INDOOR AIR QUALITY ASSESSMENT

Waterford Street School
62 Waterford Street
Gardner, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Lt. Stephen Cormier of the Gardner Fire Department and Bernie Sullivan of the Gardner Health Department, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Waterford Street School, 62 Waterford Street in Gardner MA. Reports of lingering smoke odors subsequent to a fire at the school prompted the request.

BEHA staff received a call from Lt. Cormier at approximately 10:00 AM the morning of September 12, 2002 to request air quality testing following a small fire that had occurred in the art room (see Figure I) at approximately 7:20 AM. At the time of the call the school had already been evacuated. The school was in the process of being ventilated and cleaned by a professional cleaning company. Due to the cleanup, Gardner Health and School officials decided to postpone reoccupation of the school until the following Monday (September16).

On September 13, 2002, a visit was made to this school by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) program, BEHA, to conduct an indoor air quality assessment. Mr. Sullivan accompanied Mr. Holmes during the assessment.

Methods

In addition to visual inspection for soot deposition, BEHA staff conducted a series of tests for general indoor air quality. Air tests for carbon dioxide, carbon monoxide (CO), temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo

Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). Outdoor carbon monoxide and TVOC levels were taken as comparison values to indoor levels.

Results

The school has a student population of approximately 500 and a staff of approximately 70. The tests were taken while the building was unoccupied, therefore general indoor air quality testing (e.g. carbon dioxide, temperature and relative humidity) do not reflect results that would be expected during normal operations at the school. Test results appear in Tables 1-3.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million (ppm) in all areas surveyed. Exterior doors and windows were open throughout the building, which can significantly reduce carbon dioxide levels. Carbon dioxide levels would be expected to be higher during full occupancy, with doors and windows shut.

Fresh air in classrooms is supplied by a unit ventilator (univent) system. 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 (see Figure 2). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents were operating during the assessment, however, BEHA staff recommended that univents be deactivated temporarily until filters were changed and univents could be cleaned of accumulated soot and dust (see Pictures 1 & 2).

Exhaust ventilation in classrooms is provided by a mechanical system. The exhaust system in each classroom consists of grated wall vents (see Picture 3) connected via ductwork to rooftop motors. The art room exhaust vent in Picture 3 was partially obstructed by a table, which can restrict airflow. This system was operating during the assessment. BEHA staff recommended the opening of windows (while univents were temporarily deactivated) in combination with mechanical exhaust to ventilate classrooms of residual smoke odors.

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 Department of Public Health 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 I.

Temperature readings were measured in a range of 69° F to 78 ° F, which were very close to the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building ranged from 39 to 44 percent, which was also very close to the BEHA recommended comfort range. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels would be expected to drop during the winter months due to heating and decreased outdoor relative humidity concentrations. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Residual Smoke Odors, CO and TVOCs

Smoke odor can result from residue being absorbed by porous materials or by entrapment within texture or cellular surfaces (NIDR, 1997). The smoke residue can continue to emit odors from contaminated materials. In order to assess whether smoke residues were producing irritating chemicals, air sampling was done throughout the building for TVOCs. In all areas surveyed, CO and TVOC levels were equal to or below outdoor air concentrations. However, residual smoke odors were detected in the building.

Residual smoke odors were most prevalent in the art room where the fire had taken place. The most obvious source of lingering odors was the presence of charred materials, which were still present in the room (see Pictures 4 & 5). In addition, numerous porous materials (paper, cloth, cardboard, etc.), which as mentioned can absorb odors, were stored throughout the area (see Pictures 6 & 7). BEHA staff and Mr. Sullivan recommended the removal of charred materials and porous items as soon as possible to eliminate the source of odors.

As discussed, high-powered ventilation fans equipped with high efficiency particulate arrestance (HEPA) filtration were placed throughout the building (see Picture 8) and a thorough cleaning of all classrooms was being conducted during the assessment. This involved wiping and vacuuming of all surfaces (ceiling tiles, walls, etc.) using HEPA filtered vacuum cleaners. Accumulation of soot and particulate deposition on art room surfaces was observed, notably on univent filters, interior components and on areas around the unit ventilator (see Pictures 1 & 2). Unless the interior and exterior of the univent is thoroughly cleaned, residual odors can continue to be emitted from the univent. In addition constant airflow from the univent can reaerosolize soot and particulates, which can be sources of on-going irritation to the eyes, nose and respiratory tract.

