INDOOR AIR QUALITY ASSESSMENT

Pickering Middle School
70 Conomo Avenue
Lynn, Massachusetts

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

Background/Introduction

At the request of Representative Lori A. Ehrlich, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at the Pickering Middle School, 70 Conomo Avenue, Lynn, Massachusetts. The request was prompted by mold concerns in classrooms located in a converted gymnasium. On May 7, 2010, a visit to conduct an indoor air quality assessment was made to the building by Michael Feeney, Director of BEH's Indoor Air Quality (IAQ) Program. Mr. Feeney was accompanied by Mary Ann O'Conner, Health Director for the City of Lynn.

The school is a two-story brick building constructed in 1916. Two wings were added to the building in 1953 when the adjacent Sission Elementary School was constructed (Picture 1; Figure 1). Renovations made to the building during the 1970s and 1980s include the conversion of the gymnasium located on the lowest occupied level of the building into six classrooms (A-E). Windows throughout the building are openable.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 7565. 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.

Results

The building houses approximately 650 students in sixth through eighth grades and has a staff of approximately 50. Tests were taken during normal operations at the school and 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 20 of 40 areas surveyed, indicating inadequate air exchange in a number of areas of the school at the time of the assessment. The mechanical ventilation system for the majority of areas was not operating at the time of assessment. In some classrooms, windows were open, which can greatly reduce carbon dioxide levels. With windows closed, carbon dioxide levels would be expected to increase.

The mechanical ventilation system servicing the 1916 wing is currently abandoned. The ventilation system was likely abandoned either as part of an earlier energy conservation project or during the renovations of the 1980s. Fresh air from this system was originally provided by two large fans, which are located in basement fan rooms (Picture 2). In this type of system, the two large fans draw fresh air into the fan rooms through openable windows located at the rear of the building (note: these windows are currently sealed inside storm windows). Typically, air would then be drawn through heating elements in each fan room before distribution to classrooms. Ductwork connecting the fans to wall-mounted fresh air diffusers would have facilitated the distribution of fresh air to classrooms (Picture 3).

The exhaust system appears to depend on air pressurization. Pressurization forces classroom air towards the exhaust vent and it exits the building through louvered vents located on the roof. Without operation of the fresh air supply system, exhaust ventilation from classrooms is minimized. Without pressurization created by the fresh air supply system, exhaust vents on the roof may allow cold air to backdraft into classrooms under certain wind and weather conditions.

Currently, openable windows are the only means for introducing airflow into the building. Heating is provided by wall-mounted radiators. The 1916 wing was configured to use cross-ventilation to provide comfort for building occupants. The building is equipped with windows on opposing exterior walls. This design allows air to enter an open windows on the windward side of the building, pass through the classrooms and subsequently pass through open classroom doors. Air then enters the hallway, passes through the opposing open classroom doors, into the opposing classrooms and finally exits the building on the leeward side (Figure 2). With all windows and hallway doors open, airflow can be maintained in a building regardless of the direction of the wind. This system fails if the windows or doors are closed (Figure 3). Rooms that are not opposite other classrooms have greater difficulty in creating cross ventilation and would need some means to increase air movement (e.g., floor fan in an open window). In order to facilitate airflow, hallway doors should remain open.

Classrooms A through E on the lowest level of the building were created through the subdivision of the building's original gymnasium. Originally, ventilation was provided by wall-mounted fresh air supply and exhaust vents. No vent that could serve as a source of fresh air for this location could be identified on the exterior of the building. Carbon dioxide levels in these classrooms would indicate that fresh air supply to these spaces is limited (Table 1).

