HEALTH CONSULTATION:

EVALUATION OF INDOOR ENVIRONMENTAL CONDITIONS AND POTENTIAL HEALTH IMPACTS

New Bedford High School
230 Hathaway Boulevard
New Bedford, MA

Final Report

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Bureau of Environmental Health
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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Executive Summary

This report, *Health Consultation: Evaluation of Indoor Environmental Conditions and Potential Health Impacts, New Bedford High School*, was first released in September 2011 as a draft for Public Comment. The health consultation was conducted in response to environmental health concerns expressed by staff at New Bedford High and Keith Middle Schools and neighbors that live in close proximity to the schools who were concerned about the presence of environmental contaminants, particularly polychlorinated biphenyls (PCBs). Interested parties were given six weeks to submit review comments on the document to the Massachusetts Department of Public Health, Bureau of Environmental Health (MDPH/BEH). MDPH/BEH received approximately 36 pages of detailed comments. MDPH/BEH has prepared a final report which includes revisions, as warranted, based on the comments received. A Response to Comments is provided as an Appendix (G) to this report.

In response to the September 2011 release of the public comment draft of the report, the City of New Bedford reported on a number of steps that had been taken to address MDPH/BEH recommendations. In addition, State Senator Mark C. Montigny and Representative Antonio Cabral asked the MDPH/BEH to return to New Bedford High School on August 17, 2012 to conduct a visual inspection of actions undertaken by the City of New Bedford at the school since the time of the City's response to the September 2011 draft public comment report. Appendix H of the final report contains specifics on what the City reported in its comments on the draft report as well as MDPH/BEH observations from August 2012.

The report has three major components: an indoor air quality assessment of the New Bedford High School (NBHS) including an evaluation of PCB sampling data from inside the high school, a review of information related to health concerns (including cancer) among current and former staff, and an evaluation of serum PCB results from a voluntary testing program that MDPH/BEH offered as a public service. Since the draft report was released for public comment, MDPH/BEH has updated the Health Concerns section of the report to incorporate information on seven additional cancer diagnoses received via emails from a public advocacy group in New Bedford. This information includes newly reported diagnoses as well as clarification on individuals previously reported, e.g., changed spelling of individuals' names previously reported.

In addition, MDPH/BEH has included the review and evaluation of indoor air sampling data for PCBs that were not available at the time of the draft report's release (i.e., data released after September 28, 2011). These new data include results of April and August 2011 (released on October 5, 2011) as well as April and July 2012 (released August 16, 2012) indoor air sampling rounds at the NBHS. Finally, as discussed earlier, MDPH/BEH added Appendix H to the report; this appendix documents actions reported to be completed by the City to address the recommendations made following the MDPH indoor air assessment of the building.

Based upon an exposure assessment assuming a worst case scenario, MDPH/BEH concluded that exposure to PCBs at levels detected at the NBHS would not be expected to present unusual cancer concerns for staff or students in the short- or long-term. For an adult employee, MDPH/BEH assumed that exposure occurred to the maximum concentration of PCBs ever detected in indoor air at NBHS for 8 hours per day for the entire school year for 37 years (the number of years for the longest serving employee). For a student, MDPH/BEH assumed daily exposure to the maximum detected concentration for 8 hours per day for 4 years.

Based upon all information available/provided to MDPH/BEH, the overall pattern of cancer types among current and former NBHS staff and students appears to be consistent with that of the state as a whole. There were many different types of cancer diagnosed over more than 30 years, with the most frequent diagnoses among NBHS employees being the most common types of cancer diagnosed in the general population. The most common type of cancer reported was breast cancer, which affects 1 out of every 8 women in the U.S. It is also important to note that breast cancer might be expected to occur more frequently given the demographics of this population, particularly as it relates to those at greater risk for developing breast cancer (women who are more highly educated, women of higher socioeconomic status, women who have had no children or those whose first pregnancy occurred when they were over the age of 30). To calculate a precise prevalence rate of breast cancer among school staff, additional information would have to be provided by school officials and/or City officials. MDPH/BEH has offered to meet with the City of New Bedford Health and School Departments and the New Bedford Educator's Association to discuss the breast cancer experience at the NBHS and whether additional follow-up is feasible based upon the availability of local information.

Serum PCB testing conducted by MDPH/BEH showed that all participants who are current or former staff members or students at NBHS had serum PCB levels within the typical variation seen in the U.S. population and do not indicate unusual exposure opportunities to PCBs at NBHS (i.e., participants fell within the 95th percentile). According to the United States Centers for Disease Control and Prevention (U.S. CDC), the 95th percentile of NHANES data is helpful for determining whether levels observed in public health investigations are unusual.

The MDPH/BEH Indoor Air Quality Program's inspection found a variety of issues at the NBHS. The respiratory and central nervous system symptoms (e.g., headaches, dizziness) reported by some NBHS staff at the time of the initial inspection appear to be consistent with more routine indoor air quality problems, notably less than optimum ventilation. Recommendations were made in several areas to improve the indoor air quality at the NBHS. These included recommendations specific to the HVAC system, PCB containing building materials, the pool area, science-related activities, chemical usage at the school, and moisture and mold issues. The City of New Bedford has reported implementing many of the recommendations made by MDPH. Appendix H summarizes the actions taken at the school to improve indoor environmental conditions. The MDPH/BEH Indoor Air Quality Program has also agreed to conduct a follow-up inspection of the NBHS when further improvements are completed.

Background/Introduction

In March 2007, the City of New Bedford forwarded a petition to the Massachusetts Department of Public Health's (MDPH) Bureau of Environmental Health (BEH).[1] The petition was signed by 21 New Bedford High School (NBHS) teachers and 11 neighbors of NBHS and Keith Middle School (KMS). The petition requested testing or a study of the area around the schools because of concerns related to historical contamination, particularly polychlorinated biphenyls (PCBs). NBHS is located at 230 Hathaway Boulevard and KMS is located at 225 Hathaway Boulevard in New Bedford (Figure 1). Between 1968 and 1972, NBHS was constructed on the site of a former city dump and more recently, between 2004 and 2006, KMS was constructed across Hathaway Boulevard from NBHS on fill from the former dump. KMS was constructed to replace the former Keith Middle School (also known as the former Keith Junior High School) that was located at 70 Hathaway Boulevard. The schools and the neighborhood around the former dump are now part of what has become known as the Parker Street Waste Site (PSWS)[2] (TRC, 2009b).

A list of current or former teachers and staff members of the NBHS who were diagnosed with different types of cancer was also provided to MDPH/BEH. This list has since been updated by Citizens Leading Environmental Action Network (CLEAN) and was received by MDPH/BEH via several emails (February and September 2010; May and November 2011; and January and July 2012). In addition, in January 2008, New Bedford's health agent requested, on behalf of the mayor, that MDPH/BEH's Indoor Air Quality (IAQ) Program conduct an assessment of NBHS. In response to the request and to address the concerns of NBHS staff and residents living near PSWS, BEH has undertaken the following:

- Indoor environmental evaluations of environmental conditions at the NBHS, including an evaluation of PCB sampling data collected at NBHS by various consultants
- An offer to participate in the MDPH/BEH blood testing for concerned school staff and residents to determine levels of PCBs in blood serum; measured serum PCB levels were compared to national data on serum PCB levels in the general U.S. population

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[1] This report was supported in part by funds from a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services. This document has not been reviewed and cleared by ATSDR.
[2] USEPA CERCLIS ID #: MAN000105955; MassDEP RTN: 4-0015685

- A review of the list of cancer diagnoses among current/former teachers and school staff as reported by CLEAN

This report includes the findings of the indoor environmental evaluation, which comprises an evaluation of indoor air quality (IAQ) conditions at the school and a review of current and historical PCB data for the NBHS; a summary of the results of the serum PCB testing offered to NBHS and KMS staff; and a discussion of health concerns expressed by NBHS staff. A cancer incidence evaluation and summary of the serum test results for neighborhood residents of the PSWS area will be provided in a separate BEH report entitled *Evaluation of Serum PCB Levels and Cancer Incidence Data, Parker Street Waste Site Neighborhood, New Bedford, Bristol County, Massachusetts*.

In response to the January 2008 request, on April 29, 2008, a visit to conduct an indoor air quality assessment was made to the NBHS by Michael Feeney, Director of BEH's IAQ Program. Mr. Feeney was accompanied by Cory Holmes, Sharon Lee, James Tobin and Susan Koszalka, Environmental Analysts/Inspectors within BEH's IAQ Program. Mr. Feeney, Mr. Holmes and Ms. Lee returned to the NBHS on April 30, 2008, to complete the assessment. MDPH/BEH/IAQ staff were accompanied by Christine Gorwood, Epidemiologist, and Julie Lemay, Health Assessor, from BEH's Community Assessment Program (CAP) on both days. Mr. Feeney was also accompanied by Jana Ferguson, BEH's Chief of Regional Environmental Health Services; Dr. Sucheta Doshi, a Preventive Medicine Resident with the United States Centers for Disease Control and Prevention (U.S. CDC) assigned to the MDPH's Bureau of Family and Community Health; and Marianne De Souza, Director, New Bedford Health Department (NBHD) on the April 29th visit. Manuel Velosa, NBHS Head Custodian was present on both assessment days. Mr. Feeney and Mr. Holmes returned to the NBHS on July 9, 2008, to observe moisture conditions at a time when the New England area was experiencing several days of wet, humid weather (Weather Underground, 2008).

The NBHS is a multi-wing, multi-level red brick building constructed in 1972 on a former PCB disposal site. Classrooms are located predominately in A-Block and B-Core, which are at the northern portion of the school (Figure 2). A-Block consists of four 3-story houses [A-House 1 (Green), A-House 2 (Gold), A-House 3 (Tan), and A-House 4 (Blue)] that converge at the building's core (B-Block). The lowest level of the B-Block houses the cafeterias. The second level of the B-Core opens to an administration wing (C-Block). A long hallway from the administration wing (C-Block) connects a series of buildings which house the auditorium and shops (D-Block), gymnasiums (E-Block), and pool (F-Block). Windows throughout the NBHS are openable.

Historical information and timeline regarding environmental sampling for PCBs

A number of consultants have conducted testing for PCBs within the building during the period 2006 - 2011. Reports on indoor testing for PCBs were obtained from a website maintained by the City of New Bedford (http://www.newbedford-ma.gov/McCoy/sitemap/nbhs.html). The BETA Group, Inc., of Norwood, Massachusetts, was contracted by the City of New Bedford in 2006 to perform air sampling for PCBs at NBHS in response to a 2005 United States Environmental Protection Agency (U.S. EPA) "Conditional Approval for Risk-Based Cleanup and Disposal." The conditional approval required an assessment of potential PCB contamination at NBHS (BETA, 2006). BETA collected 8 air samples (6 indoor, 2 outdoor) from April 19 - 21, 2006, from various locations within NBHS for PCB analysis. Indoor air results for total PCBs ranged from 0.0043 µg/m3 – 0.0519 µg/m3 and were reported in May 2006. Since one of the indoor air sampling results (0.0519 µg/m3) was slightly above U.S. EPA's established action level of 0.05 µg/m3, it triggered further indoor environmental investigation.

