INDOOR AIR QUALITY ASSESSMENT

Duxbury Middle School
71 Alden Street
Duxbury, Massachusetts 02332

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

In response to an anonymous request, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at Duxbury Middle School (DMS), 71 Alden Street, Duxbury, Massachusetts. On October 26, 2009, Cory Holmes and James Tobin, Environmental Analysts/Inspectors in BEH's Indoor Air Quality (IAQ) Program visited the DMS to conduct an assessment. During the assessment, BEH staff were accompanied by Don Burgess, Facilities Manager, Duxbury Public Schools (DPS).

The DMS is a red, brick building built in 1961. An addition was made in 1974. The DMS is comprised of a two-story classroom wing and several single-story wings that form a courtyard. The school contains general classroom, science classrooms, smaller educational classrooms for specialized instruction, a computer room, two gymnasiums, locker rooms, kitchen/cafeteria, library, auditorium and music/band rooms. The majority of building components are original (floors, ceilings, mechanical ventilation components). Windows are openable, however, many are reported to be in disrepair or inoperable.

Due to previous IAQ concerns, the DPS hired an environmental consultant, Envirotest Lab, Inc. (ELI), in January 2009 to conduct an evaluation of the DMS Guidance Department. The ELI report recommended that: 1) all roof leaks be repaired; 2) all moisture damaged ceiling tiles be replaced; and 3) the water damaged sheetrock wall between the library and guidance department be replaced (ELI, 2009).

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. MDPH 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 school houses approximately 800 students in grades 6 to 8 with approximately 80 staff members. Tests were taken during normal school operations 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 39 of 76 areas at the time of the assessment, which indicates poor air exchange in more than half of the areas surveyed, mainly due to deactivated/non-functional mechanical ventilation equipment. It is also important to note that several classrooms had open windows and/or were empty/sparsely populated, which typically reduces carbon dioxide levels. Carbon dioxide levels would be expected to be higher with full occupancy and/or windows closed.

Fresh air is supplied to most classrooms by unit ventilators (univent) systems (Pictures 1 through 3). A univent draws air from the outdoors through a fresh air intake located on the exterior wall of the building or from rooftop vents (Pictures 4 and 5). Return air from the classroom is drawn through an air intake located at the base of the unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. A number of univents appeared to be original equipment, approximately 40 to 50 years old. Univents of this age are difficult to maintain because replacement parts are often unavailable.

Univents have control settings of ‘on or off’ and ‘low, medium or high’ (Picture 6). Univents were found ‘off’ in many areas (Table 1/Picture 6); therefore, there was no means to provide mechanical ventilation to these classrooms at the time of the assessment. In several cases, univent fresh air intakes were sealed on the exterior of the building with plywood or cardboard and duct tape (Pictures 7 and 8). In order for univents to provide fresh air as designed, intakes/returns must remain free of obstructions. Importantly, these units must remain ‘on’ and be allowed to operate while rooms are occupied.

Exhaust ventilation in classrooms is provided by wall or ceiling vents ducted to rooftop motors (Pictures 9 and 10). Many exhaust vents were obstructed (Picture 11) and/or deactivated at the time of the assessment. As with univents, in order to function properly, exhaust vents must be activated and allowed to operate while rooms are occupied. Without adequate supply and exhaust ventilation, excess heat and environmental pollutants can build up and lead to indoor air/comfort complaints.

The heating, ventilating and air conditioning (HVAC) systems for interior rooms and common areas (e.g., gymnasium, locker rooms, auditorium) consist of rooftop or ceiling-mounted air-handling units (AHUs) (Pictures 12 and 13). Fresh air is distributed via ceiling-mounted air diffusers (Picture 14) and ducted back to AHUs via ceiling or wall-mounted return vents (Pictures 15 and 16). Several of these units had been deactivated or were inoperable at the time of the assessment; therefore, there was no means of mechanical air exchange in these areas, which was evidenced by the elevated carbon dioxide levels. Of particular note was the lack of mechanical ventilation in interior rooms without windows (e.g., guidance suite, 418, 522, 518). Since these areas cannot open windows they are entirely dependant on mechanical ventilation for air exchange. At the time of the assessment, Mr. Burgess reported that he believed a fuse was out that controlled the unit. In subsequent correspondence with Mr. Burgess, he reported that the fuse had been replaced and the AHU reactivated.

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 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 date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 15 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 and Relative Humidity

Temperature measurements ranged from 66^{o} F to 76^{o} F, which were within the MDPH recommended comfort range in the majority of areas surveyed (Table 1). 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. A number of occupants reported difficulty with temperature control. 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. In addition, it is difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., univents/exhaust vents deactivated/obstructed).

The relative humidity measured in the building ranged from 30 to 46 percent, which was below the MDPH recommended comfort range in many of the areas surveyed (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

In order for building materials to support mold growth, a source of water exposure is necessary (e.g., roof/plumbing leaks). Identification and elimination 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. Numerous areas had water-damaged/missing ceiling tiles which can indicate leaks from either the roof or plumbing system (Pictures 17 through 19/Table 1). Active leaks were evidenced by moistened ceiling tiles along the exterior wall in room 411. Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired.

BEH staff also conducted moisture testing of water-damaged wallboard in the upper library, which was found to have elevated moisture content. Mr. Burgess reported that the library roof had been repaired over the summer of 2009. Chronic leakage was observed in the form of water damaged ceiling tiles and peeling vinyl wallpaper (Pictures 19 through 21). Although the leak has been repaired, the vinyl wall paper acts as a vapor barrier, trapping moisture behind it, causing it to peel, damaging wallboard beneath it and promoting mold growth. At the time of the assessment, BEH staff recommended that the damaged wallpaper and moistened wallboard be removed using the US Environmental Protection Agency (US EPA) guidance “Mold Remediation in Schools and Commercial Buildings”. In subsequent correspondence with Mr. Burgess, he reported that removal/replacement of the water damaged wallboard in the library was scheduled for the Veterans Day 2009 break.

It is important to note that moisture content of materials measured is a real-time measurement of the conditions present in the building at the time of the assessment. Repeated water damage to porous building materials (e.g., wallboard, ceiling tiles, and carpeting) 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.

During the assessment, Mr. Burgess reported that several weeks previous to the assessment, mold growth was observed on a flexible cloth covered wall in room 212. At the time of the assessment, the flexible wall had been removed and replaced with a solid, floor to ceiling, paneled wall (Pictures 22 and 23). No current evidence of water damage or mold was observed during the MDPH assessment.

BEH staff examined the building exterior to identify breaches in the building envelope that could provide a source of water penetration. Several potential sources were identified:

- Overgrown plants/trees/bushes against the building throughout the courtyard and around the perimeter of the building (Pictures 24 through 27)
- Plants growing in close proximity to fresh air intakes (Picture 27)
- Missing/damaged sealant between expansion joints and masonry (Picture 28);

- Missing/damaged sealant around univent air intakes (Picture 29);
- Damaged/corroded exterior metal doors (Pictures 30 and 31);
- Clinging plants on exterior brick (Picture 32); and,
- Severely damaged/missing exterior caulking around windows, which in some cases has resulted in moss growth both outside and *inside* window panes (Pictures 33 through 38).

The conditions listed above can undermine the integrity of the building envelope and create/provide a means of water entry by capillary action into the building through exterior walls, foundation concrete and masonry (Lstiburek & Brennan, 2001). The freezing and thawing action of water during the winter months can create cracks and fissures in the foundation. In addition, they can serve as pathways for insects, rodents and other pests into the building. In subsequent correspondence with Mr. Burgess, he reported that windows were resealed in the interior courtyard.