Fresh air is provided to classrooms in the 1953 wing by unit ventilator (univent) systems (Picture 4). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (Figure 4). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located on the top of the unit. At the time of the assessment, univents were not operating. In order for univents to provide fresh air as designed, units must be allowed to operate while rooms are occupied. Air diffusers and intake vents must also remain free of obstructions. Mechanical exhaust ventilation is provided by wall-mounted exhaust vents. Please note, classroom 206 was subdivided into classrooms 206A and 206B. Subdivision of this room has separated the supply and exhaust systems, with supply in 206A and exhaust in 206B. In cold weather, normally occurring pollutants can accumulate in these rooms due to incomplete set of supply and exhaust in each room.

Univents in the 1953 wing appear to be original equipment and in poor repair or damaged (Picture 4). According to the American Society of Heating, Refrigeration and Air-Conditioning Engineering (ASHRAE), the service life[1] for a unit heater, hot water or steam is 20 years, assuming routine maintenance of the equipment (ASHRAE, 1991). The operational lifespan of this equipment has long passed. Given its age, continuing to maintaining the balance of fresh air to exhaust air will be difficult at best with equipment of this vintage.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to

[1] The service life is the median time during which a particular system or component of …[an HVAC]… system remains in its original service application and then is replaced. Replacement may occur for any reason, including, but not limited to, failure, general obsolescence, reduced reliability, excessive maintenance cost, and change system requirements due to such influences as building characteristics or energy prices (ASHRAE, 1991).

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 mechanical ventilation systems, in their current conditions, cannot be balanced.

The Massachusetts Building Code requires that each area have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (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 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 ranged from 71° F to 78° F, which were within the MDPH recommended comfort range in all areas. 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. Often times, temperature control is difficult, especially in an old building lacking an operational mechanical ventilation system. During the course of this assessment, BEH staff received a number of reports of temperature extremes in the building. With the 1916 wing ventilation system abandoned, no supply of fresh air (except windows) is available to temper room temperatures. In addition, temperature for classrooms in the 1953 wing are controlled by pneumatic (air pressure) systems. Thermostats were found hissing air, indicating a leak in the pneumatic control system, which results in lack of temperature control in these classrooms.

The relative humidity measured in the building ranged from 19 to 41 percent, which was close to the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. It is important to note that relative humidity measured indoors exceeded outdoor measurements by 2 to 20 percent. This increase in relative humidity can indicate that natural ventilation (i.e. open windows) alone may not be sufficient in removing normal indoor air pollutants (e.g., water vapor from respiration). Moisture removal is important, since the sensation of heat conditions increases as relative humidity increases.

The relationship between temperature and relative humidity is known as the heat index. As indoor temperature rises, the addition of humid air increases occupant discomfort and generate heat complaints. If moisture levels are decreased, the comfort of the individuals increases. Without adequate ventilation, indoor pollutants and moisture will accumulate.

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 common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As discussed, concerns about IAQ and water damage/potential mold growth and exacerbation of respiratory symptoms prompted the request for an IAQ inspection. The areas of concern involve classrooms located in subdivided space that was previously the building's original gymnasium. At the time of the assessment, BEH staff observed discolored paint at the base of the interior side of an exterior facing wall in classroom B (Pictures 5 and 6). This discolorization may be mold colonization of the wall paint. Mold growth may be the result of water infiltration through the building's foundation, potentially from water penetrating along the sidewalk/exterior wall seam (Picture 7) or exterior wall staircase seam (Picture 8). Of particular note is the stairwell in Picture 8, which shows signs of repeated, failing patching.

BEH staff observed materials that could become moistened and mold colonized (e.g., paper and cork bulletin board) or function as a water impermeable barrier by holding moisture against the wall (e.g., Mylar plastic) affixed to the classroom wall above the area of discolored paint (Picture 9). Materials that hold moisture against the wall can result in further damage to paint/wall brick. Repeated water damage to porous building materials (e.g., paint) 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/discarded.

In this particular instance, the discolored paint should be removed (Pictures 5 and 6), and the area should remain unpainted to allow monitoring for any future water penetration. It is also recommended that any remediation of water-damaged/mold contaminated materials be conducted during unoccupied periods and in a manner consistent with recommendations in "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001). The primary purpose in doing so is to protect occupants and prevent exposure.