In 2006, TRC Environmental Corporation (TRC), of Lowell, Massachusetts, was contracted by the City of New Bedford to perform follow up air testing (TRC, 2006). Over August 22 - 23, 2006, TRC collected 28 air samples for PCB analysis at NBHS. Wipe and bulk samples were also collected, based on a request by U.S. EPA, using the rationale that NBHS was constructed at a time (1950s - 1970s) during which PCBs were often used in building materials (Kohler et al., 2005; Kuusisto et al., 2006). Thus, air testing was conducted during the same two-day period as wipe and bulk samples.

A total of 23 indoor air samples (including 1 co-located pair) and two outdoor/background locations were sampled. To compare with sampling methods used by BETA (2006), one outdoor location was sampled using both EPA methods TO-10A and TO-4A, and another location sampled with TO-4A only. Both outdoor samples collected using TO-4A had polyurethane foam (PUF) and particulate filters analyzed separately for comparison at the request of USEPA (TRC, 2006). Indoor air results ranged from 0.0024 µg/m3 to 0.31 µg/m3 (23 detected out of 23 samples). Since a uniform wipe surface could not be established for many surfaces due to size/shape constraints (e.g., pipes, cooling system coils), the 22 wipe samples were qualitatively characterized for presence/absence of PCBs (13 of the 22 wipe samples had detectable PCBs). Of the 33 bulk samples collected of various materials throughout the high school, detectable PCB concentrations (27 detects, including "J" values, out of 33 samples) ranged from 0.2 mg/kg to 36.5 mg/kg (dust from a return air duct). Values denoted as "J" refer to estimated levels, meaning PCBs were present, but could not be precisely quantified. No samples exceeded the Toxic Substances Control Act (TSCA) PCB Bulk Waste Limit of 50 mg/kg. However, the TSCA PCB remediation waste standard was triggered because some materials that should not have had PCBs at any concentration did have detectable levels (e.g., foam padding). TRC recommended removing TSCA-defined PCB remediation waste and conducting cleaning before any further follow-up testing in the school to enhance the ability to identify any other potential PCB contamination (TRC, 2006).

During the summer of 2007, work began on the cleaning of air-handling systems, duct work and surfaces at NBHS. Cleaning started on July 9, 2007, and work continued, generally going block by block, until August 24, 2007. The work involved the following: cleaning of all supply, return and exhaust ducts in the school (approximately 13,572 feet of ductwork); cleaning of 20 central Heating, Ventilating, and Air-Conditioning (HVAC) components, fan coils and intakes, including replacement of all HVAC filters; cleaning of 120 return air exhaust vents (approximately 8,700 linear feet); cleaning and replacement of filters for 250 perimeter univents and corridor heaters; cleaning of enclosed space below 4,000 hallway lockers; cleaning of approximately 93,000 square feet of exposed horizontal surfaces that were visibly dusty, including boiler surfaces; and cleaning of fixed surfaces in the wood and auto shops (TRC, 2007; TRC, 2008a). In total, TRC estimated (2008a) that approximately 3,400 pounds of PCB contaminated solid material, such as dust and filters, was removed from the school.

Immediately after cleaning, another round of indoor air testing was conducted in A-Houses and B-Core areas of the school (August 14 - 15, 2007) (TRC, 2008a). The results of this round of indoor air testing were similar to the August 2006 results. A repeat round of air testing was conducted on A-Houses and B-Core areas, as well as initial indoor air testing for the remainder of the building areas (C, D, E, F Blocks) on August 29-30, 2007. Prior to the August 29-30, 2007 testing HEPA air filtration was conducted in almost all interior areas of the school (A – E). The repeat round of air testing for A-Houses and B Core yielded similar results to the earlier rounds. In evaluating further, TRC noticed that during the air sample collection that about 20 of 120 rooftop exhaust vents were non-functioning, as well as 40% of the perimeter univents in the school (TRC, 2008a).

Overall, during the two August 2007 sampling rounds, a total of 33 indoor air (includes six co-located pairs) and six outdoor air samples were collected and results ranged from 0.0025 µg/m3 – 0.69 (J) µg/m3. A total of 207 wipe samples were collected subsequent to the completion of cleaning efforts, and of these, 3 had PCBs above the detection limit (0.5 µg/wipe) but well below the U.S. EPA clean up standard (10 µg/wipe). Fourteen bulk samples of various materials (e.g., mastics, paint) were collected in rooms A-114-3, D-143, and B-240. The results ranged from 0.2 mg/kg – 14.9 mg/kg (all "J" detects).

Following repairs of the HVAC system, additional indoor air testing (28 indoor, including 4 co-located pairs, and 3 outdoor samples) was conducted at NBHS in February of 2008. According to TRC (2008b), the HVAC system was operating at full capacity during this round of sampling. Overall, the February 2008 indoor air levels for PCBs were lower than the August 2006 and August 2007 sampling rounds, suggesting that the improved functioning of the HVAC system likely resulted in lower indoor air levels of PCBs.

After the February 2008 air testing, TRC conducted an additional round of bulk/wipe sampling, in July 2008 (TRC, 2008c). A total of 63 bulk samples were collected, including materials such as carpet, vinyl floor tiles, laminate adhesives, window glazes and caulk, foam padding, joint adhesives, expansion joints, and various colors and ages of paint. Two samples exceeded the TSCA PCB Bulk Product Waste standard of 50 mg/kg and required remediation (i.e., laminate adhesives). TRC (2008c) recommended additional bulk sampling as part of the remedial planning process. A total of 290 bulk samples (including 13 field duplicates) were collected from up to 71 locations throughout the school during the December 2008 – March 2009 round (U.S. EPA 2009; TRC, 2009a). Five samples exceeded the TSCA PCB Bulk Product Waste standard (i.e., 3 samples of univent interior rust-inhibitor coatings, a sample of laminate adhesive, and a sample of blue paint) (TRC, 2009b).

As part of an EPA Removal and Abatement Plan (RAP) for designated PCB Bulk Product Waste, 31 B-Block univents and painted sheetrock containing PCBs (rooms B-230, A-211-3, and A-213-4) were removed over the summer 2010 (TRC, 2010a; 2010b). TRC conducted targeted indoor air sampling in the room that houses the daycare (A-227-4) on August 25, 2010 (0.00763 (J) µg/m3; 0.0054 (J) µg/m3 duplicate) (TRC, 2011a). TRC completed a fluorescent ballast inventory throughout NBHS during the fall of 2010, and reported comprehensive results in a memo dated February 7, 2011 (TRC, 2011c). A recent round of indoor air sampling for PCBs at NBHS was conducted in February 2011 (TRC, 2011b). A total of 48 indoor air samples, including 20 of the 26 locations sampled in February 2008, and 2 outdoor air samples were collected (TRC, 2011e and f). Twenty-five of the 48 samples had detectable PCBs, ranging from 0.00252 (J) – 1.45 (J) µg/m3. Because results for 8 locations were above a level EPA flagged for further investigation (>0.05 µg/m3), these 8 rooms were re-sampled in April 2011 after increased ventilation was implemented. In addition, light fixture trays thought to have residual PCBs were removed in 4 of the rooms (TRC, 2011g). Results for those 8 rooms (9 samples, including one duplicate) had detectable PCBs in every room except A-2-212 (<0.00347), ranging from 0.048 µg/m3 to 1.25 µg/m3 (TRC, 2011h). TRC submitted a second RAP to EPA in March 2011, with plans to remove remaining PCB bulk waste (i.e., paint in rooms B-230, A-3-211, and A-4-213), regulated PCB remediation waste (i.e., removal and replacement of 1320 potentially PCB contaminated foam cushion seats in the auditorium) and removal and replacement of PCB containing fluorescent light ballasts and remediation of up to 2900 impacted light fixtures over the summer 2011 (TRC, 2011d). A final round of indoor air sampling was conducted in August 2011 after work was completed. Eleven rooms plus one locker were sampled (15 samples, including 3 duplicates), with results indicating detectable PCBs in 15 of 15 samples, ranging from 0.00536 µg/m3 to 0.577 µg/m3 (TRC, 2011h).

Methods

Indoor Air Quality Sampling Methods

During the April 2008 MDPH assessment, air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551/7565. Air tests for airborne particulate matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. During the July 2008 assessment, surface temperatures of walls, floors and univent cabinets were measured with a ThermoTrace infrared thermometer. MDPH/BEH/IAQ staff also performed a visual inspection of building materials for water damage and/or microbial growth. Following each day of indoor air quality assessment, MDPH staff met with the School Principal at the time as well as the HVAC technician to discuss conditions observed at the school, including the conditions of the ventilation system and carbon dioxide levels that were measured.

Methods Used to Evaluate Potential Health Risks Associated with PCBs in NBHS

A summary of indoor environmental testing activities for PCBs, and associated timeline during 2006 – 2011, was provided previously in the historic information and timeline section. MDPH/BEH/ETP staff reviewed the data available to derive quantitative estimates of health risks associated with opportunities for PCB exposure at this school. PCB testing results were also evaluated relative to results for the IAQ evaluation, which may help to better understand the patterns of PCB detections in NBHS, e.g., rooms with poor air exchange/ventilation may have higher air levels of PCBs.

To evaluate potential health concerns that may be associated with exposure opportunities to PCBs at NBHS, health-based screening values, called comparison values, were used for initial comparison. These values include cancer risk evaluation guides (CREGs) and environmental media evaluation guides (EMEGs), which are values that have been scientifically peer reviewed or derived using scientifically peer-reviewed values and published by the U.S. Agency for Toxic Substances and Disease Registry (ATSDR). CREG values provide information on the potential for carcinogenic effects, while EMEG values are used to evaluate the potential for non-cancer health effects. Chronic EMEGs correspond to exposures lasting one year or longer in a residential setting. CREG values are derived assuming a lifetime of daily exposure (i.e., 70 years) in a residential setting.

Comparison values are specific concentrations of a chemical for air, soil, or water that are used by health assessors to identify environmental constituents that require further evaluation. These comparison values are developed based on health guidelines and assumed exposure situations that represent conservative estimates of human exposure. Chemical concentrations detected in environmental media that are less than a comparison value are not thought to pose a health threat. However, chemical concentrations detected in environmental media above comparison values do not necessarily mean health effects will occur. In order for a compound to affect one's health, it must not only be present in the environmental media, but one must also come in contact with the compound. Therefore, if a concentration of a chemical is greater than the appropriate comparison value, the potential for exposure to the chemical should be further evaluated to determine whether or how much exposure is occurring for the specific situation and whether health effects might be possible as a result of that exposure.

