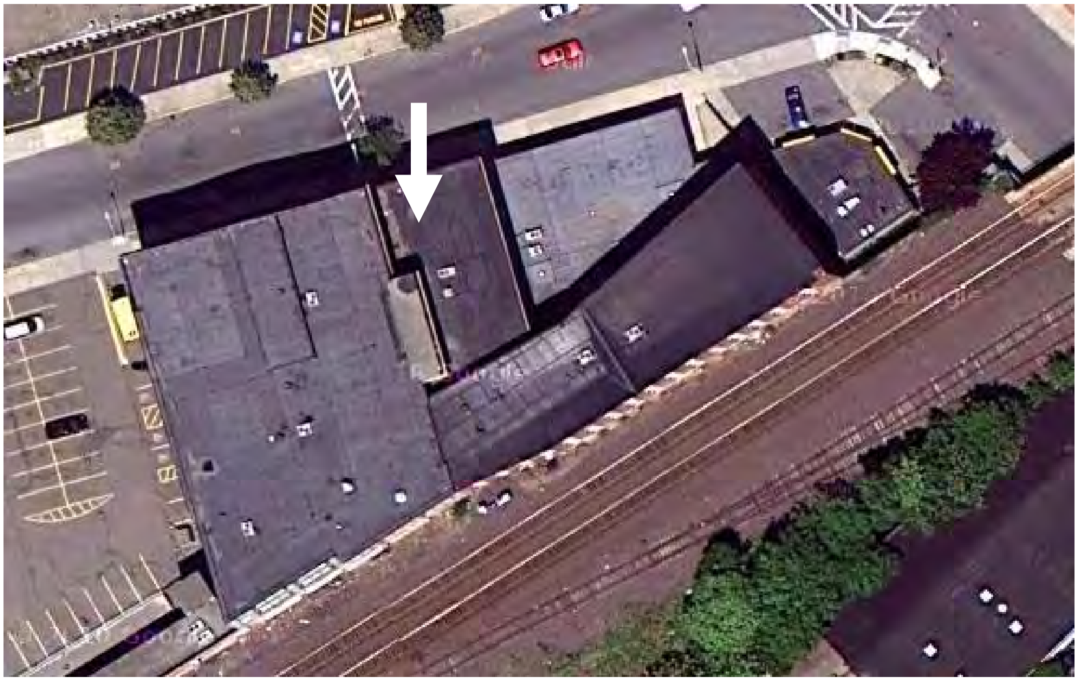
Picture 7

Rippled Framed Materials, Indicative of Water Vapor Exposure

Picture 8

Water Damaged Carpeting In A Hallway Adjacent To The DCF Offices

Picture 9



Arrow Indicates Location of Roof above DCF Reception

Picture 10

Supply Vent Occluded with Dust

Picture 11

Exhaust Vent Occluded with Dust

Location: MA Dept. of Children and Families

Address: 20 Wheeler Street, Lynn, MA

Indoor Air Results

Date: April 9, 2010

Table 1

Location	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
Outside (Background)									
1	0	71	57	661	0	Y	Y	Y	Efflorescence Mold odor Door open
2	1	71	57	732	0	N	Y	N	Efflorescence Mold odor Door open
3	0	71	56	643	0	Y	Y	N	
4	0	72	54	659	0	Y	Y	N	
5	0	72	54	657	0	Y	Y	N	
6	0	72	53	643	0	y	Y	N	Efflorescence
7	0	73	52	665	0	Y	Y	N	
8	0	73	51	675	0	Y	Y	N	
13	4	73	52	759	0	Y	Y	N	

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

Location: MA Dept. of Children and Families **Indoor Air Results**

Address: 20 Wheeler Street, Lynn, MA **Date: April 9, 2010**

Table 1 (continued)

Location	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
12	1	74	50	764	0	N	Y	N	
11	4	74	49	766	0	N	Y	N	
15	4	75	48	727	0	Y	Y	N	
16	1	74	46	644	0	Y	Y	N	
14	4	75	46	632	0	Y	Y	N	
17 storage	0	74	45	597	0	Y	Y	Y	Efflorescence
19	1	74	45	808	0	Y	Y	Y	Plants
20	0	74	45	836	0	N	Y	N	
21	0	74	45	805	0	Y	Y	N	Plants
23	0	73	45	800	0	Y	Y	N	Plants
24	2	73	47	808	0	Y	Y	N	Water damaged ceiling tiles

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 1 (continued)

Location	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
25	4	73	47	845	0	y	Y	N	
Reception	1	74	46	841	0	N	Y	N	Water damaged ceiling tiles
26	2	74	46	871	0	Y	Y	N	Water damaged ceiling tile
27	1	74	46	864	0	Y	Y	N	
28	2	75	44	875	0	Y	Y	N	
30	1	75	43	829	0	Y	Y	N	
31	2	75	43	883	0	Y	Y	N	Water damaged ceiling tile
32	0	75	40	845	0	N	Y	N	
33	1	75	40	870	0	N	Y	N	
34	1	74	41	855	0	N	Y	N	
Kitchen	6	75	41	1000	0	N	Y	Y	

ppm = parts per million
ND = non-detectable

Comfort Guidelines

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

Location: MA Dept. of Children and Families **Indoor Air Results**

Address: 20 Wheeler Street, Lynn, MA **Table 1 (continued)** **Date: April 9, 2010**

Location	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
43	1	73	44	860	0	N	Y	N	
44	0	73	43	897	0	N	Y	N	
45	0	72	43	837	0	N	Y	N	
46	0	72	47	828	0	N	Y	N	

ppm = parts per million
ND = non-detectable

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%