The school auditorium also had signs of water damage. This was evidenced by the presence of peeling paint and efflorescence along exterior brick walls (Picture 10). Efflorescence appears as a white, chalky residue and 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 around brick, water-soluble compounds in bricks and mortar dissolve, creating a solution. As the solution moves to the surface of the brick or mortar, the water evaporates, leaving behind white, powdery mineral deposits. A coat of paint can serve as a water impermeable barrier, which can trap moisture. While brick and mortar are not viable sources for mold growth, water trapped in spaces between the paint and brick can become mold growth media. To prevent further damage to exterior brick work, repointing may be necessary to prevent further water penetration.

Water damage was noted on plaster ceilings, walls and window sills through out the school. As with brick and mortar, ceiling plaster does not provide a source for mold growth;

however, water and dust trapped in paint layers can be a source. The extensive water damage to plaster and walls indicate that both the roof likely needs to be replaced.

A number of other conditions observed along the building exterior may be also conducive to water penetration through the building envelope. Shrubbery and other plants were also observed to be growing in cracks and crevices in close proximity to the foundation walls. The growth of roots against the exterior walls can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level. Over time, this process can undermine the integrity of the building envelope and provide a means of water entry into the building through capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001).

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 effects. 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. Outdoor carbon monoxide concentrations were non-detect (ND) the day of the assessment (Table 1). No measureable levels of carbon monoxide were detected in the building during the assessment (Table 1).

Particulate Matter

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 (μg/m3) 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 μg/m3 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 was measured at 4 μg/m3. PM2.5 levels measured indoors ranged from 2 to 8 μg/m3 (Table 1), which were below the NAAQS PM2.5 level of 35 μg/m3. 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 indoors 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 stoves and/or microwave ovens in kitchen areas; use of photocopiers, fax machines 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 classrooms for products containing these respiratory irritants.

Several classrooms contained dry erase boards and markers. Materials such as permanent markers, dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Other Concerns

The abandoned ventilation system can serve as a pathway for basement particulates and odors to migrate into classrooms and other occupied areas of the building. In general, cold air migrates to areas with heated air, thereby creating drafts. The temperature in the basement and fan rooms will generally be lower than that of occupied areas, therefore colder basement air will move to classrooms if breaches and exit points exist. A number of different source pathways allow for basement air, odor and particulates to enter the ventilation system. These openings allow basement air, odors and particulate matter to become entrained into the vent system and migrate into occupied areas.

Of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were seen on windowsills, tabletops, counters, bookcases and desks. The large amount of items stored in classrooms provides a means for dusts, dirt and other potential respiratory irritants to accumulate. Many of the items, (e.g. papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to the eyes, nose and respiratory tract. These items should be relocated and/or cleaned periodically to avoid excessive dust build up.

A number of pest attractants were identified within or around the building as demonstrated by the use of rodent bait traps in the building (Picture 11). Rodent infestation can result in indoor air quality related symptoms due to materials in their wastes. Mouse urine contains a protein that is a known sensitizer (US EPA, 1992). A sensitizer is a material that can produce symptoms (e.g., running nose or skin rashes) in sensitive individuals.

A three-step approach is necessary to eliminate rodent infestation:

- removal of the rodents;
- cleaning of waste products from the interior of the building; and
- reduction/elimination of pathways/food sources that are attracting rodents.

To eliminate exposure to allergens, rodents must be removed from the building. Please note that removal, even after cleaning, may not provide immediate relief since allergens can exist in the interior for several months after rodents are eliminated (Burge, 1995). Once the infestation is eliminated, a combination of cleaning and increased ventilation and filtration should serve to reduce allergens associated with rodents. In efforts to eliminate pest problems, baited traps were placed in a number of classrooms.