Air sample results were compared with the ATSDR CREG of 0.01 micrograms per cubic meter (0.01 µg/m3). The ATSDR CREG was derived based on daily exposure over a lifetime for all populations, including children. There are no available ATSDR EMEGs for PCBs in indoor air. For surface wipes, there are no health based comparison values. The U.S. EPA has a regulatory clean-up standard of 10 micrograms PCBs per 100 square centimeters (10 µg/100cm2) for wipes collected from indoor residential surfaces that have been affected by a spill of a low-concentration PCB mixture (40 CFR 761.125). In addition, the California Department of Toxic Substance Control (CA DTSC) has published a recommended clean-up guideline for PCBs on surface areas in schools of 0.1 µg/100cm2. This recommended guideline for California is intended to be protective of short and long term exposures involving dermal contact and incidental ingestion (CA DTSC, 2003). It is important to note that exceedance of a clean up level does not suggest health effects may occur. Rather it is a level that drives the need to further clean areas.

Serum PCB Methods

As previously noted, the MDPH/BEH/CAP conducted blood serum PCB testing of individuals concerned about opportunities for exposures to PCBs at the NBHS and PSWS.

The goal of the blood sampling offer was to determine if school staff and students at New Bedford High School and Keith Middle School had elevated serum PCB levels compared to the U.S. population based on comparison with CDC's reference ranges for the general U.S. population. According to CDC, biomonitoring studies of serum PCBs can provide physicians and public health officials with data to evaluate whether individuals have been exposed to higher levels of PCBs than the general population. The measurement of an environmental chemical, including PCBs, in a person's blood or urine does not by itself mean that the chemical causes disease or say anything about potential risk.

The blood serum PCB testing program consisted of two phases. The first phase consisted of the administration of an exposure assessment questionnaire designed to obtain information on risk factors that are known to or may affect serum PCB levels (e.g., age, fish consumption, occupational exposures), as well as information on school-specific factors, such as years of employment at NBHS. Prior to completing the exposure assessment questionnaire, BEH required that each participant (or parent, in the case of children) sign a consent form (see Appendix A). The questionnaire was administered by an MDPH contractor, the John Snow Institute (JSI) Center for Environmental Health Studies. Interviews occurred at the Normandin Middle School in New Bedford. Some interviews took place in Portuguese, with translators trained to administer the questionnaire. BEH conducted outreach activities to publicize this offer to both English and Portuguese speakers. It included a BEH presentation at a Public Involvement Plan meeting for the PSWS, press releases, press interviews, and the distribution of fact sheets.

The original intent of the first phase was to identify approximately 100 individuals most likely to have the highest serum PCB results based upon exposure information reported in the questionnaire. MDPH/BEH planned to score each questionnaire based on its extensive experience in predicting serum PCB levels based on known or likely risk factors for PCB exposure. However, given that the total number of people that completed the exposure assessment questionnaire was 124, MDPH/BEH decided to offer all phase one participants the opportunity to participate in the phase two blood testing. Information collected by this questionnaire was used to evaluate serum PCB results. In particular, information regarding age, place of residence, and location and length of employment of school staff were evaluated in the report. Information, including diet, other occupational exposures, and specific routes of exposure related to the PSWS were also evaluated on an individual level on a case-by-case basis.

The second phase consisted of the collection of blood samples for serum PCB analysis by MDPH's William A. Hinton State Laboratory Institute (SLI) Division of Analytical Chemistry. BEH contracted with Favorite Healthcare Staffing, Inc. to provide phlebotomy services for the serum PCB testing. BEH also worked with the NBHD to coordinate the blood draws. The NBHD supplied space and some basic supplies (e.g., gauze, band aides, sharps disposal) for the blood draws and assisted BEH in answering participant questions. Two 10-milliliter (mL) red-top BD Vacutainers® of blood were collected from each participant. A fact sheet was given to each participant at the time of the appointment to explain the sample analysis process (see Appendix B).

Results of serum PCB testing were compared with U.S. Centers for Disease Control (U.S. CDC) National Health and Nutrition Examination Survey (NHANES) bio-monitoring data for the civilian U.S. population for the most recent period available at the time of this report (2003-2004). Due to NHANES stratified random sampling design and large sample numbers, this survey provides the most representative biomonitoring data for the general U.S. population available. Thus, NHANES is the most appropriate reference range to compare with results from a specific population (such as the NBHS community). NHANES data are used by public health and medical professionals across the country for these types of comparisons. These data provide health professionals with a reference range so that they can determine whether any specific individual or populations of individuals have been exposed to higher levels of PCBs than the general U.S. population.

On each day of sampling, MDPH/BEH transported blood samples from the NBHD to MDPH's SLI in Jamaica Plain. Sample tracking forms were completed to accompany each shipment. SLI staff centrifuged the samples to extract, aliquot, and store the serum samples until all the samples were collected. In addition, SLI transported sample aliquots to MDPH's Lemuel Shattuck Hospital in Jamaica Plain for lipid analysis.

MDPH began offering blood draw appointments in February 2009 and SLI completed testing of blood samples in February 2010. Samples were stored frozen pending analysis. According to the National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM), Method 8004, PCBs in serum are stable indefinitely if frozen. Additionally, according to a personal correspondence with CDC's Dioxin and Persistent Organic Pollutants Laboratory, it has been their experience that PCBs in Quality Control samples (serum spiked with known quantities of PCBs) are stable for 2 – 5 years, the amount of time they use these QC samples. Thus, we would not expect any effect related to the time between collection and analysis on serum PCB levels for NBHS participants.

The method for determination of PCB congeners was developed at CDC and transferred to the SLI. The standard operating procedure (SOP AC.012) for determination of PCB congeners in human serum details a solvent extraction, silica gel clean-up and dual capillary column gas chromatographic analysis with electron capture detection.

Quality assurance measures for the method include the analysis of reagent blanks that are monitored for contamination and subtracted from the samples in each run; the analysis of fortified serum samples, the results of which are plotted on lot & instrument specific quality control charts for review to determine compliance with acceptance criteria for the batch; and individual sample fortification with surrogate analytes that are evaluated for compliance with acceptable recovery criteria. Other batch specific controls include criteria for the calibration curve and internal standard recovery.

Analysis of serum samples was conducted by SLI using a congener-specific analytical method similar to methods used by the U.S. CDC in the national survey. Serum PCB levels were reported by SLI two ways: the first was on a whole volume basis in micrograms per liter (µg/L) of serum and the second was on a lipid-adjusted basis in nanograms per gram (ng/g) of lipid. Historically, when PCBs were measured in serum, the results were reported on a whole weight basis only. Currently, with advances in analytical chemistry, they are also reported on a lipid-adjusted basis. Blood serum contains lipids (fats), and PCBs concentrate in lipid, or fatty, fractions in the blood. Because different people may have different concentrations of lipids in their blood, PCB concentrations in blood are adjusted (or normalized) based on the lipid content. This adjustment allows for comparisons of blood serum PCB levels among different people and populations (U.S. CDC, 2009). It should be noted that NHANES currently reports whole weight results in ng/g of serum (U.S. CDC, 2009; MDPH, 2009). To compare SLI's results to NHANES results, the SLI values were converted from whole volume (µg/L) to whole weight (ng/g) using the average density of serum (1.026 g/mL) (Turner, 2006). The units, µg/L and ng/g, are both equivalent to parts per billion (ppb), which is used throughout the rest of the report for simplicity.

To compare the New Bedford results to NHANES, a total PCB concentration was calculated following NHANES methodology for each of the New Bedford participants by summing the concentrations of the 15 most commonly detected congeners which includes two pair of co-congeners reported together (U.S. CDC, 2006; U.S. CDC, 2009; Patterson, 2009). These congeners are 52, 74, 99, 105, 118, 138/158, 146, 153, 156, 170, 180, 187, 194, 196/203, and 199. It should be noted that, unlike NHANES, SLI reports congeners 138 and 158 separately.

To calculate total PCB levels, as well as summary statistics such as geometric means and percentiles, CDC assigns sample results that were not detected above the method's limit of detection (LOD) a value equal to the LOD divided by square root of 2. New Bedford participants' individual serum PCB results, as well as summary statistics (e.g., geometric means and percentiles) were calculated using this method to be comparable to CDC summary data.

The total serum PCB concentrations (whole weight and lipid-adjusted) for each participant were compared to the NHANES total PCB concentrations (whole weight and lipid-adjusted). Because it is well established that PCBs in serum increase with age, it is important to compare a participant's serum PCB level with the comparable age group from the national data (12-19 years, 20-39 years, 40-59 years, and 60+ years) (U.S. CDC, 2006; Miller et al., 1991; Patterson et al., 2009). When comparing to NHANES data, the following summary statistics were used:

- The 50th percentile value (also known as the median) – the midpoint of the serum PCB levels for all NHANES participants when they are arranged in order from lowest to highest.
- The 95th percentile value – serum PCB levels below which 95% of the levels measured in NHANES participants are found; according to the U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual

Due to differences among individuals, you would expect to see a range of serum PCB levels in the general population. The range of concentrations reported by NHANES provides health professionals with information on the degree of variation that can be expected in the general population. According to the U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual. Based on this guidance from CDC, an individual with serum concentrations above the 50th percentile but below the 95th percentile is within the typical level of variation seen in the general U.S. population. Thus, MDPH used the 95th percentile value for comparison with the participants' serum PCB results.

Additionally, BEH qualitatively compared the specific congener pattern for New Bedford participant results to what is typically seen in the U.S. population based on the latest NHANES data (2003-2004) (U.S. CDC, 2008 and 2009). For the qualitative congener pattern evaluation, MDPH visually compared the distribution of percent contribution of the congeners most commonly seen in serum and analyzed by SLI for all New Bedford participants to the percent contribution of these congeners for all ages from the NHANES data. In addition, a subset of sample results was submitted to CDC for review to confirm that individual differences noted were within the range typically seen.

Health Interview Methods

As mentioned, BEH/CAP staff accompanied IAQ staff on the April 2008 visit. All NBHS employees were offered the opportunity to be interviewed in relation to health and IAQ concerns. Participating employees provided information and were asked questions by CAP staff about their health concerns in relation to the indoor air quality at NBHS.

Results

Indoor Air Quality

At the time of the 2008 assessment, the NBHS has a student population of approximately 3,100 and a staff of approximately 500. Tests were taken under normal operating conditions. At the time of the MDPH assessments, three rooms (A-4-210, A-4-212 and B-240) were closed for cleaning as part of on-going PCB remediation efforts. Test results for April 29, 2008 appear in Table 1, while those for April 30, 2008 appear in Table 2. Test results for July 9, 2008, including dew point calculations, appear in Table 3.

Ventilation

It can be seen from Table 1 that carbon dioxide levels were higher than 800 parts per million (ppm) in 115 of 223 areas surveyed on April 29, 2008, indicating a lack of adequate air exchange in approximately half of the areas sampled. In a number of areas, carbon dioxide levels were greater than 2,000 ppm, indicating a significant lack of ventilation in these classrooms. It should be noted that three-quarters of the rooms testing below 800 ppm carbon dioxide had four or fewer occupants, the majority of which had no occupants. On April 30, 2008, all areas assessed had carbon dioxide levels below 800 ppm. However, it is important to note that nine of 18 areas tested (all in E and F Blocks, which consist of athletic areas including gyms and locker rooms) were empty or sparsely populated at the time carbon dioxide testing was conducted. Low occupancy can greatly reduce carbon dioxide levels; carbon dioxide levels would be expected to increase with higher occupancy.