Plants were noted in several classrooms. Plants can be a source of pollen and mold, which can be respiratory irritants for some individuals. Plants should be properly maintained and equipped with drip pans to prevent water damage to porous building materials, which can lead to mold growth. Plants should also be located away from ventilation sources (e.g., air intakes, univent diffusers) to prevent the entrainment and/or aerosolization of dirt, pollen or mold.

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 school 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 non-detect (ND) (Table 1). No measurable levels of carbon monoxide were detected inside the building (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/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 μg/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 were measured at 7 μg/m^3 (Table 1). PM2.5 levels measured indoors ranged from 1 to 25 μg/m^3 (Table 1), which were below the NAAQS PM2.5 level of 35 μg/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 schools 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, cooking in the cafeteria stoves and microwave ovens; 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 quality can also be negatively influenced by the presence of materials 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 and common areas for products containing these respiratory irritants.

The majority of classrooms contained dry erase boards and related materials. Materials such as 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. One classroom had a number of cans of spray paint in a sink cabinet accessible to students (Picture 39). Spray paints contain VOCs that can be irritating and are flammable as well, therefore, should be located in an area inaccessible to students.

Several areas that contain photocopiers and laminators are not equipped with local mechanical exhaust ventilation to help reduce excess heat and odors (Table 1). Lamination machines melt plastic and give off odors and VOCs. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992).

Plug in air deodorizers and other scented materials (i.e., reed/oil diffusers) were observed in some areas (Table 1/Pictures 40 and 41). Air deodorizers can contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Furthermore, deodorizing agents do not remove materials causing odors, but rather mask odors that may be present in the area.

In an effort to reduce noise from sliding desks/chairs, tennis balls had been sliced open and placed on the base of the legs (Table 1). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause VOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997).

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. In several classrooms, items were observed on the floor, windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms 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.

Accumulated dusts/debris and cobwebs were seen in classrooms and other areas throughout the school (Table 1).

A number of air diffusers, exhaust/return vents and personal fans (Picture 14 through 16 and 42) were observed to have accumulated dust. If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize accumulated dust particles. Re-activated univents and fans can also aerosolize dust accumulated on vents/fan blades.

Filters are reportedly changed once per year, which may be less frequent than recommended by the manufacturer. It has been the experience of BEH IAQ staff that most schools change filters 2 to 4 times per year, usually during school vacations. Changing filters can enhance the univents efficient removal of particles from the airstream.

An accumulation of chalk dust and dry erase particulate was observed in some classrooms (Picture 43). When windows are opened or univents are operating, these materials can become airborne. Once aerosolized, they can act as irritants to eyes and the respiratory system.

The unused shower area of the boy's locker room was being used for storage. The shower room has drains are equipped with traps. Without regular water input, the traps for these drains can dry out which can lead to sewer gas odors penetrating the room through unsealed traps. Sewer gas odors can be irritating to the eyes, nose, and throat.

Finally, piles of wood dust and debris were observed on wood cutting machines and flat surfaces in the wood shop. It appeared that the room contains a local exhaust system dedicated to collecting dust from equipment, however, at the time of the assessment a shop-vac was set up to draw wood dust to exhaust out of an exterior door (Pictures 44 and 45), which can lead to security issues.

During the assessment, BEH staff found damaged insulation material that likely contained asbestos. The presence of this material and the recommendation to encapsulate it by a licensed asbestos remediation firm was documented in a letter released subsequent to the MDPH inspection (Appendix B).

Recommendations

The conditions related to indoor air quality problems at the DMS raise a number of issues. The general building conditions, maintenance, work hygiene practices and the condition of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further degrade 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. It is important to note that DPS has reportedly hired an architectural firm to complete a building-wide feasibility study of the DMS addressing current and future needs of the building. [Note: DPS has reportedly submitted a statement of interest to the Massachusetts School Building Authority (MSBA) as a first step to address future needs.]

For these reasons, a two-phase approach is required for remediation. The first consists of **short-term** measures to improve air quality and the second consists of **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

The following **short-term** measures should be considered for implementation:

1. Examine each univent and AHU for function. Consider consulting an HVAC engineer concerning the calibration of univent fresh air control dampers throughout the school.

2. Operate all ventilation systems throughout the building (e.g., gymnasium, locker rooms, cafeteria, classrooms) continuously during periods of school occupancy. To increase airflow in classrooms, set univent controls to “high”.

3. Inspect exhaust motors and belts for proper function. Repair and replace as necessary.

4. Remove all blockages from univents and exhaust vents to ensure adequate airflow.

5. Close classroom doors to maximize air exchange.

6. Increase filter changes for HVAC equipment (e.g., univents, AHUs and ACs). Filter changes for HVAC equipment should be changed as per the manufacturer’s instructions or more frequently if needed. Vacuum interior of units prior to activation 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.

7. Use openable windows in conjunction with classroom univents and exhaust vents to increase air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.

8. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).

9. 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).

10. Ensure roof/window/plumbing leaks are repaired and remove/replace any remaining water-stained ceiling tiles.

11. Move plants along the exterior of univent air intakes approximately 5-feet to prevent entrainment of pollen, moisture or mold.

12. Remove clinging plants from exterior walls.

13. Remove moss growth from window sills, clean and disinfect.

14. Seal window panes and frames to prevent water penetration drafts and pest entry.

15. Seal spaces in masonry/joints and univent fresh air intakes.

16. Contact a masonry firm or general contractor to repair holes/breaches in exterior walls to prevent water penetration, drafts and pest entry.

17. Make repairs to exterior doors to seal holes.

18. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

19. Clean personal fans, univent air diffusers, return vents and exhaust vents periodically of accumulated dust.

20. Clean chalkboards and dry erase board trays regularly to avoid the build-up of particulates.

21. Consider providing local exhaust ventilation for photocopiers and laminations machines, or relocate to an area with mechanical ventilation.

22. Restore operation of the local wood dust collection system in the wood shop, make repairs as needed. Ensure that excess wood dust is cleaned after completion of projects.

23. Ensure flammable products (e.g., spray paints) are stored in proper cabinets inaccessible to students.

24. Cap abandoned plumbing fixtures in locker rooms (sinks, showers, water fountains) or ensure water is poured into the drains every other day (or as needed) to maintain the integrity of the traps.

25. Refrain from using air fresheners and deodorizers to prevent exposure to VOCs.

26. For more advice on mold please consult the document "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html.

27. Consider adopting the US EPA (2000) document, "Tools for Schools", as an instrument for maintaining a good indoor air quality environment in the building. This document is available at: http://www.epa.gov/iaq/schools/index.html.

28. 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://www.state.ma.us/dph/MDPH/iaq/iaqhome.htm.

The following **long-term** measures should be considered:

1. Contact an HVAC engineering firm for an assessment of the ventilation system's control system (e.g., controls, air intake louvers, thermostats). Based on the age, physical deterioration and availability of parts for ventilation components, such an evaluation is necessary to determine the operability and feasibility of repairing/replacing the equipment.
2. Consider having exterior walls re-pointed and waterproofed to prevent water intrusion. This measure should include a full building envelope evaluation.
3. Consider replacing window systems to prevent air infiltration and water penetration.
4. Replace damaged exterior doors.
5. Consideration should be made for a full roof replacement to prevent chronic leaks.
6. Consider creating a centralized location of heat/odor producing office equipment (e.g., photocopiers/lamination machines) equipped with local exhaust ventilation.