Conclusions/Recommendations

The conditions noted at the building raise a number of indoor air quality issues. The abandonment/alteration of the original ventilation system and its components has essentially removed any means to provide mechanical ventilation for the building. Lack of environmental pollution dilution and/or removal by the ventilation system resulting from minimized airflow into the building can result in the build up and concentration of environmental pollutants in occupied area.

When considered individually, the general building conditions; design and operation (or lack) of HVAC equipment; lack of capital maintenance to the building envelope and repair of water damaged materials present conditions that could degrade indoor air quality. When combined, these conditions can serve to further negatively affect indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons, a two-phase approach is required, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address overall indoor air quality concerns.

Short Term Recommendations

1. Examine and repair breaches in the building's foundation, including areas around the sidewalk/exterior wall seam and exterior wall staircase seam.
2. Remove all materials affixed to below grade exterior walls.
3. Conduct remediation activities in the building in a manner consistent with recommendations in "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001). This document

can be downloaded from the US EPA website:
http://www.epa.gov/iaq/molds/mold_remediation.html.

4. Ensure that the general mechanical ventilation system is deactivated and/or sealed (i.e., supply and return vents) in areas of remediation.
5. Remove or cover books/items in area of remediation with plastic polyethylene sheeting.
6. Seal off area of remediation, if possible, with plastic polyethylene sheeting.
7. Place water damaged/mold colonized building materials in plastic trash bags and seal for removal.
8. Clean areas/surfaces in remediation area with a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all non-porous surfaces on remediation activities are completed.
9. Consider measures to restore existing HVAC equipment in the 1916 wing. If mechanical ventilation systems cannot be restored to their original function, ensure abandoned exhaust and supply vents are properly sealed in classrooms and on the roof. Louvers in each fan room should be sealed to prevent basement air migration into classrooms via the abandoned ventilation system.
10. Examine, maintain and operate univents as designed in the 1953 wing. Ensure these units remain free of blockages.
11. Use open windows and hallway doors to enhance airflow during warm weather. Be sure to close windows and doors at the end of the school day. To aid in the draw of fresh outdoor air in warm weather, use portable fans directing air out windows on the leeward side of the building. Fans positioned in this manner will serve to increase the draw of outdoor air across a floor without interfering with the natural, internal airflow pattern of

the building. To aid cross ventilation, open hallway doors in areas with inoperable transoms.

12. Implement prudent housekeeping and work site practices to minimize exposure to spores. This may include constructing 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 (e.g., linoleum, cement, etc.) should be disinfected with an appropriate antimicrobial agent. Non-porous surfaces should also be cleaned with soap and water after disinfection.
13. Repair water damaged ceilings, windows and building materials. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
14. Increase fresh air supply for classrooms A through E.
15. Remove plants and weeds that are growing along building foundation.
16. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
17. Use the principles of integrated pest management (IPM) to rid this building of pest. Activities that can be used to eliminate pest infestation may include the following activities.
    a. Do not use recycled food containers. Seal recycled containers in a tight fitting lid to prevent rodent access.
    b. Remove non-food items that rodents are consuming.
    c. Stored foods in tight fitting containers.

d. Avoid eating at workstations. In areas were food is consumed, periodic vacuuming to remove crumbs are recommended.

e. Regularly clean crumbs and other food residues from toasters, toaster ovens, microwave ovens coffee pots and other food preparation equipment;

f. Examine each room and the exterior walls of the building for means of rodent egress and seal appropriately. Holes as small as ¼" is enough space for rodents to enter an area. If doors do not seal at the bottom, install a weather strip as a barrier to rodents

g. Reduce harborages (cardboard boxes) where rodent may reside.

h. Refer to the IPM Guide, which can be obtained at the following Internet address: http://www.state.ma.us/dfa/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf

18. Consider adopting the US EPA (2000) document, "Tools for Schools" as a means to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.

19. 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/environmental_health.