Classroom Supply Ventilation

Fresh air for classrooms in each of the houses, as well as those in the outer core of B-Block is supplied by unit ventilator (univent) systems (Picture 1). A univent typically draws air from the outdoors through a fresh air intake located on the exterior wall of the building and returns air through an air intake located at the base of the unit (Figure 3). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. Univents were found deactivated in many areas at the time of assessment (Table 1). Obstructions to airflow, such as items stored on or in front of univents were observed in many areas (Table 1; Pictures 2 and 3). In one area (classroom A-1-113), Styrofoam-based art projects were placed on univents for drying. Particulates and odors, especially during the heating season, can be distributed within a classroom if items are placed on/over univents. In order for univents to operate as designed, units must be activated while rooms are occupied. In addition, air diffusers and return vents should remain free of obstructions.

Based on MDPH/BEH/IAQ experience, fresh air intakes for the majority of univents at the NBHS are atypical of those usually observed in schools. Univent fresh air intakes are typically installed through the exterior wall, in a location that would provide the least resistance to air drawn into the univent. Some univents at the NBHS had a standard univent fresh air intake (Picture 4). Fresh air intakes for many below grade classrooms are installed in cement–lined pits that are covered with metal grates and bird screens. Fresh air is drawn through the screened grate into a pit and into the univent (Figure 4; Picture 5). For many of the pits, bird screens were found covered with a substantial layer of pine needles (Picture 6). This layer of pine needles presents several problems:

1. It blocks the draw of outdoor air; and
2. It prevents evaporation of moisture, which can be drawn into classrooms by the univent, providing a mold growth medium.

Univent pits also had substantial amounts of debris (e.g., leaves, plants, standing water), which can all be sources of mold growth (Picture 7). Univent pits are likely to collect water from rainfall. Moisture, debris and potential mold spores can be captured, drawn in, and distributed to classrooms by univent systems.

At the NBHS, univent fresh air intakes for A-Block classrooms are located on the exterior brick wall behind a secondary wall system. This secondary wall, known as a spandrel wall panel, consists of a pebble slab installed below the window systems for the second and third levels of the building (Picture 8). A cement windowsill extends from the building to meet the spandrel slab and protect the space between walls. A metal grate located at the bottom between the spandrel wall panel and the existing brick wall allows air to pass between the two walls (Figure 5, Picture 9). Air is drawn behind the spandrel wall panel through the metal grate and into the univent fresh air intake (Picture 10). It appears that rainwater may be passing through the spandrel and brick walls, as evidenced by the corrosion and disintegration of the metal grates (Picture 10). Evidence of bird nesting materials was observed in these damaged metal grates (Picture 11). In this configuration and condition, any water vapor and pollutants present in the space between the spandrel panel and brick wall can be captured and drawn into the univent and subsequently distribute indoors, raising concerns associated with respiratory impacts. Concerns regarding bird wastes are discussed in the Moisture/Microbial Concerns - Bird Waste portion of this report.

Please note, the majority of univents at the NBHS are original equipment, approximately 35 years old. Univents of this age can be difficult to maintain because replacement parts are often unavailable. At the time of assessments, MDPH/BEH/IAQ observed many univents in disrepair. Damaged univent diffusers were also observed in numerous classroom areas (Picture 12). Damaged diffusers can allow debris and larger materials to fall into the univent, which can cause damage to parts within the unit. According to the American Society of Heating, Refrigeration and Air-Conditioning Engineering (ASHRAE), the service life[3] for a unit heater, hot water or steam is 20 years, assuming routine maintenance of the equipment (ASHRAE, 1991). While maintenance/facilities personnel are maintaining the univents, the operational lifespan of this equipment has passed. Given the age of the equipment, continuing to maintain the balance of fresh air to exhaust air will be difficult at best.

[3] 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).

The synthetic fiber filters installed in univents at the NBHS offer minimal filtration and require cutting-by-hand and fitting into a metal rack (Picture 13). The purpose of a filter is to provide filtration of respirable dusts. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency should be installed in place of current filter media. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992).

Furthermore, cleaning activities conducted during the summer of 2007 to remove dust containing PCBs from univents may have accelerated the degradation of univent parts, as use of water to clean coils and drip pans can cause rusting of equipment. With univents in their current condition, the sole source of fresh air in many areas is via open windows.

During the April 30, 2008, assessment, one member of the NBHS teaching staff reported smoke and odors coming from a classroom univent. MDPH/BEH/IAQ accompanied Mr. Velosa to the classroom; Mr. Velosa examined the unit and reported that the ball bearing joints were seizing, causing the motor to abrade the fan belt. NBHS maintenance staff reported that such problems have become more common with univents at the school.

Classroom Exhaust Ventilation

The mechanical exhaust ventilation system for classrooms with univents is provided by rooftop exhaust fans ducted to wall-mounted exhaust vents. Exhaust vents are located on walls adjacent to hallway doors. At the time of assessment, draw of air could not be detected from some exhaust vents, indicating that the rooftop exhaust fans were not operating (Table 1). Additionally, the efficiency of some exhaust vents is hindered by their location near hallway doors. When classroom doors are open, these vents will tend to draw from the hallway, rather than from the classroom (Picture 14). Without sufficient supply and exhaust ventilation, environmental pollutants can build up, leading to indoor air quality/comfort complaints. Furthermore, many of these vents were found blocked by items (Picture 15). As with univents, classroom exhaust vents must be operating and free of blockages in order to remove normally occurring pollutants from classrooms. Classroom doors should remain closed when exhaust vents are functioning.

Other Mechanical Systems

Mechanical ventilation in large areas (e.g., gymnasiums, the auditorium, pool and cafeterias) and some offices and classrooms is provided by air-handling units (AHUs) ducted to air diffusers which supply fresh air (Picture 16); wall- or ceiling-mounted exhaust vents return air to the AHUs (Picture 17). Areas such as the shops have rooftop exhaust fans, which are ducted to wall mounted exhaust vents. It was reported by NBHS maintenance/facility staff that some AHUs in certain areas, such as the B-Block core, have the capacity to chill air in warm weather. Mechanical ventilation was reportedly operating at the time of assessments; however, BEH could not detect airflow from supply and exhaust vents in a number of areas (Tables 1 and 2), because vents were turned off, blocked or had weak air flow.

All restrooms in the school had wall- or ceiling-mounted exhaust vents ducted to rooftop fan motors. These units were off at the time of assessment. An exhaust vent in a third floor bathroom was also backdrafting (i.e., outdoor air penetrating into the space) at the time of assessment. Exhaust fans for bathrooms must be operating during occupied periods to ensure pollutants and moisture are removed.

In addition to an AHU, the pool (F-Block) also has a dehumidification system that is designed to prevent moisture accumulation in the pool area. Air from the pool is drawn into a vent (Picture 18) that is connected to a dehumidifier on the roof. After treatment, the conditioned air is pumped into a flexible duct, which releases it through a slit on the side of the duct (Pictures 19 and 20). MDPH/BEH/IAQ observed pressurization problems related to the ventilation system in the pool; these issues are discussed in the Moisture/Microbial Concerns - Pool Odors section of this report.

Science classrooms are equipped with chemical fume hoods ducted to the roof. No record of the last date of calibration/inspection of the hoods, however, was available. A chemical hood should be recalibrated on an annual basis or as recommended by the manufacturer to ensure proper function. In addition, MDPH/BEH/IAQ staff observed a passive vent in the cabinet of one chemical hood in classroom B371. This passive vent was adjacent to an exhaust vent for the room (Picture 21). If the rooftop exhaust fan for this vent is not operating as designed, backdrafting can occur. This could result in fumes from the chemical hood on being distributed within the classroom if penetrations/breaches exist in the chemical fume hoods exhaust ductwork.

The auto shop has local exhaust ventilation; however, this system was not observed to be operating during the assessment. A functioning exhaust system is necessary for the removal of combustion products from car exhausts as well as from chemicals, solvents and cleaners associated with cleaning equipment and routine car maintenance.

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 existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

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 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

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

Temperature

Temperature measurements ranged from 64°F to 75°F on April 29, 2008 and 67°F to 72°F on April 30, 2008, within or close to the lower end of the MDPH recommended comfort guidelines in all areas surveyed during these assessment dates. During the July 9, 2008 visit, temperatures ranged between 73°F and 83°F, above the recommended MDPH recommended comfort guidelines in most 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.

Relative Humidity

The relative humidity ranged from 52 to 75 percent on April 29, 2008 and 28 to 74 percent on April 30, 2008 during the assessment, which were within or above the MDPH recommended comfort range. Relative humidity ranged between 45 and 81 percent on July 9, 2008; the levels measured were above the MDPH recommended comfort range in most areas. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. As previously discussed, many univents were not operating at the time of the April 2008 assessments. Indoor relative humidity levels were greater than 70 percent in many classroom areas, likely due to lack of air exchange. 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 very common problem during the heating season in the northeast part of the United States.

Please note, elevated relative humidity levels were also measured in the major hallway connecting C- through F-Blocks (Table 2) and may be related to the pool's dehumidification system. As mentioned, pool related issues are discussed in the Moisture/Microbial Concerns-Pool Odors portion of this report.

Microbial/Moisture Concerns

Bird Waste

Bird nesting materials were observed on metal grates that are installed between the exterior wall and spandrel wall panel to allow air to be drawn into univent fresh air intakes (Picture 11). The presence of nesting materials raises concerns associated with the univent system to potentially draw in and distribute bird dander, wastes and other particulates into classrooms. Bird wastes in a building are a concern because of diseases associated with exposure to such wastes. This is especially true for immune-compromised individuals. Other diseases of the respiratory tract may also result from chronic exposure to bird waste. Exposure to bird wastes is thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) is another condition closely associated with exposure to bird wastes in either the occupational or bird raising setting. While immune-compromised individuals have an increased risk of health impacts following exposure to the materials in bird wastes, these impacts may also occur in healthy individuals exposed to these materials. Considering the potential health impacts associated with exposure to bird wastes, the need for clean up and appropriate disinfection is critical. Measures to prevent further bird nesting should be employed. The space between the spandrel and exterior walls should be cleaned and disinfected; damaged metal grates should be replaced. MDPH/BEH/IAQ staff discussed the conditions observed with NBHS personnel following the April 30, 2008 assessment.