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Picture 1

1960's Vintage Univent

Picture 2

1970's Vintage Univent

Picture 3

Ceiling-Mounted Univent

Picture 4

Univent Fresh Air Intake

Picture 5

Univent Fresh Air Intakes Covered with Metal Hoods

Picture 6

Univent Control Switches, Note Unit Switched to the "Off" Position

Picture 7

Univent Fresh Air Intake (in courtyard) Sealed With Plywood

Picture 8

Univent Fresh Air Intake (along front of building) Sealed With Cardboard and Duct Tape

Picture 9

Ceiling-Mounted Exhaust Vent

Picture 10

Wall-Mounted Exhaust Vent

Picture 11

Exhaust Vent Obstructed by Classroom Furniture

Picture 12

Rooftop AHUs

Picture 13

Ceiling-Mounted AHU in Gym

Picture 14

Ceiling-Mounted Supply Diffuser, Note Accumulated Dust/Debris

Picture 15

Ceiling-Mounted Return Vent, Note Accumulated Dust/Debris

Picture 16

Wall-Mounted Return Vent, Note Accumulated Dust/Debris

Picture 17

Water Damaged Ceiling Tiles in Classroom

Picture 18

Water Damaged Ceiling Tiles

Picture 19

Water Damaged Ceiling Tiles, Wallboard and Peeling Vinyl Wall Paper in the Upper Library

Picture 20

Water Damaged Wallboard and Peeling Vinyl Wall Paper in the Upper Library

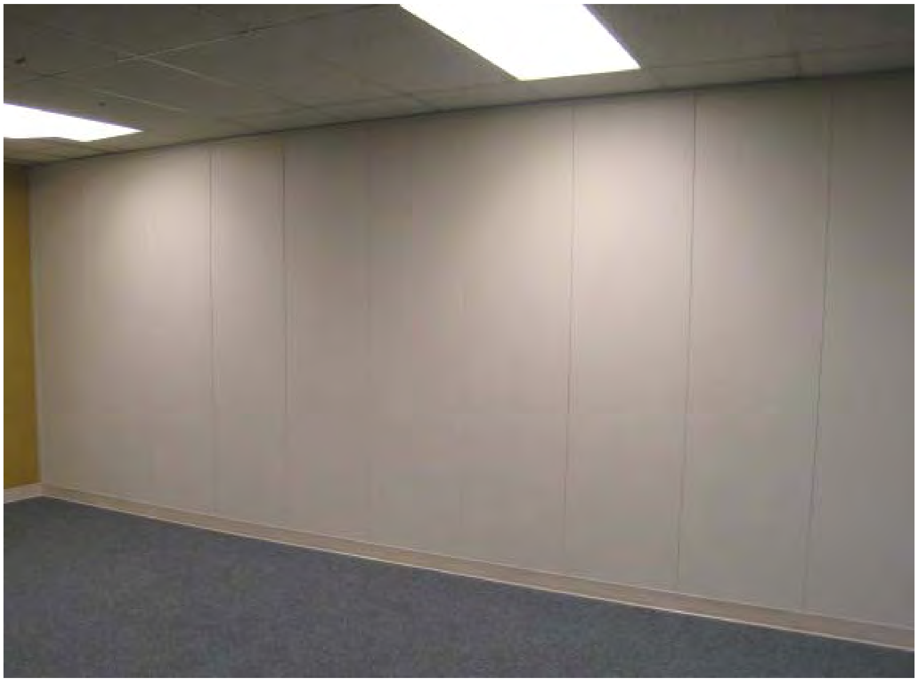
Picture 21

Close-Up of Water Damaged Wallboard in Upper Library

Picture 22

“New” Floor to Ceiling Paneled Wall in Classroom 212

Picture 23



“New” Floor to Ceiling Paneled Wall in Classroom 212

Picture 24

Overgrown Plants/Shrubs/Trees against Exterior Walls in Courtyard

Picture 25

Overgrown Plants/Shrubs/Trees against Exterior Walls in Courtyard

Picture 26

Over Grown Shrubs/Plants against Exterior Wall

Picture 27

Overgrown Shrubs against Exterior Wall in Courtyard, Note Fresh Air Intake for Univent