Long Term Recommendations

1. Contact an HVAC engineering firm for a full building-wide ventilation systems assessment. Based on historical issues with air exchange/indoor air quality complaints, age, physical deterioration and availability of parts for ventilation components, such an evaluation is necessary to determine the operability and feasibility of replacing the equipment, including thermostats.

2. Consider consulting a building engineer for permanent methods to repair roof leaks, which may include replacing the roof. Once the leaks are repaired, repair water-damaged plaster and replace missing/water damaged ceiling tiles.

3. Consider consulting a building engineer for methods to reduce water penetration through exterior walls, which may include repointing.

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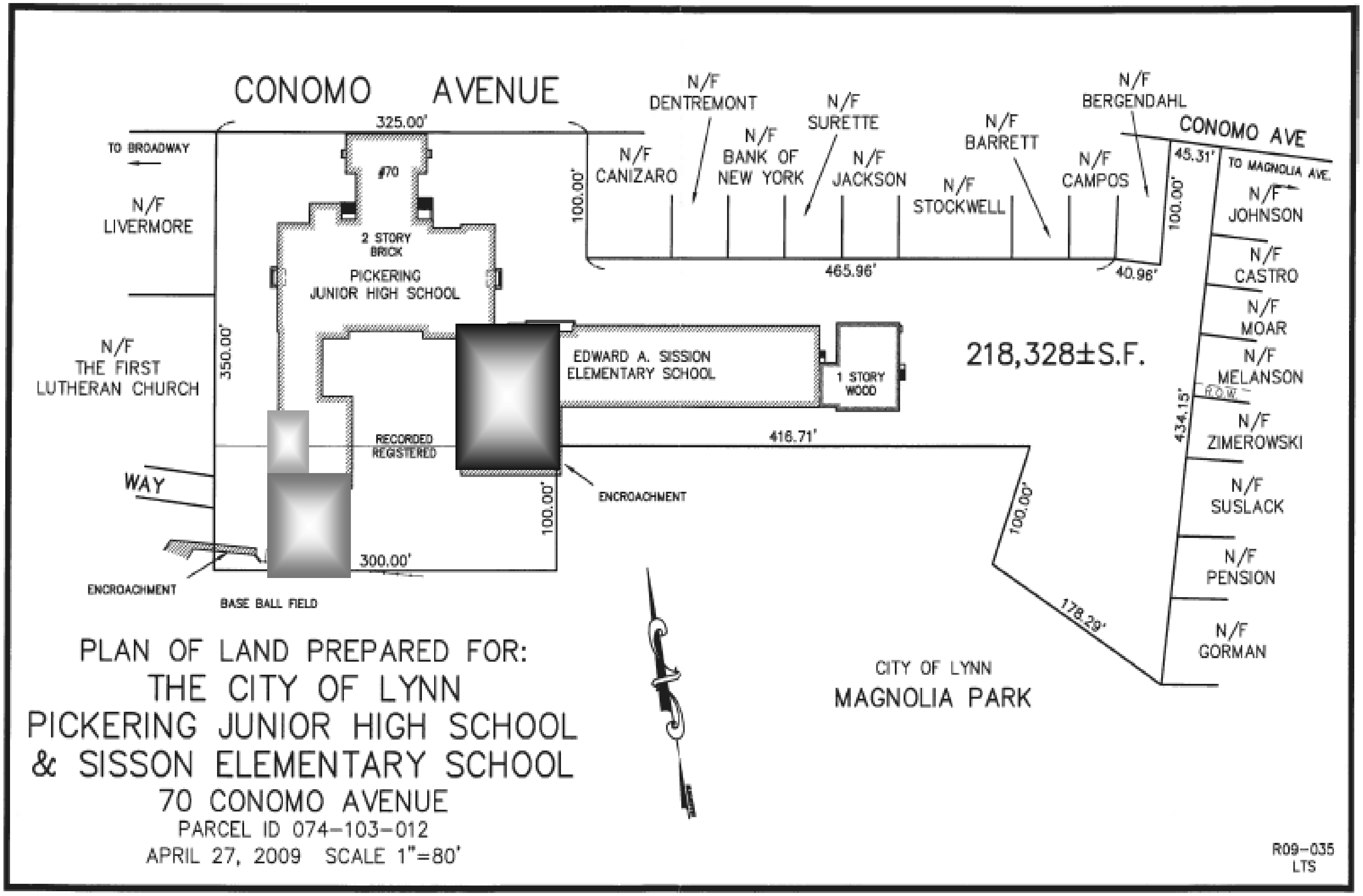
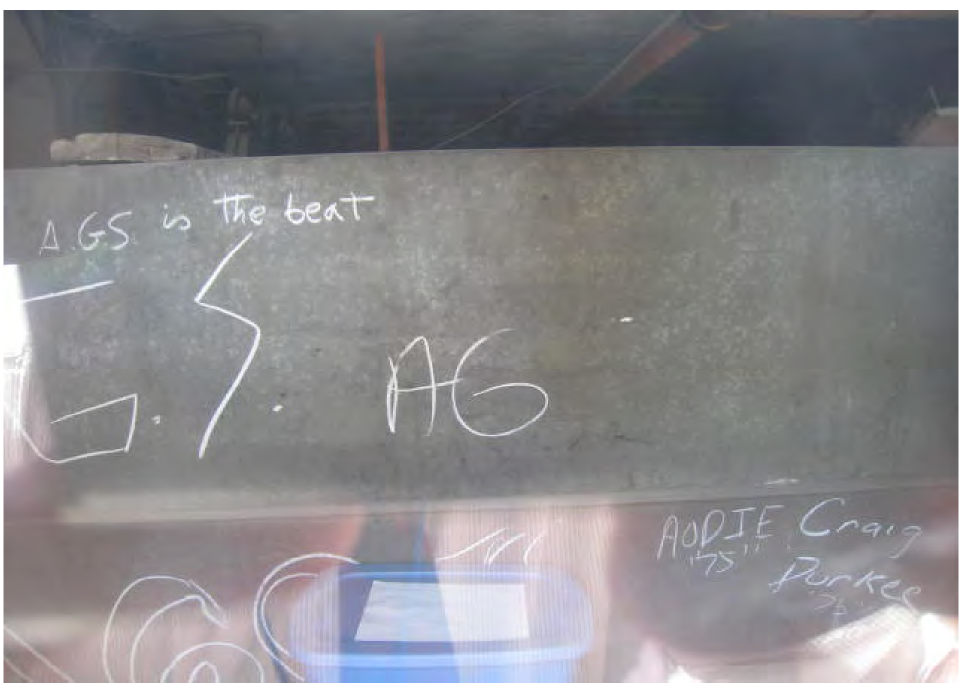
Figure 1
Pickering Middle School/Edward A. Sisson Elementary School
(Shaded areas are 1953 wings of Pickering Junior High School)