Pool Odors

Pool treatment/chlorine odors were detected outside of the indoor pool area in D- and E-Block hallways during the April 30, 2008 visit (Figure 6). When the fire doors between C- and D-Blocks were open, odors were also apparent in C-Block. These odors were traced to the indoor swimming pool, located in F-Block, which is at the southernmost portion of the NBHS complex (Figure 6). As discussed, a dehumidification system is installed in the pool room. The purpose of the dehumidification system is to provide air once moisture has been removed, creating positive pressure. The existing exhaust system must remove air at an adequate rate to balance the flow of air supplied. Without adequate exhaust ventilation, air from the pool area can penetrate other portions of the school. The following conditions and air measurements indicate that the pool area is not properly vented:

- Odor of pool treatment at the C-Block Hallway (a distance estimated to be 500 feet).
- Relative humidity in the pool was 60 percent. Relative humidity in the hall was 70 percent or 10 percent greater than the pool area itself.
- Wall above the doorway of the pool stairwell shows signs of mold colonization in areas of water drippage (Picture 22).
- Breaches were observed between the pool ceiling and the wall shared with the stairwell, as indicated by light penetrating into the hallway (Picture 23).
- Both interior and exterior walls of the pool have efflorescence (Pictures 24 and 25). Efflorescence is a characteristic sign of water damage to building materials, but it is not mold growth. As moisture penetrates and works its way through building materials (e.g., brick and mortar), water-soluble compounds dissolve, creating a solution. As this solution moves to the surface, the water evaporates, leaving behind white, powdery mineral deposits. Of note is that the efflorescence is not uniform from the roof edge downward on the exterior of the building, but appears to begin at a level that is below the dehumidifier duct (Picture 25). This would indicate that the dehumidifier may be driving moisture through the exterior wall, causing an unusual pattern of efflorescence.

It appears that the dehumidification system at the NBHS may be pressurizing the pool area, forcing air into the pool locker room and out through holes in the pool wall to a stairwell that leads to the main hallway. Strong consideration should be given to balancing the HVAC equipment in this area to prevent movement of pool odors to other portions of the building. Under Massachusetts state regulations, the pool at NBHS is considered a “semi-public” pool that should be operated and maintained in accordance with 105 CMR 435.29, Minimum Standards for Swimming Pools (State Sanitary Code: Chapter V).

Condensation in lower level of NBHS

During the April 2008 assessment, MDPH/BEH/IAQ staff received reports of condensation on floors in the ground level of each wing and the central core kitchen, particularly during hot humid weather. MDPH/BEH/IAQ staff also observed dehumidifiers in a number of classrooms on the first level, further indicating increased indoor relative humidity as a concern in these lower level classrooms. MDPH/BEH/IAQ staff returned to examine these areas on July 9, 2008 to observe the building during hot, humid weather. At the time of the July 2008 visit, no active water leaks were observed and no visible accumulated moisture was noted on floors, walls or ceilings.

The source most likely causing condensation to form is untempered air entering through open windows and operating univents. Condensation is the collection of moisture that occurs when untempered air is introduced to an area where building components have a temperature at or below the dew point. Univents on the ground floor can draw moisture-laden air from the subterranean pits located around the exterior of the building (Picture 5). In this instance, condensation accumulates on the floors, causing staining between floor tiles. The material observed between tiles is likely floor tile mastic that expanded when exposed to accumulating moisture (Picture 26).

The dew point is the temperature that air must reach for saturation to occur and is determined by air temperature and relative humidity. If a surface has a temperature equal to or below the dew point, condensation will accumulate. For example, at a temperature of 80o F and indoor relative humidity of 80 percent, the dew point for water to collect on a surface is approximately 73°F (IICRC, 2000). Therefore, any surface that has a temperature below 73°F would be prone to condensation generation. Surfaces in direct contact with soil (e.g., foundations) will tend to have a surface temperature significantly lower than other building components. Area such as tiles on slab floors, walls directly cooled by chilled ventilation air (e.g., vice principal's office) or subterranean walls may all be prone to generating condensation.

To determine the dew point of the floor surfaces, MDPH/BEH/IAQ staff measured the temperature of floors and adjacent surfaces using a laser thermometer (Table 3). Dew point of the floor can be calculated based on the air temperature and the relative humidity of the room. Results were as follows:

- Temperature indoors ranged from 71°F to 83°F.
- Relative humidity indoors ranged from 45 percent to 81 percent.
- Floor temperature ranged from 55°F to 73°F (Table 2).

After calculating the dew point, it was determined that 42 of 51 rooms/hallways assessed (> 80 percent of areas assessed) had floor temperatures below or equal to the dew point measured in each location (Table 3). NBHS staff had dehumidifiers operating in all ground floor classrooms at the time of this assessment. If the floor temperature measured during the assessment is typical of these surfaces during the summer, it is reasonable to assume that condensation generation is the most likely source of water slicking the floor.

Similar conditions were also present in the kitchen cafeteria, due to air leaking from the freezer year-round. The floor temperature outside the freezer near a space in the door measured 32°F, which would likely result in continuous condensation formation in this location (Table 3). Highlighting this condition is the deterioration of the kitchen flooring, which is lifting up from moisture exposure at the location where chilled air escapes from the freezer (Picture 27).

The U.S. EPA and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24-48 hours of becoming wet (U.S. EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Water in Mechanical Room

MDPH/BEH/IAQ observed water pooling on the floor of the mechanical room, some of it surrounding utility control panels (Pictures 28 and 29). Measures should be in place to drain water away from these panels to prevent damage to electrical components or outages.

Building-wide Issues

Water-damaged ceiling tiles typically indicate water infiltration through the roof or pipe leaks. The building currently experiences water infiltration through the roof and window systems, as evidenced by water-damaged/missing ceiling tiles and catch buckets in some classrooms (i.e., A-1-307, A-1-310 and A-2-307; Pictures 30 and 31). Many windows also showed signs of damage indicating water penetration. A damaged pipe and water-damaged ceiling tiles were observed in the hallway near the weight room. Visible mold growth was observed on a ceiling tile near the boy’s locker room, and metal holders for ceiling tiles were rusted; these conditions typically indicate water penetration. Measures should be taken to repair the cause of leaks. Following remediation, damaged ceiling tiles should be removed and replaced.

Breaches were observed between the countertop and sink backsplashes in some classrooms. If not watertight, water can penetrate through these seams. Water penetration and chronic exposure of porous and wood-based materials can cause these materials to swell and show signs of water damage. As discussed, moistened materials that are not dried within 24 to 48 hours can become potential sources for mold growth. Mold growth was observed on the backsplash of a sink in room A-1-227 (Picture 32).

Plants were located in a number of areas and in some instances, above univent air diffusers (Picture 33). Plants, soil and drip pans can serve as sources of mold growth, thus should be properly maintained. Over-watering of plants should be avoided and drip pans should be inspected periodically for mold growth. Plants and related materials should also be located away porous materials (e.g., carpeting, paper products) to prevent damage and potential microbial growth in/on these materials.

Dehumidifiers were observed in a number of areas especially in the tan wing. As discussed previously, the building experiences condensation problems during periods of increased relative humidity. Occupants and custodial staff should periodically examine, clean and disinfect these units as per the manufacturer's instructions to prevent growth and odors.

Several areas had aquariums (Table 1). The water in one aquarium appeared green in color, indicating algal growth (Picture 34). Aquariums should be properly maintained to prevent microbial/algal growth as they can emit unpleasant odors into the classroom.

Plant and moss growth was observed in cracks and crevices around the building's exterior (Pictures 35 and 36). Shrubs/trees and mulch in close proximity to the building holds moisture against the building exterior and prevents drying. The growth of roots against exterior walls can bring moisture in contact with the foundation. Plant roots can eventually penetrate the wall, leading to cracks and/or fissures in the sublevel foundation. Over time, these conditions can undermine the integrity of the building envelope and provide a means of water entry into the building via capillary action through 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 that can create additional penetration points for both water and pests.

Other breaches were observed in the exterior of the building (Picture 35). Such breaches/damage can allow water and pest penetration into the building. These breaches should be sealed.

Other IAQ Concerns

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, MDPH/BEH/IAQ 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 (105 CMR 675.000: Requirements to Maintain Air Quality in Indoor Skating Rinks, 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 U.S. EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (U.S. 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 (U.S. 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) during the April 29 and April 30, 2008 testing. No measurable levels of carbon monoxide were detected indoors during both dates of testing (Tables 1 and 2).

Particulate Matter (PM2.5)

The U.S. 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 micrograms per cubic meter (μg/m3) in a 24-hour average (U.S. EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, U.S. 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 (U.S. EPA, 2006). Particulates size can be directly linked to their potential for causing health problems. Particles less than 10 micrometers in diameter exhibit a greater health risk because they get deeper into the lungs. Larger particles are of less concern; however they can serve as a source of eye, nose, and throat irritation (AirNow, 2003). 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.

The outdoor PM2.5 concentration for April 29, 2008 was 3 μg/m3, while indoor PM2.5 levels ranged from ND to 28 μg/m3 in classrooms and common areas, which were below the NAAQS PM2.5 level of 35 μg/m3 (Table 1). However, MDPH/BEH/IAQ measured PM2.5 levels of 65 μg/m3 and 732 μg/m3 in the tan area girls' and boys' restrooms, respectively.

These measurements are reflective of smoking activities in bathrooms where exhaust ventilation was deactivated. On April 30, 2008, PM2.5 concentrations were 16 μg/m3 outdoors and 5 to 12 μg/m3 indoors, which were below the NAAQS PM2.5 level. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in buildings can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in 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 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, MDPH/BEH/IAQ examined rooms for products containing these respiratory irritants.

Mercury-containing thermometers were observed in science prep room B-311. Mercury is of particular concern due to its toxicity, associated health risks, environmental impacts, and the high cost of cleanup from spills. There are several alternatives to the use of the mercury thermometers that are as effective and affordable (e.g., thermometers filled with red mineral spirits or alcohol). Broken thermometers that do not contain mercury are decidedly easier, safer, and less costly.

Air fresheners, reed diffusers, deodorizing materials and cleaning products were observed in several areas. Air deodorizers contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Many air fresheners contain 1,4-dichlorobenzene, a VOC which may cause reductions in lung function (NIH, 2006). Furthermore, deodorizing agents do not remove materials causing odors, but rather mask odors that may be present in the area.

Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999). These products can all be irritating to the eyes, nose and throat.

Other Concerns

A number of other conditions that can affect indoor air quality were noted during the assessment. Sewer gas like odors reported in science room B-309, which had a floor drain for the emergency shower. Drains are usually designed with traps in order to prevent sewer odors/gases from penetrating into occupied spaces. When water enters a drain, the trap fills and forms a watertight seal. Without a periodic input of water (e.g., every other day), traps can dry, breaking the watertight seal. Without a watertight seal, odors/sewer gases can travel up the drain and enter the occupied space.

Window-mounted air conditioners (ACs) were observed in several areas. These units are normally equipped with filters, which should be cleaned or changed as per manufacturer's instructions to avoid the build-up and re-aerosolization of dirt, dust and particulate matter. A number of personal fans, exhaust vents, and air diffusers were observed to have accumulated dust/debris. Re-activated diffusers, vents or fans can aerosolize accumulated dust. If exhaust vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles.