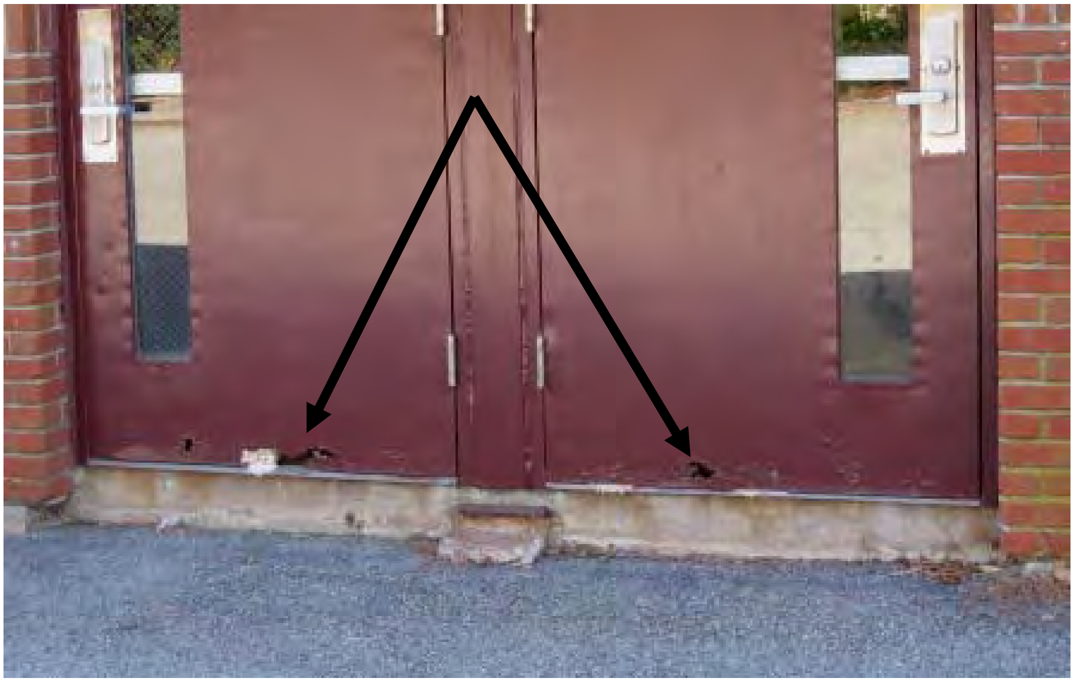
Picture 28

Missing Damaged Sealant in Expansion Joint, Pen Inserted by BEH to Show Depth

Picture 29

Missing Damaged Sealant around Univent Air Intake

Picture 30



Damaged/Corroded Metal Exterior Doors

Picture 31

Close-Up of Damaged/Corroded Metal Exterior Doors

Picture 32

Clinging Plants on Exterior Brick

Picture 33

Loose Caulking on Exterior Window Sill

Picture 34

Severely Damaged/Missing Caulking around Exterior Windows

Picture 35

Severely Damaged/Missing Caulking around Exterior Windows

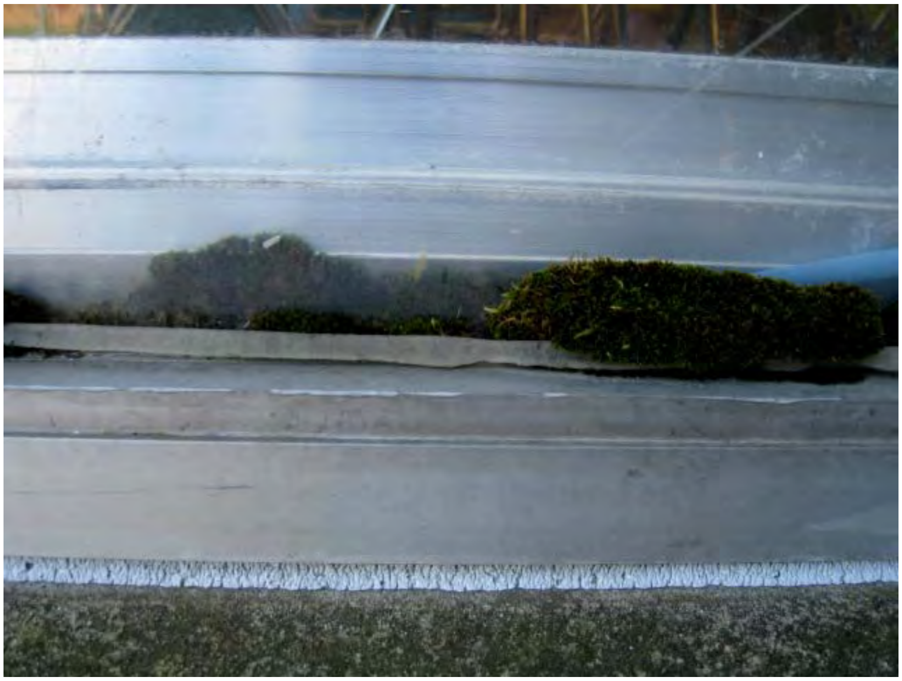
Picture 36

Severely Damaged/Missing Caulking around Exterior Window Frame

Picture 37

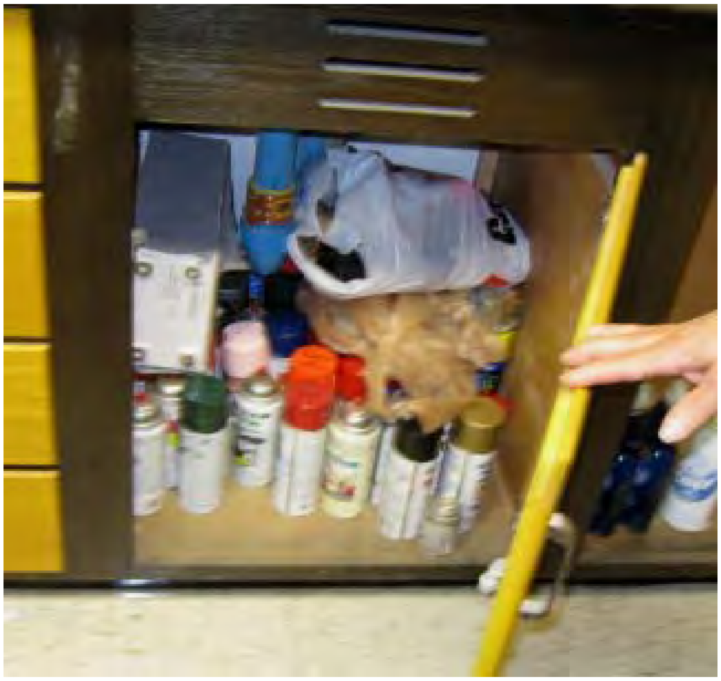
Moss Growth Inside Window Pane

Picture 38



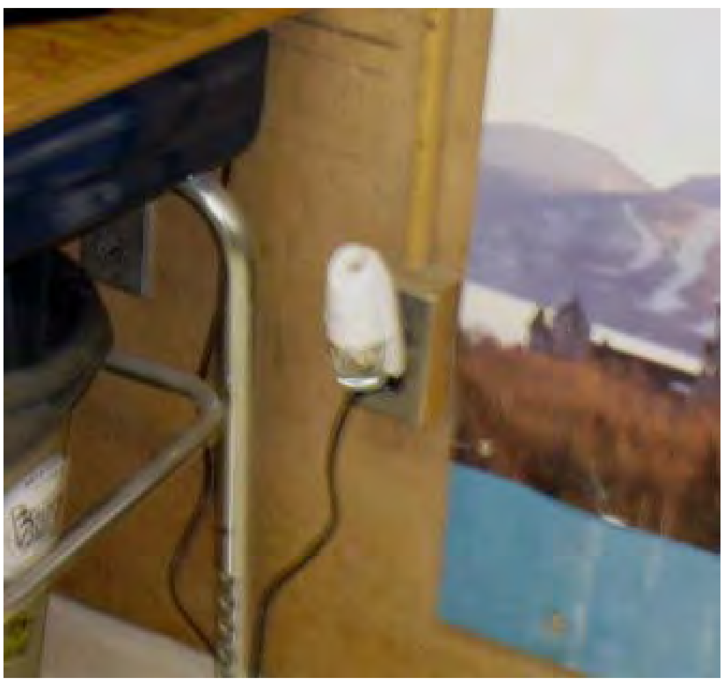
Moss Growth Inside and Outside of Window Pane

Picture 39



Multiple Cans of Spray Paint in Classroom Cabinet under Sink

Picture 40



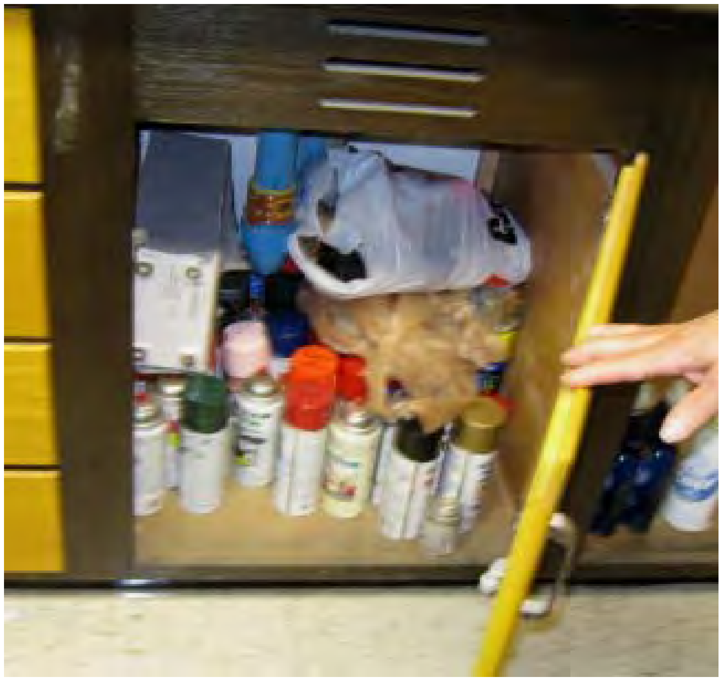
Plug-in Air Deodorizer

Filename: DuxDMS09
Directory: L:\IAQwebsiteready\December2009\December 21, 2009
Template: C:\Documents and Settings\GTocco\Application Data\Microsoft\Templates\Normal.dot
Title: INDOOR AIR QUALITY ASSESSMENT - Duxbury Middle School
Subject: In response to an anonymous request, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at Duxbury Middle School (DMS), 71 Alden Street, Dux
Author: MDPH - Indoor Air Quality Program
Keywords:
Comments:

Creation Date: 12/29/2009 10:33:00 AM
Change Number: 38
Last Saved On: 2/24/2010 10:45:00 AM
Last Saved By: GTocco
Total Editing Time: 220 Minutes
Last Printed On: 2/24/2010 10:46:00 AM
As of Last Complete Printing
Number of Pages: 42 (approx.)
Number of Words: 7,138 (approx.)
Number of Characters: 36,480 (approx.)