Conclusions/Recommendations

In the event that residual smoke odors persist in the building, the following recommendations are made:

1. Ensure univent filters were changed and that the interior and exterior of univent cabinets were thoroughly cleaned. Activate univents continuous during periods of school occupation.

2. Discard any charred and/or smoke damaged materials or if necessary seal in an airtight container. Plastic bags that can be made airtight can be used to seal materials (Zlotnik, C., 1996)

3. Ensure all flat classroom surfaces and the interior of lockers were cleaned and smoke contaminated clothing was removed.

References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

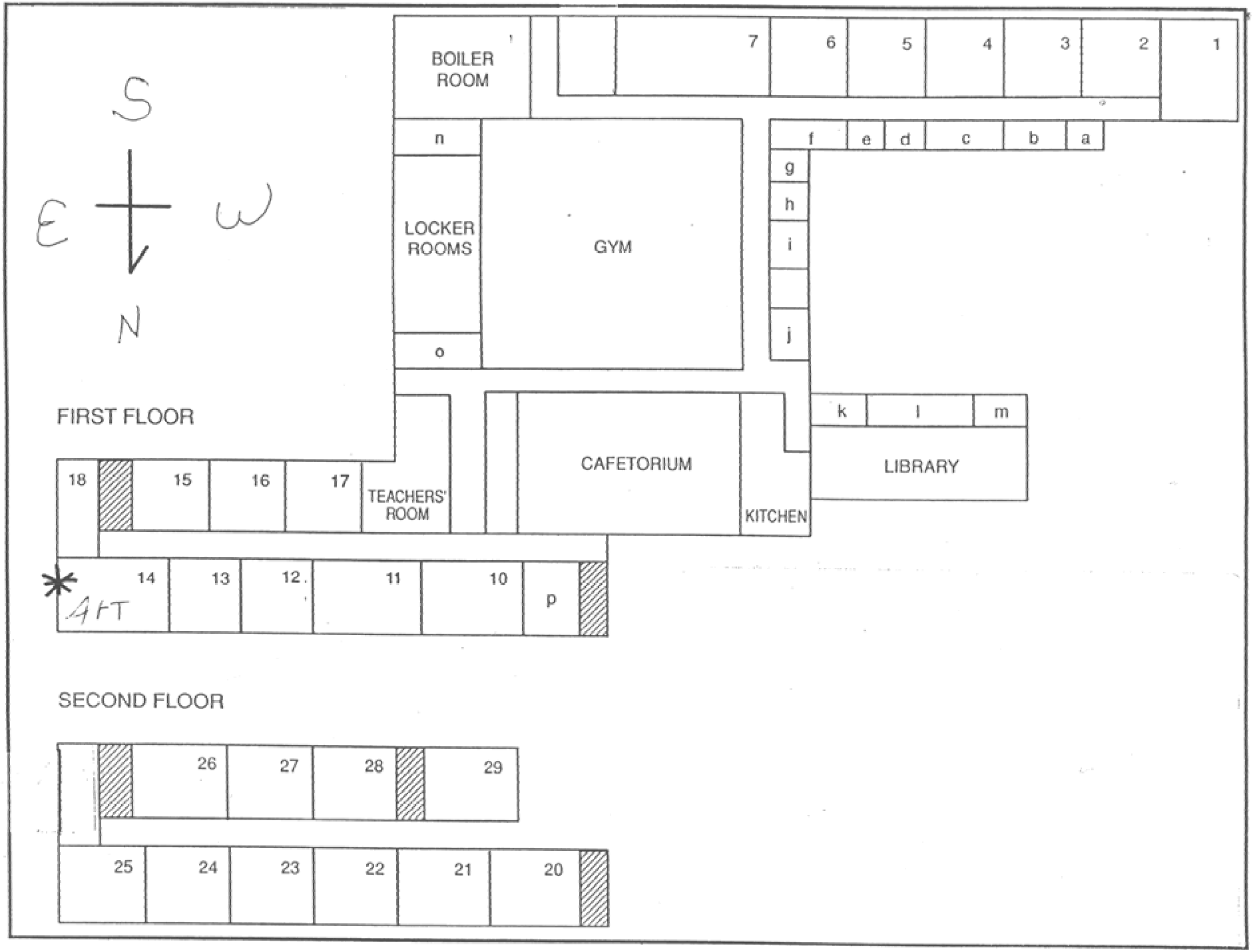
NIDR. 1997. NIDR Guidelines for Fire and Smoke Damage Repair. 1st ed. National Institute of Disaster Restoration, Annapolis Junction, MD.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Zlotnik, C. 1996. Unsmoke (Reg. Copyright) Systems Fire Restoration Technology Manual. Damage Mitigation and Building Restoration for a Healthy Indoor Environment. Mid Atlantic Environmental Hygiene Resource Center, Philadelphia, PA.