Picture 1

Pickering Middle School/Sisson Elementary School Complex

Picture 2



Fan in Rear of PMS basement behind a Storm Window

Picture 3

Fresh Air Supplies in 1916 classrooms, Note Missing Louvers

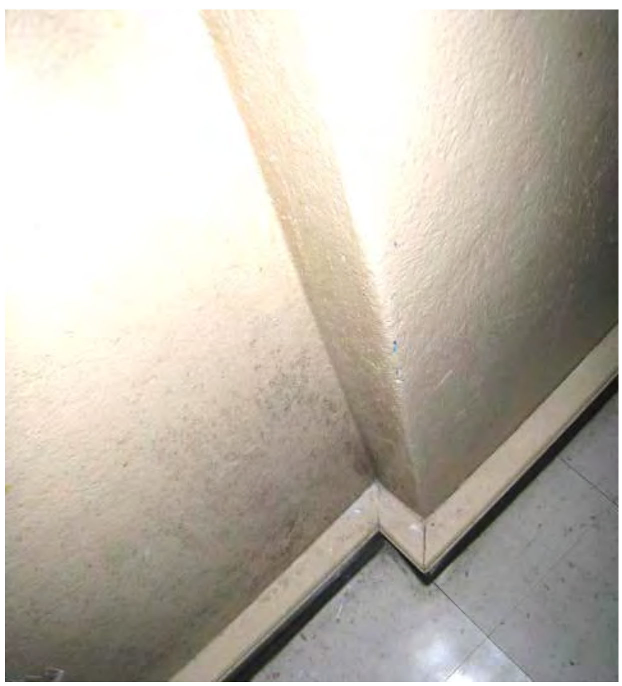
Picture 4

Univent, Note Broken Louvers Indicating Lack of Repair

Picture 5

Water-Damaged Paint

Picture 6



Water-Damaged Paint

Picture 7

Seam in Tarmac/Exterior Wall, Directly above Classroom with Darkened Paint

Picture 8

Exterior Stairwell above Classroom with Darkened Paint, Note Patching

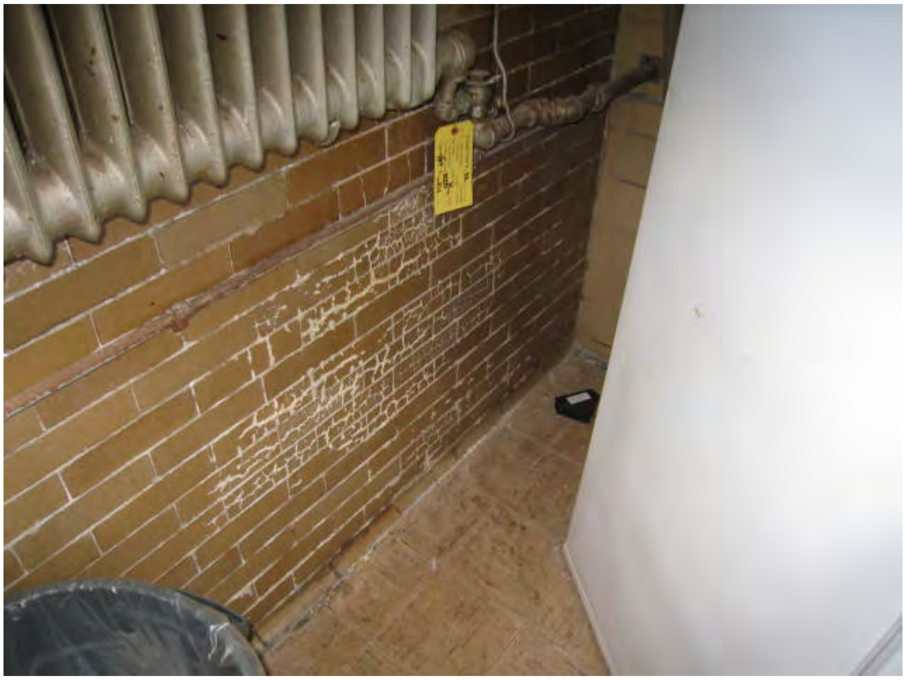
Picture 9

Bulletin Board and Mylar Plastic on Classroom Exterior Wall, Note Wall Damage

Picture 10

Water Damage in Auditorium

Picture 11



Rodent Bait Trap

Location: Pickering Middle School **Indoor Air Results**

Address: 70 Conomo Avenue, Lynn, MA **Date: 5.7.2010**

Table 1 (continued)