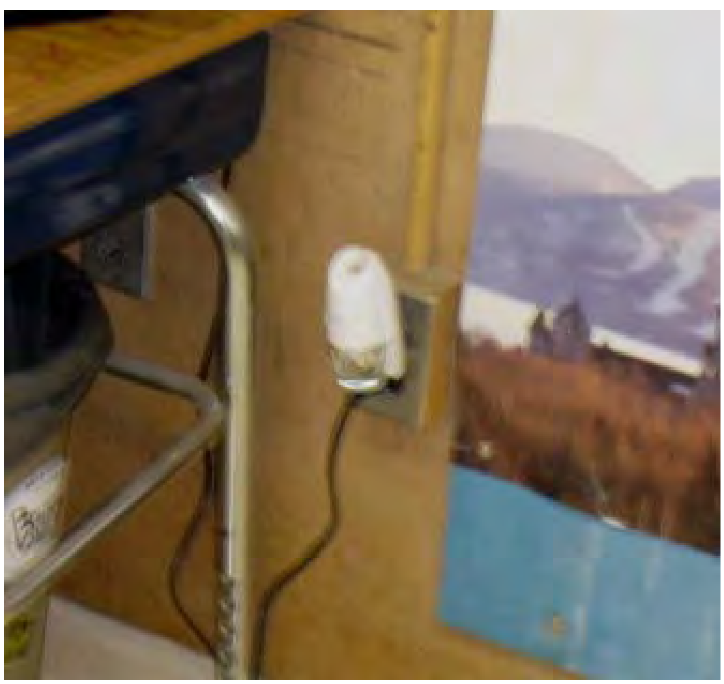
Moss Growth Inside and Outside of Window Pane

Picture 39



Multiple Cans of Spray Paint in Classroom Cabinet under Sink

Picture 40

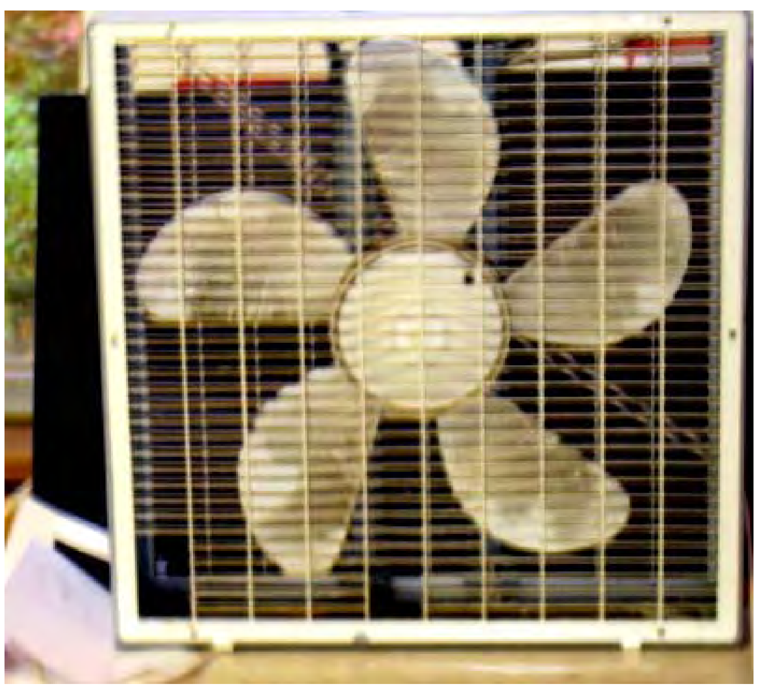


Plug-in Air Deodorizer

Picture 41

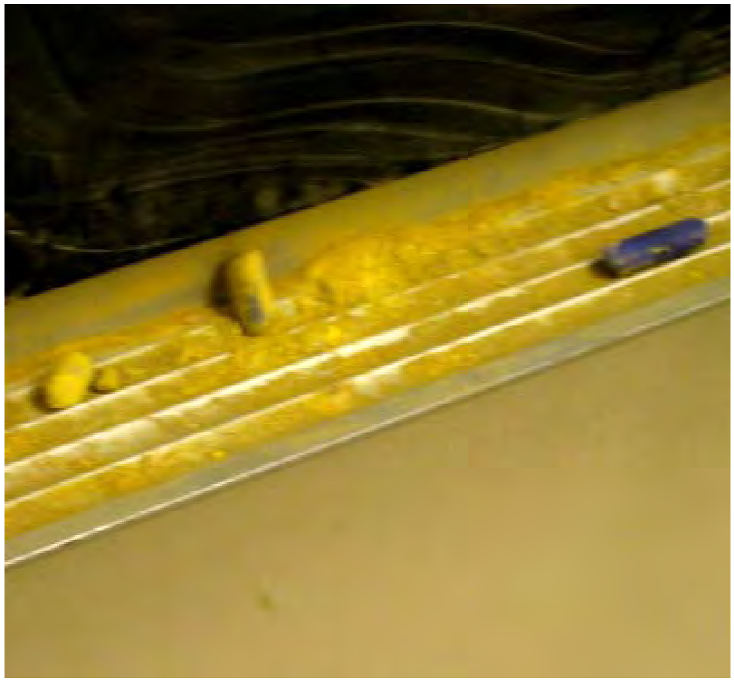
Reed/Oil Deodorizer

Picture 42



Personal Fan in Classroom with Accumulated Dust/Debris on Fan Blades

Picture 43



Accumulated Chalk Dust

Picture 44

Shop-Vac in Wood Shop with Exhaust Hose in Open Exterior Door

Picture 45

Exhaust Hose from Shop-Vac (in Wood Shop) in Open Exterior Door

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

Address: 71 Alden Street, Duxbury, MA **Table 1** **Date: 10/26/2009**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
background		53	46	364	ND	7				Cool, sunny
320	2	75	32	807	ND	6	Y Open	Y	Y	22 occupants gone ~5 mins, 2 WD CTs, DO, TB, PF
321	22	75	33	702	ND	3	Y Open	Y	Y	Heat complaints, DO
322	1	73	37	735	ND	4	Y	Y	Y	22 occupants gone ~15 mins, 5 WD CTs
Prep Room					ND	2	N	Y	Y	3 WD CT
324	24	75	37	853	ND	2	Y	Y	Y	DO, 3 WD CT, 4 Damaged CT
315	22	75	40	1073	ND	6	Y	Y	Y off	8 WD CT, TB, DO, cobwebs/acuum dust debris corners
314	18	76	40	1231	ND	6	Y	Y	Y off	Exhaust off, TB, WD CTs
312	26	75	36	885	ND	4	Y	Y	Y	TB, 3 WD CT, PF, DO, exhaust-dust/debris

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect
UV = univent
AC = air conditioner
aqua. = aquarium
MT = missing tile
CT = ceiling tile
DEM = dry erase materials
DO = door open
PC = photocopier
PF = personal fan
TB = tennis balls
terra. = terrarium
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%
Particle matter 2.5 < 35 ug/m^3

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

Address: 71 Alden Street, Duxbury, MA **Date: 10/26/2009**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
311	0	76	36	751	ND	4	Y	Y	Y	DO, 4 WD CT
412	0	71	32	452	ND	1	Y	Y	Y	Classroom unoccupied, divider wall removed/replaced due to mold growth, tile mastic around floor tiles
411	4	71	38	784	ND	3	Y	Y off	Y off	UV and exhaust off, WD CT-High moisture (damp) active leak near windows
410	0	71	35	584	ND	3	N	Y	Y	Dusty CTs around supply vent
Library Upper					ND			Y	Y	WD CTs previous roof leak-reportedly repaired summer 09, WD peeling vinyl wallpaper, moistened wallboard beneath wallpaper under WD CTs
418	0	71	38	784	ND	3	Y	Y off	Y off	Supply and exhaust off, 8 WD CTs-dry/low moisture, rusty metal ceiling rails
Teacher's Lounge	9	73	36	754	ND	6	N	Y off	Y off	Supply and exhaust off, dust-ceiling
Guidance Main	3	73	37	758	ND	5	N	Y off	Y off	Supply and exhaust off

ppm = parts per million
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Relative Humidity: 40 - 60%
Particle matter 2.5 < 35 ug/m^3