Figure 1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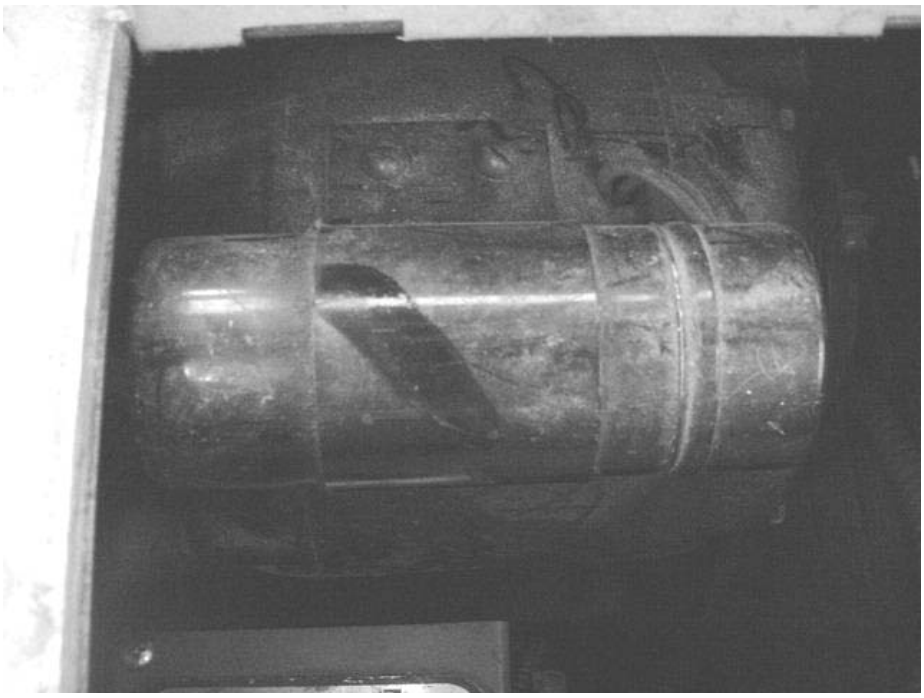
Picture 1