Upholstered furniture (i.e., couches, gym mats) was noted in a few classrooms, some of which was damaged (Picture 37). These upholstered items are covered with fabric that comes in contact with human skin, which can leave oils, perspiration, hair and skin cells. Dust mites feed upon human skin cells and excrete waste products that contain allergens. Furthermore, increased relative humidity levels above 60 percent can also perpetuate dust mite proliferation (U.S. EPA, 1992). In order to remove dust mites and other pollutants, frequent vacuuming of upholstered furniture is recommended (Berry, 1994). It is also recommended that upholstered furniture present in schools be professionally cleaned on an annual basis or every six months if dusty conditions exist (IICRC, 2000).

In some classrooms, items were observed on 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.

Accumulated chalk dust and pencil shavings were noted in some classrooms. Chalk dust is a fine particulate that can easily become airborne, irritating the eyes and respiratory system.

In some areas, ceiling tiles were missing and/or ajar; in other areas items were observed hanging from ceiling tiles. The movement or damage to ceiling tiles can release accumulated dirt, dust, and particulates that accumulate in the ceiling plenum into occupied areas.

Small space heaters were observed in several areas. Care should be taken as to where these units are used and that no flammable materials (papers, books, boxes, etc.) are in close proximity to constitute a fire hazard.

Quantitative Evaluation of Potential Health Risks from Opportunities for Exposure to PCBs

Three general types of samples (i.e., air, wipe and bulk) were analyzed for PCBs. For purposes of evaluating potential health concerns, the data for indoor air concentrations of PCBs along with information on IAQ parameters are most appropriate. Wipe samples are typically used to determine the effectiveness of cleanup activities, and bulk samples are used to try to identify possible sources of PCBs.

Indoor air samples were analyzed by the City of New Bedford's initial contractor, BETA, for all 209 individual PCB congeners (BETA, 2006). PCB molecules have individual congeners that are unique and differ based on the number and position of chlorine atoms on the molecule. There are 209 possible combinations, meaning 209 individual PCB congeners. Congeners that are organized into groups according to similar numbers of chlorine atoms (e.g., dichlorobiphenyls, trichlorobiphenyls, etc.) are called homologues. TRC, the current City of New Bedford contractor, analyzed air samples for PCB homologues. TRC summed the measures of detectable homologues, including "J" or estimated values, to come up with a figure for total PCBs. It should be noted that homologue methods don't allow for congener identification.

Wipe samples were analyzed for Aroclors. Aroclors were commercial mixtures of PCBs that comprised a variety of PCB congeners when they were produced. Bulk samples were also analyzed for Aroclors. The Aroclor analysis for wipe and bulk samples targeted 7 Aroclors (i.e., 1016, 1221, 1232, 1242, 1248, 1254, and 1260). For wipe and bulk samples, results were reported as total PCBs (i.e., the sum of the results for detectable Aroclors, including “J” values).

Table 4 presents maximum levels of PCBs detected in indoor air over all sampling rounds (conducted over 2006 – 2011 by both BETA and TRC) summarized by house/block/floor within the school. In addition, the maximum total PCB levels in indoor air are summarized as to whether the values exceed the ATSDR CREG of 0.01 µg/m3.

Table 5 presents data summarized by sample date, including media sampled (i.e., air, wipes, bulk), sampling and analytical test methods, and results. The number of indoor air values that exceeded the ATSDR CREG is noted on Table 5, as well as an indication of the number of wipes (with detectable PCBs) that exceeded the CA DTSC guideline. Finally, hundreds of bulk samples were collected and analyzed for PCBs over the various test dates for a number of different types of building materials, both porous (e.g., foam upholstery) and non-porous (e.g., vinyl tile). Where applicable, Table 5 notes whether PCB Bulk Product Waste was identified (i.e., materials originally manufactured with PCBs that have levels above 50 mg/kg). Figures 7a and 7b provide maximum detected levels of PCBs in indoor air for each sample round, as well as information regarding the timing of remedial activity and sampling for other media (i.e., wipes, bulk) in relation to the indoor air sampling (Figure 7c depicts disturbance of walls and baseboard areas typical of bulk sampling).

In April 2006, the BETA Group, Inc., collected 6 indoor air samples from “high traffic” areas in the school (including one classroom in D Block, 4 hallway areas in A Houses 1 - 3 and B Core, and the Boy’s gym) and 2 outdoor/background air samples. Samples were collected over a 24-hour period, according to U.S. EPA Method TO-4A (1999a). Results for the 6 indoor samples indicated total PCB concentrations ranging from 0.0043 to 0.052 µg/m3. Four of the six indoor air samples slightly exceeded the ATSDR CREG, with a maximum of 0.052 µg/m3. The 2 outdoor/background samples were collected in the playground near the outside of A-House 4 (Blue) and the Auto Shop (D-116) and results were 0.00087 µg/m3 and 0.00105 µg/m3, respectively.

TRC conducted indoor air testing for PCBs at NBHS for a total of 4 rounds over the years 2006 – 2008. Additionally, TRC conducted follow up indoor air testing in 2010 and 2011. TRC used sample collection method TO-4A, initially to compare results with BETA, then piloted and continued to use U.S. EPA Method TO-10A (1999). Results from the 2 methods should be similar, although TO-4A is generally more sensitive (i.e., can quantify lower concentrations) than TO-10A. The pilot testing of method TO-10A through comparison of co-located background sample results indicated the TO-10A method was sensitive enough to achieve project criteria and approved for use by USEPA.

MDPH/BEH reviewed indoor air results over 2006-2008 by building wing (i.e., A-Houses, B Core, and C, D, E, and F Blocks) and by floors within each wing, to evaluate the pattern of PCB detections. In addition, MDPH/BEH compared areas where samples of multiple media were taken in close proximity (e.g., air/wipes, air/bulk, etc.), and compared sample results of PCBs in indoor air with results of MDPH/BEH Indoor Air Quality (IAQ) measurements of carbon dioxide (CO2) levels in rooms, conducted over April 29 – 30, 2008. The CO2 data are an indicator of the adequacy of fresh air ventilation, and inadequate air exchange is one of several factors that may affect PCB levels in indoor air. The detection limit for the wipe samples was 0.5 μg/100 cm2 wipe, above the CA DTSC recommended guideline. The majority of wipe samples taken throughout the school on multiple test dates were non-detect, therefore, it was not possible to meaningfully interpret these results in relation to the CA guideline. However, the detection limit was well below the EPA guideline of 10 μg/100 cm2.

In total, 89 indoor air samples from 30 locations were analyzed for PCBs over the years 2006 – 2008. Of these 89 samples, 75 of the samples had concentrations of PCBs greater than the CREG. Five samples were non-detect for PCBs in indoor air (rooms B-113, B-114, D-237 – Auditorium, D-116 (auto shop) and E-117 – Girl's gym), all collected in February 2008. Rooms B-113 and B-114 were not measured for CO2 because they are the shipping room and mechanical room, respectively, and therefore, are not "occupied" similar to classrooms or other occupied areas. However, CO2 levels in room D-237 (555 ppm; occupancy 50) and E-117 (520 ppm; occupancy 15) were both below 800 ppm, indicating adequate ventilation may have explained non-detectable PCBs in these rooms.

Of the 30 locations with indoor air results, 24 rooms had available CO2 data. Of the 24 rooms with CO2 data, all but 5 had PCB concentrations greater than the CREG. Three of the 5 rooms with PCBs less than the CREG were D-237 (auditorium), D-116 (auto shop) and E-117 (girls' gym) previously discussed. The other two rooms with PCBs less than the CREG (A-4-205 and E-136) had CO2 levels of 672 ppm and 468 ppm with occupancy of 7 and 11, respectively, again indicating acceptable air exchange. Nine of the 24 rooms had CO2 levels above 800 ppm (i.e., classrooms A-1-117, A-1-205, A-1-227, A-2-227, A-2-311, A-3-114, A-4-110, and A-4-315, and the cafeteria A-4-103). For 11 rooms with concentrations of PCBs greater than the CREG (i.e., classrooms A-1-303, A-2-105, A-3-205, A-3-307, A-4-212, B-240 and B-309, locations B-242 and B-288, and shop rooms D-106, and D-116) CO2 levels were below 800 ppm, but 8 of these 11 rooms had no or low occupancy at the time of CO2 testing. The MDPH typically considers occupancy less than 50% of the typical occupancy of a given area to be low occupancy. As previously mentioned, CO2 levels will be lower with few or no occupants in a room even if ventilation is less than adequate. The PCB data for nine of these 11 rooms indicate the lack of ventilation is likely contributing to the building up of PCB concentration in the indoor air.

TRC conduced a survey in the fall of 2010 to investigate all fluorescent light ballasts in NBHS for the presence of PCB containing materials and/or visible residue (e.g., from leakage). They tabulated and summarized the information in a February 2011 memo to EPA (TRC, 2011c), noting type and locations of impacted ballasts (2,946 ballasts noted as impacted). According to their memo, the percentage of impacted ballasts (i.e., ballasts with visible residue potentially containing PCBs) for each of the four A Houses range from about 37% to 45% (A House Green 44.6%, A House Blue 41%, A House Tan 40.8%, and A House Gold 37.4%). In blocks B – F the range of percentage impact is from 23% (D-Block) to 67% (F-Block). The stairwells and hallways were reported to have an average of 84% impacted ballasts. The intensive clean up activities conducted at NBHS in 2007 do not indicate that light fixtures were cleaned. This is supported by the TRC ballast inventory which indicated residues remain on light fixtures throughout the school. Only one wipe sample was available for a light fixture, and that sample indicated a PCB level of 1.776 µg/wipe, which is above the CA DTSC clean up guideline (0.1 µg/wipe). While the wipe test in this case was taken to determine the need to further clean, TRC removed all impacted ballasts during the summer of 2011, consistent with TSCA regulatory requirements (TRC, 2011d, h).

Since 2008, additional focused indoor air testing for PCBs has been conducted. One indoor air sample was analyzed for PCBs in the daycare (room A-4-227) in August 2010 (result was less than the CREG; 0.00763 (J) µg/m3) (TRC, 2011a). In February 2011, another 48 indoor air samples were collected, including 20 of 26 locations that were sampled in 2008, and analyzed for PCBs (TRC, 2011e and f). [TRC also analyzed 11 additional indoor air samples for a smaller group of PCB congeners called dioxin-like congeners. According to TRC's evaluation of the data, results of these analyses were about at or less than EPA industrial Regional Screening Levels (RSLs) (TRC, 2011e and f).] Two outdoor/background samples were also collected.

Twenty five of the 48 indoor air samples collected in February 2011 had detectable PCBs, ranging from 0.00252 (J) µg/m3 to 1.45 µg/m3. Of the 25 detects, 17 samples had levels above the CREG. Three classrooms (A-1-110, 1.1 (J) µg/m3; A-1-315, 1.45 (J) µg/m3; and A-2-203, 0.441 (J) µg/m3) were closed for further testing and investigation (TRC, 2011g). Notably, TRC identified evidence of leakage of PCB residue from fluorescent light ballasts on light fixture trays in these rooms as well as a fourth room (A-3-307; 0.139 (J) µg/m3) with the next highest PCB level. Impacted light fixture trays in these rooms were removed over school vacation in April 2011, and additional follow up indoor air samples were collected in these 4 rooms, plus another 4 locations at that time (rooms A-2-112, A-2-311, A-4-212, and A-4-315).