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Guidance Conf Room	8	73	42	1154	ND	6	N	Y off	Y off	Supply and exhaust off, DEM odors
Guidance Corbin Office	0	73	39	845	ND	5	N	Y off	Y off	Supply and exhaust off
99	18	72	40	1128	ND	4	Y	Y	Y off	Exhaust off, TB
101	2	70	36	700	ND	3	Y	Y	Y	DO, plants
103	0	70	40	943	ND	5	Y	Y off	Y	Supply off, occupants at lunch, plug-in air freshener
105	27	71	42	1074	ND	5	Y Open	Y	Y	Window broken-open/duct tape, PF, items on UV
107	27	71	46	1280	ND	3	Y	Y	Y	TB, DO
109	0	71	46	1746	ND	3	Y	Y	Y	Occupants at lunch, exhaust blocked with poster, mastic around floor tiles, exposed pipe insulation near UV possible asbestos-recommended encapsulation

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect
UV = univent
AC = air conditioner
aqua. = aquarium
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DEM = dry erase materials
DO = door open
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Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems	Particle matter 2.5	< 35 ug/m^3

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

Address: 71 Alden Street, Duxbury, MA **Date: 10/26/2009**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
201	1	73	36	985	ND	6	Y	Y off	Y off	UV and exhaust off, UV reportedly deactivated due to noise
202	0	74	42	1213	ND	25	Y	Y off	Y off/weak	UV off, exhaust off/weak, DO
Auditorium	0	71	35	430	ND	2	N	Y	Y	
422	1	74	30	632	ND	3	Y	Y	Y	Stored items on UV; DEM; DO
323	1	73	32	662	ND	4	Y	Y	Y	Exhaust near door to prep room; DEM
325	25	73	33	819	ND	4	Y 1 open	Y	Y	DO
313	23	73	37	954	ND	5	Y	Y	Y	Exhaust near door to prep room; AT; DEM; DO; TB
312/313 prep	0	73	35	849	ND	4	N	Y	Y	
409	0	71	30	548	ND	3	N	Y		Debris/dust on vents; DEM; 2 DO; PF

ppm = parts per million
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ND = non detect
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AC = air conditioner
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%
Particle matter 2.5 < 35 ug/m^3

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

Address: 71 Alden Street, Duxbury, MA **Date: 10/26/2009**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
414	6	74	34	585	ND	3	Y	Y off	Y	DEM; DO; Exterior door
413	24	72	34	772	ND	3	Y	YV on	Y	Stored items on UV; WD CTs above UV; DEM; DO; Exterior door – bees nest
Library		66	46	685	ND	4		Y		WD along windows; PC with no exhaust; vinyl wallpaper
416	0	70	40	694	ND	4	N	Y	N	WD CTs; 2 DO; PF; DEM
522	0	76	33	684	ND	4	N	Y off	Y off dust	Ventilation off; Computer lab; PF; DO
Guidance Main	3	73	33	732	ND	6	N	Y		PC; microwave
Guidance Limmer	0	73	34	752	ND	5	N	Y	N	DO
Guidance Epstein	0	73	38	1082	ND	5	N	Y	N	DO
Guidance Closed Door	0	73	35	717	ND	4	N	Y	N	

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UV = univent
AC = air conditioner
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Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems	Particle matter 2.5	< 35 ug/m^3

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
100	0	71	32	517	ND	3	Y	Y	N	CPs; DEM
102	0	73	33	717	ND	4	Y	Y	Y weak	Plants; DEM; DO; PF
104	0	73	37	1284	ND	6	Y	Y off	Y weak blocked by board	Bags on top of UV; DEM; PF
106	6	73	38	1039	ND	6	Y	N	N	PC; PF; microwave; refrigerator
108	18	73	32	794	ND	4	Y 1 open	Y off	Y weak	
200	4	71	39	875	ND	3	Y	Y off	Y in bathrooms	2 bathrooms with exhaust vents, switch on wall; WD CTs; DEM; DO; microwave
204	0	72	39	918	ND	5	Y	Y off	Y weak	DEM; DO
203	0	72	38	978	ND	5	Y	Y off	Y off	DEM
205	17	73	38	1084	ND	5	Y 1 open	Y off	Y	

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect
UV = univent
AC = air conditioner
aqua. = aquarium
MT = missing tile
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Carbon Dioxide: < 600 ppm = preferred
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> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%
Particle matter 2.5 < 35 ug/m^3

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

Address: 71 Alden Street, Duxbury, MA | **Date: 10/26/2009**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
206	18	73	43	1258	ND	7	Y	Y off	Y weak	PF
207	20	73	40	1474	ND	7	Y	Y off	Y	PF; DEM odor
208	0	72	35	920	ND	7	Y	Y off	Y weak	DO
209	0	72	36	862	ND	5	Y	Y off	Y blocked	Plants on UV; PF; DEM; DO
210	1	72	35	892	ND	4	Y	Y off	Y weak	DEM
520	1	74	33	694	ND	5	N	Y off	Y off	Ventilation off; DO
415	1	75	31	678	ND	5	N	Y off	Y off	Ventilation off
Print Room	1	75	31	675	ND	14	N	Y off	Y off	Ventilation off; debris/dust on ceiling around vents; PC in use; laminator; DO
518	1	74	30	584	ND	9	N	Y off	Y off	Ventilation off; CD; PF; WD CTs; DO

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AC = air conditioner
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DO = door open
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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	Particle matter 2.5	< 35 ug/m^3

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

Address: 71 Alden Street, Duxbury, MA **Table 1 (continued)** **Date: 10/26/2009**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m³)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
General Music	16	71	41	959	ND	6	N	Y off	Y off	Ventilation off; WD CTs; DEM
514	1	71	30	488	ND	4	Y 1 open	Y off	Y off	CPs; DEM; TB
512	0	72	42	1288	ND	9	Y	Y off	Y off	22 occupants gone 1 minute; AD; CPs; DO; microwave; refrigerator; stove
512 therapy OT/PT	0	71	43	1402	ND	8	Y	Y off	Y off	
Band Office	0	71	40	1138	ND	7	N	Y off	Y off	
Band Practice room 1	0	71	41	1242	ND	5	N	Y off	Y off	
Band Practice room 2	0	71	42	1220	ND	5	N	Y off	Y off	
Band Room	0	71	40	1132	ND	8	Y	Y	Y	WD CTs; DEM; space around exterior door
Wood Shop	0	70	36	751	ND	7	Y	Y	Y	Sawdust on equipment, floor and surfaces; portable shop vacuum in use as exhaust; TB; saw exposed

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UV = univent

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aqua. = aquarium
MT = missing tile
CT = ceiling tile

DEM = dry erase materials
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Location: Duxbury Middle School **Indoor Air Results**