Soot/Dust Accumulation on Motor inside Univent Cabinet

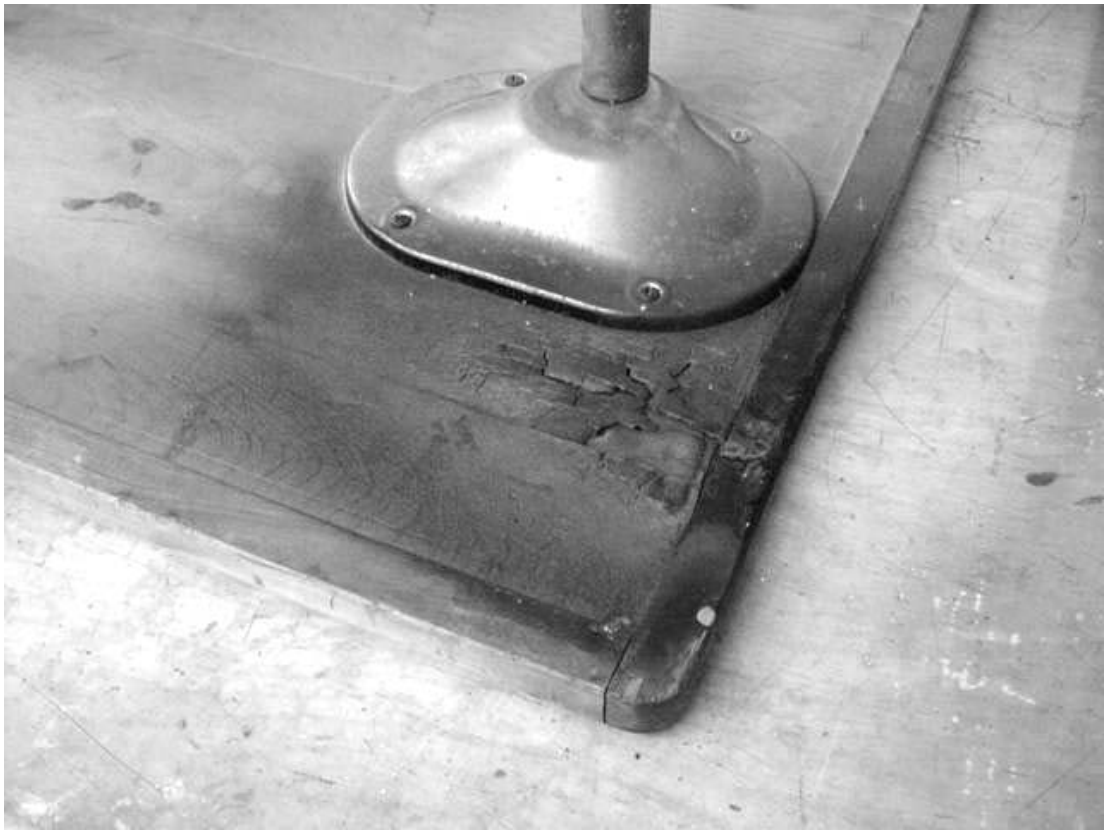
Picture 2

Soot Buildup on Univent Filter as Indicated by Black Line across Filter Medium

Picture 3

Wall Mounted Exhaust Vent in Art Room, Note Vent is Partially Blocked by Table

Picture 4



Charred Table In Art Room

Picture 5

Charred Doors in Art Storeroom

Picture 6

Porous Materials Stored in Art Room Cabinet

Picture 7

Porous Materials Stored in Art Room

Picture 8

Exhaust Fan Equipped With HEPA Filtration

TABLE 1

Indoor Air Test Results – Gardner, Waterford Street School September 13, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	TVOCs *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
								Intake	Exhaust	
Background	341	2	0.0	84	28					Clear, breezy, sunshine
Art Room	348	0-1	0.0	78	32	0	Y	Y	Y	Lots of paper/porous materials, strong residual odors, burnt materials (table, doors) still present in area giving off odors, windows and classroom door open, dust/soot accumulation on flat surfaces and on univent filter
Hallway outside Art Room		0-1	0.0							Exterior doors open
18	372	0-1	0.0	72	40	0	Y	N	Y	Windows open
15	389	0-1	0.0	72	40	0	Y	Y	Y	Windows open
Music	400	0-1	0.0	70	42	0	Y	Y	Y	Windows open
12	417	0-1	0.0	69	43	0	Y	Y	Y	Windows open
17	403	0-1	0.0	72	44	0	Y	Y	Y	Windows open

*** ppm = parts per million parts of air**

Comfort Guidelines **CT = ceiling tiles**

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

TABLE 2

Indoor Air Test Results – Gardner, Waterford Street School September 13, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	TVOCs *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
								Intake	Exhaust	
11	380	0-1	0.0	70	44	0	Y	Y	Y	
Teacher's Room	356	0-1	0.0	70	43	0	Y	Y	Y	
Kindergarten		0-1	0.0	69	43	0	Y	Y	Y	
Cafeteria		0	0.0	70	44	0	Y	Y	Y	
29		0-1	0.0	72	41	0	Y	Y	Y	
20		0-1	0.0	71	42	0	Y	Y	Y	
21		0-1	0.0	71	41	0	Y	Y	Y	Windows open
22		0-1	0.0	72	42	0	Y	Y	Y	
27		0-1	0.0	72	42	0	Y	Y	Y	Windows open
23		0-1	0.0	72	39	0	Y	Y	Y	Windows open
26		0-1	0.0	73	40	0	Y	Y	Y	

*** ppm = parts per million parts of air**

Comfort Guidelines **CT = ceiling tiles**

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

TABLE 3

Indoor Air Test Results – Gardner, Waterford Street School September 13, 2002

Location	Carbon Dioxide *ppm	Carbon Monoxide *ppm	TVOCs *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
								Intake	Exhaust	
Staff Room		0-1	0.0	73	40	0	Y	Y	Y	Windows open
25		0-1		72	39	0	Y	Y	Y	Windows open

*** ppm = parts per million parts of air**

CT = ceiling tiles

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%