Location	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Outside (Background)		70	21	363	ND	4				
Auditorium		73	33	812	ND	4	Y	Y	Y	DO
Auditorium balcony	0	74	34	860	ND	6	Y	Y	Y	WD plaster
Book storage	0	74	28	766	ND	5	Y	Y	Y	DO
CIT office	1	77	26	750	ND	3	Y	Y	Y	DO, WD plaster
Library	0	76	26	698	ND	3	Y	Y	Y	DO
Meeting room	0	75	26	724	ND	6	N	N	N	WD plaster
Nurse's office	2	76	19	503	ND	2	Y open	N	N	Efflorescence/plaster
Room B	25	72	39	1373	ND	6	N	y	Y	
Room C	23	71	41	1622	ND	6	N	Y	Y	WD plaster
Room D	27	73	40	1461	ND	5	N	Y	Y	

ppm = parts per million
µg/m3 = micrograms per cubic meter
AT = ajar tile
CT = ceiling tiles
DO = door open
MT = missing tile
ND = non-detect
PF = personal fan
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: Pickering Middle School **Indoor Air Results**

Address: 70 Conomo Avenue, Lynn, MA **Table 1 (continued)** **Date: 5.7.2010**

Location	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Room E	0	73	40	1441	ND	4	N	Y	Y	
Teacher's room	3	76	29	853	ND	4	Y	Y	Y	DO, WD plaster
Teacher's room	0	71	40	1406	ND	6	Y	N	N	WD plaster
002	0	72	29	650	ND	2	Y	N	N	10 WD-CT
011	0	72	29	758	ND	7	Y	N	N	DO
013	0	71	23	431	ND	2	Y	N	N	DO, Efflorescence
014	24	73	25	1453	ND	8	Y	N	Y	DO, WD brick
017	1	72	24	577	ND	4	Y	N	Y	
102	1	76	23	684	ND	4	Y	Y	Y	10 MT, Exhaust blocked by cabinet
103	1	76	24	753	ND	3	Y	Y	Y	DO, Supply off, Exhaust off, 10 WD-CTs
108	5	75	24	769	ND	4	Y	Y	Y	

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Address: 70 Conomo Avenue, Lynn, MA **Table 1 (continued)** **Date: 5.7.2010**

Location	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
109	0	75	26	705	ND	3	Y	Y	Y	DO
110	0	75	29	866	ND	4	Y	Y	Y	DO
111	14	76	28	883	ND	5	Y	Y	Y	DO, WD plaster, Boxes blocking exhaust vent
114	0	73	31	1085	ND	6	Y open	Y	Y	DO
115	30	76	30	1024	ND	5	Y	Y	Y	DO
117	4	75	20	571	ND	6	Y	N	N	Efflorescence/plaster
204	21	78	28	1099	ND	2	Y	Y	Y	Old dish washer w/ dry trap
205	23	77	29	849	ND	3	Y	N	Y	1 AT, Plants, PF, Wall subdivides supply from exhaust
206A	0	78	26	888	ND	2	Y	Y	N	
206B	0	78	26	863	ND	2	Y	N	Y	
207	0	78	27	683	ND	2	Y	Y	N	1 MT, Wall subdivides supply from exhaust

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Location: Pickering Middle School | **Indoor Air Results**

Address: 70 Conomo Avenue, Lynn, MA | **Date: 5.7.2010**

Table 1 (continued)

Location	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
208	0	77	25	1038	ND	2	Y Open	Y	Y	DO, WD plaster, Dry erase materials
209	0	76	27	790	ND	3	Y	Y	Y	
210	0	72	20	413	ND	2	Y	Y	Y	DO, WD plaster
211A	0	78	25	888	ND	6	Y	Y	Y	DO, WD plaster
211B	12	77	29	979	ND	3	Y	N	N	DO, PF
214	1	74	27	711	ND	6	Y Open	Y	Y	Exhaust blocked with bookcase
215	0	76	26	795	ND	2	Y open	Y	Y	Broken window, Clutter
217	0	74	24	671	ND	2	Y	Y	Y	DO, WD plaster, Broken window

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