Address: 71 Alden Street, Duxbury, MA **Date: 10/26/2009**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m³)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Server Room	0	72	41	858	ND	10	N	Y		Network server; beanbag seats
Kiln Room									Y	Kiln has dedicated local exhaust
136 Art Room	0	72	32	432	ND	2	Y	Y	Y	Space around exterior door
145 Art Room	20	72	38	849	ND	5	Y	Y	Y	Aqua; PF; DO
175	0	72	31	469	ND	5	Y 1 open	Y	Y	DO
Boys Locker Room	0	71	32	481	ND	4	N	Y	Y	Showers used as storage
Lower Gym	20	68	31	420	ND	3	N	Y	Y	2 of 4 exterior doors open
Small Gym	13	69	37	548	ND	4	N	Y	Y	
Gym	0	70	30	428	ND	2	N	Y	Y	
Café	0	70	46	1368	ND	9	Y	2 UVs off	Y	

ppm = parts per million
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ppm = parts per million	AC = air conditioner	DEM = dry erase materials	TB = tennis balls
µg/m^3 = micrograms per cubic meter	aqua. = aquarium	DO = door open	terra. = terrarium
ND = non detect	MT = missing tile	PC = photocopier	WD = water-damaged
UV = univent	CT = ceiling tile	PF = personal fan	

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	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems	Particle matter 2.5	< 35 ug/m^3

Appendix B

The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
Bureau of Environmental Health
250 Washington Street, Boston, MA 02108-4619
Phone: 617-624-5757 Fax: 617-624-5777
TTY: 617-624-5286

DEVAL L. PATRICK
GOVERNOR

TIMOTHY P. MURRAY
LIEUTENANT GOVERNOR

JUDYANN BIGBY, M.D.
SECRETARY

JOHN AUERBACH
COMMISSIONER

November 10, 2009

Tracy L. Mayo, R.S., Health Agent
Town of Duxbury
878 Tremont Street
Duxbury, MA 02332-4499

Dear Ms. Mayo:

As you know, in response to an anonymous complaint, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health's (BEH) Indoor Air Quality (IAQ) Program conducted an IAQ assessment at the Duxbury Middle School (DMS). Concerns about general IAQ, water damage/potential mold growth and exacerbation of respiratory symptoms prompted the request. On October 26, 2009, the building was visited by Cory Holmes and James Tobin, Environmental Analysts/Inspectors in BEH's IAQ Program. During the assessment, BEH staff were accompanied by Don Burgess, Facilities Manager, Duxbury Public Schools.

As part of the assessment, BEH staff examined the building for a variety of conditions related to IAQ. The status of the ventilation system, potential moisture problems/microbial growth and sources of respiratory irritants were examined, the details of which will be discussed in a forthcoming report. The focus of this letter is to address exposed pipe insulation observed during the October 26, 2009 assessment.

At the rear of classroom 109, BEH staff observed damaged/exposed insulation that may contain asbestos around hot water pipes that feed the unit ventilator (univent; Pictures 1 and 2). It appears that the original univent in room 109 (Picture 3) was replaced with a more modern unit (Picture 4). Installation of this new univent required the destruction of the adjacent cabinet for access to hot water pipes feeding the univent. It was unknown at the time of the assessment when this work had occurred. In subsequent conversation with Mr. Burgess, it was reported that this work was conducted approximately 6 years ago as a result of a frozen pipe.

Upon its discovery, BEH staff recommended to Mr. Burgess that the insulation be encapsulated by a licensed member of the Duxbury maintenance staff or an asbestos abatement contractor. At

Appendix B

the time of the assessment, Mr. Burgess reportedly contacted a private contractor to coordinate remediation efforts.

In subsequent communication to Cory Holmes on October 27, 2009, Mr. Burgess reported that the pipe insulation had been sealed by Jonathan Clarke of Jonathan Clarke Plumbing and Heating, Inc., and the cabinet was being rebuilt to prevent access. Mr. Holmes recommended that Mr. Burgess ensure that a professional asbestos remediation firm evaluate Mr. Clark's work and take further action if needed.

Mr. Burgess contacted Mr. Holmes on October 28th to report that Banner Environmental Services Inc. (Banner), a licensed asbestos remediation firm, evaluated the pipes in room 109 and determined that approximately 6 to 9 feet of pipe had asbestos insulation and would have to be remediated. Mr. Burgess reported that Banner would conduct full remediation with containment, with an industrial hygienist present for air monitoring to commence after 3:00 PM Friday October 30th.

On November 2nd, Mr. Burgess again contacted Mr. Holmes to report that the pipes were fully remediated (Pictures 5 and 6). Mr. Holmes asked that reports related to the asbestos remediation be provided to MDPH for its files.

Please feel free to contact us at (617) 624-5757 if you are in need of further information or technical assistance regarding this issue.

Sincerely,

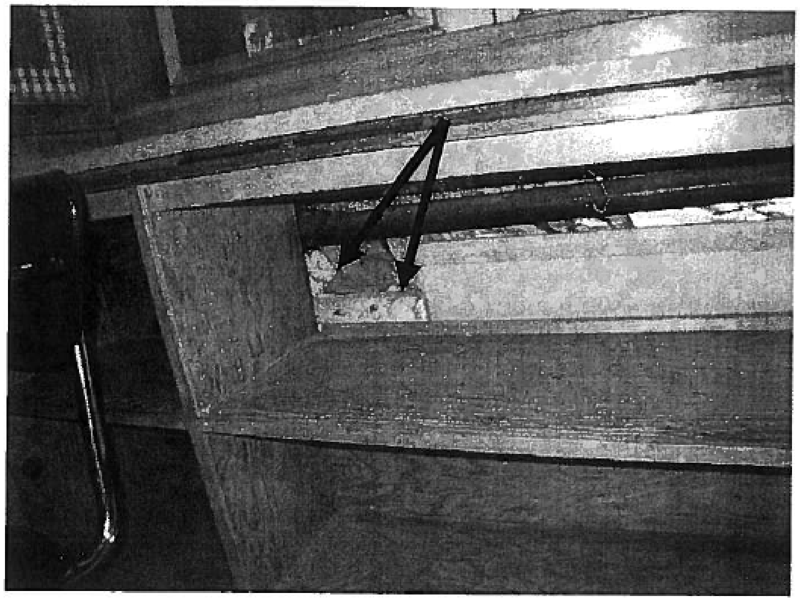
Suzanne K. Condon, Associate Commissioner
Director, Bureau of Environmental Health

cc: Michael A. Feeney, Director, Indoor Air Quality Program, BEH
Susan K. Skeiber, Superintendent, Duxbury Public Schools
Susan Nauman, Business Manager, Duxbury Public Schools
Don Burgess, Facilities Manager, Duxbury Public Schools
Blake Dalton, Principal, Duxbury Middle School
Senator Robert L. Hedlund
Representative Daniel K. Webster

Enclosure(s)

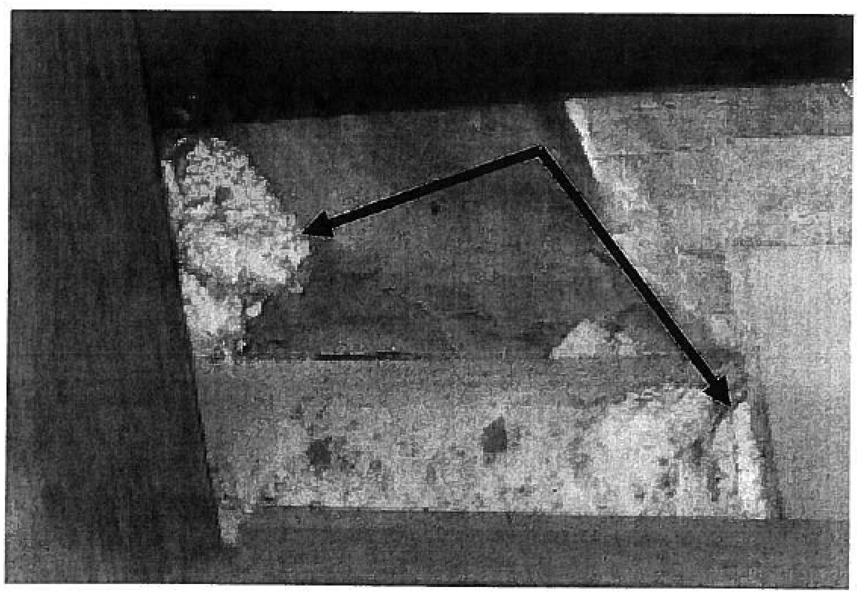
Appendix B

Picture 1



Exposed Pipe Insulation Left Corner of Shelf, Note Back Panel of Cabinet has Been Removed to Access Pipes