Of the 20 locations that were sampled both in February 2008 and February 2011, 5 locations had similar levels of PCBs in both rounds, 10 locations had lower levels of PCBs in indoor air in 2011, and 5 locations were higher in 2011. One of the five rooms with higher levels of PCBs in February 2011 than February 2008 was A-3-307. This room had an impacted light fixture tray that was removed in April 2011. Follow up indoor air testing two days after the light fixture tray was removed in A-3-307 indicated another increase, indicating the timing of the sampling so close to disturbance of the PCB containing materials may have impacted results. PCB levels in this room then decreased in August 2011, several months after the impacted light fixture tray was removed. No information regarding characteristics in the other 4 rooms (e.g., impacted light fixtures, HVAC malfunction) were available to evaluate potential reasons for the increase in PCB levels in 2011.

Fifteen new locations were sampled in 2011 that had never been tested for PCBs in indoor air previously, including the two classrooms, A-1-110 and A-1-315 which had the highest levels of PCBs detected in indoor air in any sampling round (1.1 (J) µg/m3 and 1.45 (J) µg/m3). It should be noted that these 2 classrooms had CO2 levels of 1629 ppm and 1297 ppm and occupancy of 6 and 19 people, respectively, thereby indicating that inadequate ventilation likely contributed to higher levels of PCBs. MDPH/BEH IAQ staff also noted that at the time of CO2 testing in 2008 the supply and exhaust were off in room A-1-110; the supply was off and the window was open in room A-1-315, indicating suboptimal ventilation.

The results of the April 2011 round of indoor air sampling (9 samples, including duplicate) ranged from ND (<0.00347 µg/m3) in room A-4-212 to 1.25 µg/m3 in room A-1-315. Although the overall maximum PCB level in indoor air was down in April 2011, the highest detections of PCBs in this round were found in the 4 rooms with PCB containing light fixture trays that were removed right before testing (i.e., A-1-110, 0.851 µg/m3; A-1-315, 1.25 µg/m3; A-2-203, 0.343 µg/m3; and A-3-307, 0.167 µg/m3) and in another room (i.e., A-2-311, 0.225 µg/m3). Eight rooms sampled in April 2011 (including the 5 rooms above), another 3 rooms that were sampled in February 2011 but not April 2011, and locker 1579 were all re-sampled in August 2011 after remedial work (e.g., bulk removal of remaining PCB impacted light fixtures, paint, auditorium seating). All sample results from the August 2011 round had detectable PCBs, ranging from 0.00536 µg/m3 to 0.577 µg/m3 (TRC, 2011h). Of the 4 rooms with impacted light fixtures that were removed immediately before the April 2011 round, August 2011 PCB levels decreased in 3 of these rooms (i.e., A-1-110, 0.411 µg/m3; A-1-315, 0.577 µg/m3; and A-3-307, 0.0683 µg/m3) and increased slightly in room A-2-203 (i.e., 0.564 µg/m3) (TRC, 2011h). Rooms A-1-110, A-1-315, and A-2-203 remain closed. In 2012, adjustments were made to the ventilation system to increase air exchange in room A-2-203, and re-sampling was conducted in April 2012 with results of 0.343 µg/m3 and 0.383 µg/m3 (duplicate) (TRC, 2012a). Univent air filters were changed, ceiling tiles were removed/replaced, and all moveable furniture was removed in this room before an additional sample event in July 2012, with results of 0.559 µg/m3 and 0.526 µg/m3 (duplicate) (TRC, 2012a). It is unclear why levels continue to fluctuate in room A-2-203, but, as noted above, remedial activity has been ongoing. It is the understanding of MDPH that the status of rooms A-1-110 and A-1-315 are pending further ventilation system assessment and adjustment (TRC, 2012b).

A-House 1 (Green)

Four areas in A-House 1 (Green) were sampled for PCBs in indoor air (n = 16) during the period April 2006 – February 2008: one location on the first floor, room A-1-117 (3 samples, results ranging from 0.01 µg/m3 – 0.099 µg/m3); 2 locations on the second floor, including A-1-205 (3 samples, results ranging from 0.0041 (J) – 0.045 µg/m3) and the hallway at locker

1579 (7 samples, including duplicates, results ranging from 0.014 (J) – 0.062 (J) µg/m3); and one location on the third floor, room A-1-303 (3 samples, results ranging from 0.0084 (J) – 0.04 (J) µg/m3). Fourteen of 16 samples were greater than the ATSDR CREG (0.01 µg/m3). The 2 samples less than the CREG were collected from A-1-205 (<CREG in August 2007) and A-1-303 (<CREG in February 2008).

Indoor air testing for carbon dioxide (CO2) by MDPH/BEH/IAQ staff, conducted over April 29-30, 2008 (Tables 1 and 2), indicate the ventilation system may have still been malfunctioning in the Green House during the February 2008 air testing. Supply or exhaust vents were noted as off or blocked in rooms A-1-117, A-1-205, and A-1-227 where PCBs were detected at or above the CREG in February 2008, and CO2 levels were greater than 800 ppm. Room A-1-303 had a PCB concentration less than the CREG in February 2008 and a CO2 concentration less than 800 ppm, but there were no occupants in the room at the time of CO2 testing. February 2011 testing indicated two rooms in Green House (A-1-110 and A-1-315) had the highest levels of PCBs in indoor air ever detected in the school on any test date (1.1 (J) µg/m3 and 1.45 (J) µg/m3, respectively) (Table 4). IAQ testing indicated suboptimal ventilation (i.e., CO2 levels of 1629 ppm and 1297 ppm, respectively) and noted the HVAC supply vents were off in both rooms, and the exhaust vent was also off in A-1-110.

A total of 27 wipe samples were collected in various areas of A-House 1 (Green), including samples collected on each of the 3 levels. All but 4 wipe samples were ND, with detections ranging from 0.472 (J) – 1.776 (J) µg/wipe, all from the 2nd floor.

Nearby, in a hallway by the men's bathroom (2nd floor Green hallway between rooms A-1-225 and A-1-205), a wipe sample was collected from the top surface of a light fixture on August 22, 2006 (1.776 µg/wipe).

A-House 2 (Gold)

Four areas in A-House 2 (Gold) were sampled for PCBs in indoor air (n = 10) from April 2006 – February 2008: one location on the first floor, room A-2-105 (3 samples, results ranging from 0.003 µg/m3 – 0.046 µg/m3); two areas on the second floor, room A-2-227 (3 samples, results ranging from 0.011 (J) µg/m3 – 0.039 (J) µg/m3) and a hallway on the second floor near locker 2579 (one sample collected by BETA in April 2006, resulting in a level well below the CREG of 0.000013 µg/m3); and one location on the third floor, room A-2-311 (3 samples, PCB concentrations ranging from 0.019 (J) – 0.11 µg/m3). Eight of the 10 samples exceeded the CREG. Indoor air levels declined below the ATSDR CREG in February 2008 in room A-2-105 on the 1st floor. PCB levels in A-2-227 and A-2-311 declined to just slightly above the ATSDR CREG in February 2008 (0.011 (J) and 0.019 (J) µg/m3, respectively), however, CO2 levels in these rooms were 1636 and 1861 ppm (19 and 16 occupants, respectively), and IAQ staff noted some malfunctioning of the ventilation system in room A-2-227. The CO2 level in A-2-105 was less than 800 ppm, but the room had only 2 occupants at the time of testing.

Wipe results in Gold House (n = 16) were all ND, except for rooms A-2-227 (wipe on ceiling exhaust vent above door 1.14 (J) µg/wipe, collected August 22, 2006), and A-2-311 (wipe on univent 0.549 µg/wipe, also collected August 22, 2006).

A-House 3 (Tan)

Four areas in A-House 3 (Tan) were sampled for PCBs in indoor air (n = 11) over April 2006 – February 2008: room A-3-114 on the first floor (5 samples, PCB concentrations ranging from 0.032 (J) – 0.26 µg/m3); room A-3-205 on the second floor (3 samples, results ranging from 0.0086 (J) – 0.064 (J) µg/m3); and two areas on the third floor, room A-3-307 (2 samples, with PCB concentrations of 0.085 (J) and 0.13 (J) µg/m3) and the 3rd floor hallway near locker 3185 (one sample collected by BETA in April 2006 with a PCB level of 0.0414 µg/m3). PCB levels in 10 of the 11 samples exceeded the CREG, and the 11th sample (0.0086 (J) µg/m3) was collected from A-3-205 during February 2008.

Multiple bulk samples (e.g., dust taken from ductwork; window glaze; paints and mastics) were collected from A-3-114 over August 13 – 16, 2007; air samples were collected simultaneously, on August 14, 2007. While no bulk sample detections exceeded the TSCA 50 mg/kg PCB Bulk Waste standard, it's plausible that disturbance of bulk materials while conducting the air testing in this room may have contributed to PCBs measured in air (0.076 (J) and 0.069 (J) µg/m3). MDPH/BEH/IAQ staff measured CO2 levels in air in this room over April 29-30, 2008 (1689 ppm, 26 occupants in room) and noted that the supply and exhaust vents were both off. The PCB concentration measured in this room in February 2008 (no bulk sampling conducted) declined to 0.032 (J) µg/m3. February 2011 results for this room indicated PCB levels were non-detect (<0.00339 µg/m3), suggesting that disturbance of bulk materials while testing in 2007 may have contributed to indoor air levels of PCBs which have since declined after no further disturbance.

PCB air levels in room A-3-205 on the 2nd floor declined from a maximum of 0.064 (J) µg/m3 (August 14, 2007) to below the ATSDR CREG (0.0086 (J) µg/m3) during the February 2008 round of air testing. No bulk sampling was conducted in this room during the August 2007 air testing. CO2 levels measured in this room by MDPH/BEH/IAQ staff over April 29-30, 2008 were below 800 ppm (769 ppm, 8 occupants in room). PCB air levels in room A-3-307 on the 3rd floor of Tan House declined from 0.13 (J) µg/m3 (August 14, 2007) to 0.085 (J) µg/m3 in February 2008. Again, no bulk sampling was conducted in this room during the August 2007 air testing.

A-House 4 (Blue)

A-House 4 (Blue) contains a daycare (room A-4-227) on the second floor, where children approximately 3 – 4 years old attend for half-days from September to early May. No air sampling for PCBs was conducted in this room during any round of testing from April 2006 – February 2008. The CO2 level measured by MDPH/BEH/IAQ staff over April 29-30, 2008 was 1256 ppm, (occupancy 30, window open), and the single wipe sample collected in this room was non-detect. One indoor air sample (plus duplicate) was taken in the daycare room in August 2010, and the results were reported in January 2011 (TRC, 2011a). Results of the sample plus duplicate (0.00763 J and 0.0054 J µg/m3, respectively) were well below the ATSDR CREG (0.01 µg/m3).