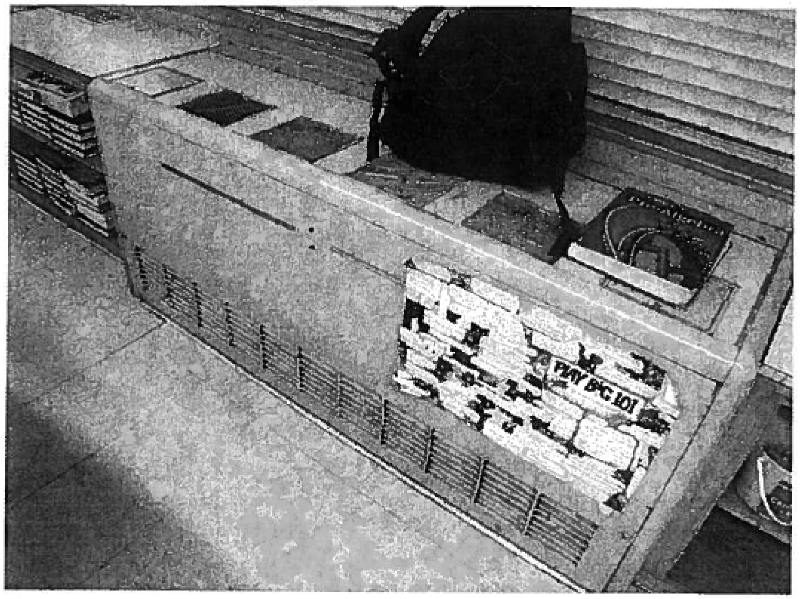
Picture 2



Close-Up of Exposed Pipe Insulation Left Corner of Shelf

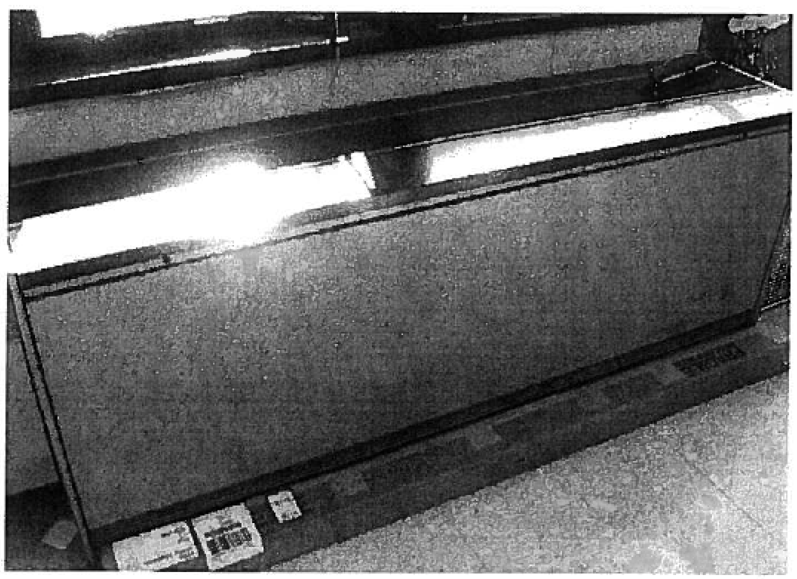
Appendix B

Picture 3



Original 1060's Vintage Univent

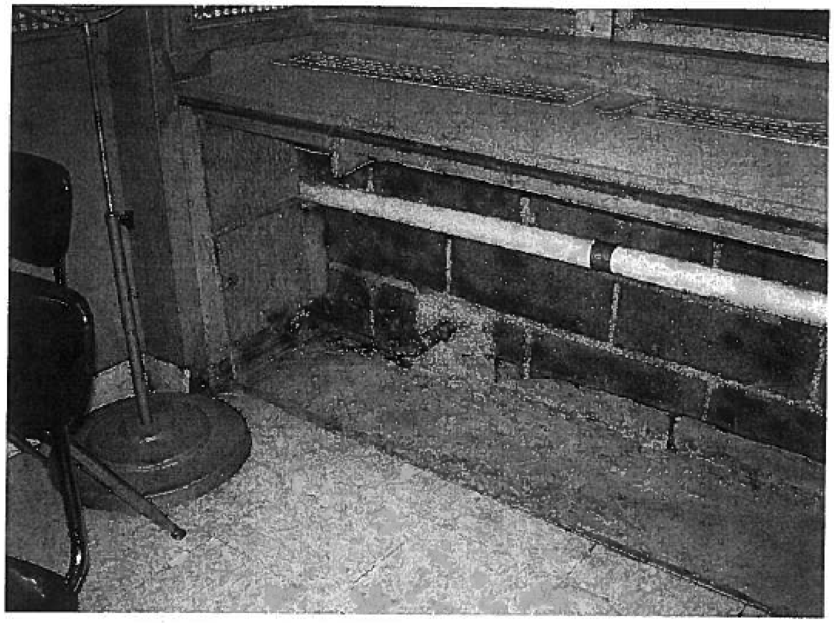
Picture 4



Modern Univent as Seen in Classroom 109

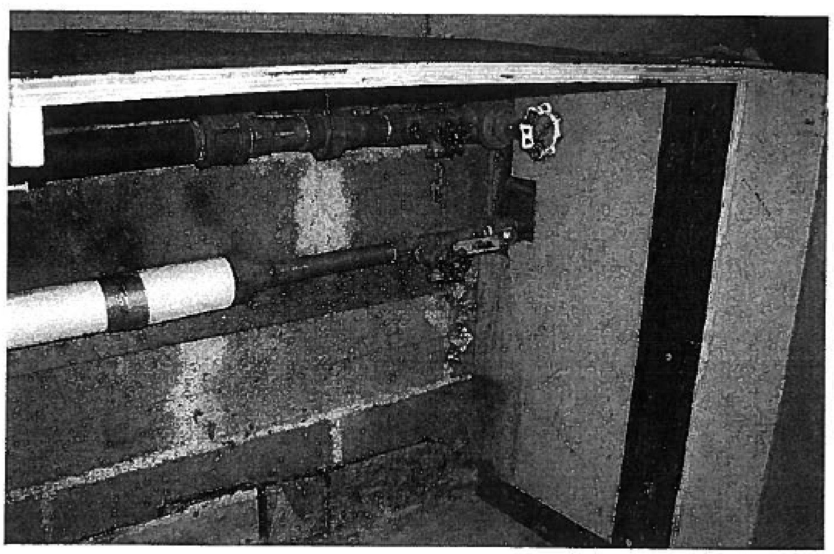
Appendix B

Picture 5



Post-Remediation Picture of Univent Pipes in Classroom 109
(Picture Provided by Don Burgess, Duxbury Public Schools)

Picture 6



Post-Remediation Picture of Univent Pipes in Classroom 109
(Picture Provided by Don Burgess, Duxbury Public Schools)

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Title: INDOOR AIR QUALITY ASSESSMENT - Duxbury Middle School
Subject: In response to an anonymous request, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at Duxbury Middle School (DMS), 71 Alden Street, Dux
Author: MDPH - Indoor Air Quality Program
Keywords:
Comments:

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