Five areas in A-House 4 (Blue) were sampled for PCBs in indoor air over April 2006 – February 2008 (n = 20): rooms A-4-110 (8 samples, PCB concentrations ranging from 0.0016 (J) to 0.69 (J) µg/m3) and A-4-103 (Blue cafeteria) on the first floor (3 samples, results ranging from 0.0014 (J) – 0.025 µg/m3); rooms A-4-205 (2 samples, with PCB concentrations of 0.0037 (J) and 0.0056 (J) µg/m3) and A-4-212 on the second floor (4 samples, results ranging from 0.13 (J) – 0.62 (J) µg/m3); and room A-4-315 on the 3rd floor (3 samples, results ranging from 0.043 (J) – 0.23 (J) µg/m3). Fifteen of the 20 samples had concentrations of PCBs greater than the CREG. Three of the 15 samples with PCBs above the CREG were collected from room A-4-212, which had a CO2 level less than 800 ppm (481 ppm) when measured over April 29-30, 2008. However, the room was closed for cleaning and occupancy was zero during CO2 testing.

Three of the remaining 12 samples with air levels of PCBs above the CREG were collected from room A-4-315, which had a CO2 level of 1417 ppm (supply was blocked and occupancy was 24 people at the time of CO2 testing). The remaining 8 air samples with PCB levels above the CREG were collected from rooms A-4-110 and A-4-103, and both of these rooms had CO2 levels above 800 (911 ppm and 1015 ppm, respectively; occupancy zero and 7, respectively, although approximately 150-200 people had just left A-4-103 prior to CO2 testing). Of the 5 samples that had PCBs in air below the CREG, two were taken from room A-4-205 with CO2 levels below 800 ppm (672 ppm); the February 2008 samples collected in rooms A-4-103 and A-4-110 (0.0014 (J) µg/m3 and 0.0016 (J)/0.0056 (J, dup) µg/m3, respectively) were all below the CREG.

A bulk sample of return air vent dust from room A-4-110 (1st floor, Blue House) was taken on August 22, 2006, on the same day of air testing for PCBs, with a result of 4.442 (J) mg/kg. The detected Aroclors in this dust sample were 1242, 1254, and 1260 (all "J" values). The air sampling for PCBs in this room on the same date resulted in 0.059 µg/m3, with primary (non-"J") detects of di-, tri-, and tetra-chlorobiphenyls. According to ATSDR, 80% of commercial mixture Aroclor 1242 was comprised of these homologues. The primary detect in air testing for PCBs in this same room (A-4-110) during the August 2007 round (0.69 (J) µg/m3), immediately post-cleaning, were penta-chlorobiphenyls (non-"J"); mono- through tetra-chlorobiphenyls were detected, but were estimated "J" values for this sample. It is not surprising that the most volatile PCBs (e.g., the lightest or the mono- to tetra- chlorinated) would show up in air testing. Notably, according to ATSDR (2000), penta-chlorobiphenyls comprised approximately 71% of commercial Aroclor 1254 mixtures. Therefore, PCBs measured in the return duct dust measured in 2006 (4.442 (J) mg/kg) for this room (A-4-110) were potentially captured in both 2006 and 2007 air sampling. While it is not possible to ascertain with certainty whether the PCBs in dust disturbed for testing may have contributed to PCB levels measured in air in this room, it is plausible that disturbing the return duct dust for bulk testing in August 2006 contributed to elevated air levels of PCBs. Adding to this likelihood is the observation that six months after cleaning, and approximately 1.5 years after bulk testing, air levels in this room dropped below the CREG during the February 2008 air testing round (0.0016 (J) / 0.056 (J) µg/m3, duplicate). Furthermore, PCB levels measured in A-4-110 in February 2011 were non-detect (<0.00333 µg/m3) suggesting that results of earlier rounds of testing in this room may have been impacted by disturbance of bulk materials for testing.

Paired air/bulk data is also available for room A-4-212 (2nd floor, Blue House). This room was closed for cleaning when MDPH/BEH/IAQ staff measured CO2 (481 ppm, April 29-30, 2008), and, therefore, was unoccupied. The maximum PCB level in air measured in this room was 0.62 (J) µg/m3 on August 14, 2007, immediately post-cleaning, but before HEPA filtration; post-HEPA filtration, on August 29, 2007, PCBs in air declined slightly to 0.56 (J) µg/m3. Approximately 6 months post-cleaning, PCB air levels dropped to 0.13 µg/m3, still elevated above the ATSDR CREG of 0.01 µg/m3, and, although levels dropped in February 2011 (0.0842 (J) µg/m3), results were still above the CREG. No indoor air testing for PCBs was conducted in this room in 2006, but a round of bulk sampling was conducted here on 8/22/06, with the following results: window caulk inside classroom, 34.43 mg/kg, primary detect Aroclor 1242, some Aroclor 1254 detected also; and a bulk sample of return air duct dust resulted in 36.5 (J) mg/kg (Aroclors 1242, 1254, and 1260 detected, all "J" or estimated values). PCB detects in indoor air in this room in 2007 and 2008 indicated primarily di- through penta-chlorobiphenyls ("J" values). Again, it's plausible that disturbing materials for bulk sampling in 2006 (i.e., caulk/dust) may have impacted PCB levels measured in air, which have lowered in 2008 and again in 2011.

B-Core

Six areas in B-Core were sampled for PCBs in air (n=19) over April 2006 – February 2008: two areas on the 1st floor, including rooms B-113/shipping hallway (3 samples, results ranging from <0.0038 to 0.04 µg/m3) and B-114/chiller deck/mechanical room (3 samples, results ranging from <0.0037 to 0.075 µg/m3); 3 areas on the 2nd floor, including rooms B-240 (6 samples, PCB levels ranging from 0.0052 to 0.32 (J) µg/m3), B-242 (3 samples, PCB levels ranging from 0.027 – 0.03 µg/m3), and B-288 (3 samples, PCB levels ranging from 0.02 – 0.041 µg/m3); and one area on the 3rd floor, room B-309 (1 sample, PCB level of 0.0149 µg/m3). Of the 19 samples collected and analyzed for PCBs in air in these 6 areas, 2 were non-detect (Rooms B-113 and B-114, detection limits <0.0038 and <0.0037 µg/m3, respectively, both samples collected in February 2008, approximately 6 months post-cleaning). Sixteen of 19 samples had concentrations of PCBs greater than the CREG (rooms B-113, B-114, both pre-cleaning or immediately post-cleaning, and rooms B-240, B-242, B-288 and B-309). One of the 19 samples, taken from room B-240 (February 2008, approximately 6 months post-cleaning) had a PCB level slightly above the CREG (0.025 (J) µg/m3, the average of 2 duplicate samples).

Room B-240 (0.31 µg/m3) had the highest quantifiable level of PCBs detected in the school during any sampling round (that is, the value was not an estimated, or J value). Paired air/wipe/bulk/CO2 data is available for this room. The CO2 level measured by MDPH/BEH/IAQ staff (April 29-30, 2008) was 500 ppm, likely due to the fact that the room was unoccupied and was closed for cleaning during CO2 testing. Some exhaust vents were noted as weak or blocked and a number of supply vents in the area were noted as off or blocked by IAQ staff during CO2 testing throughout B-Core. The only wipe sample collected in the room, taken on top of a bookcase, had detectable PCBs (1.56 µg/wipe, sampled on August 22, 2006) above the CA DTSC guideline (0.1 µg/wipe) but below the U.S. EPA clean-up standard (10 µg/wipe). Two bulk samples (of 19 total) collected from room B-240 exceeded the U.S. EPA TSCA standard (50 mg/kg, Bulk Product Waste), including laminate adhesive from the counter/cabinet (230 (J) mg/kg) sampled on 7/17/08, and rust-proof interior univent coating (65.4 (J) mg/kg) sampled on 2/17/09. Other samples, such as window glaze, mastics, and paints, sampled during August 2007, July 2008, and December 2008 rounds, contained detectable PCBs that were well below 50 mg/kg. No bulk samples were collected from this room in 2006 when an air sample was collected (8/22/06, 0.31 µg/m3), however, bulk samples were collected at that time from a nearby room (B-242). Air levels of PCBs in B-240 stayed fairly constant during the 2007 testing rounds (0.29 (J) and 0.32 (J) µg/m3 on 8/14/07; 0.25 (J) µg/m3 on 8/29/07); however, given that multiple bulk samples were collected from this room at or around the same time of air testing, it is again entirely plausible that disturbing these materials for testing contributed to elevated air levels. Notably, when air was tested during the February 2008 round, levels of PCBs came down to 0.0052 (J) and 0.044 (J, dup) µg/m3, and were non-detect in February 2011 (<0.00324 µg/m3). It appears no additional bulk testing was conducted in the school after August 2007, again suggesting that disturbance of PCB containing materials may have affected indoor air concentrations of PCBs measured in earlier rounds. According to TRC (2010a; 2010b), all B-Core univents were removed and replaced during summer 2010.

C-Block

No indoor air sampling for PCBs was conducted by BETA or TRC in C-Block during April 2006 – February 2008 (and no rooms in C-Block were tested for CO_2 by MDPH IAQ staff). February 2011 indoor air testing for PCBs was conducted in the main office (C-216) and results were non-detect (<0.00339 µg/m3). In addition, the majority of wipe samples collected in or around the air-handling systems in this area of the school (e.g., return, exhaust vents) were non-detect (<0.5 µg/wipe). However, in the boiler room (C-101) four wipe samples collected had detectable levels of PCBs, all above the CA DTSC guideline, and one (7.07 µg/wipe, taken of lubricant on an air handler) was close to the U.S. EPA standard of 10 µg/wipe. It is important to note that surface wipe samples are taken to help determine where more aggressive cleaning may be necessary, not to assess health risks. The U.S. EPA and CA DTSC clean-up levels cited here are useful in determining the need for cleaning in the school. Since these wipe samples in C-101 were collected post-cleaning (July 2008), these areas should be inspected and cleaned with greater frequency.

D-Block

Four areas in D-Block were sampled for PCBs in air (n=10) over April 2006 – February 2008: 3 areas on the 1st floor, including room D-106 (1 sample taken with a PCB level of 0.0107 µg/m3), room D-116/auto shop (3 samples, PCB levels ranging from ND (<0.0031) to 0.013 µg/m3), and room D-122/CCP lab (3 samples, PCB levels ranging from 0.011 to 0.066 µg/m3); and one area sampled on the 2nd floor, room D-237/auditorium (3 samples, PCB levels ranging from ND (<0.0035) to 0.0053 µg/m3). Of the 10 samples collected and analyzed for PCBs in air in these 4 areas, 5 samples had PCBs concentrations greater than the CREG. The maximum level of PCBs in indoor air detected on the 1st floor of D-Block (0.066 (J) µg/m3) was sampled immediately post-cleaning in the CCP lab. PCB levels in air declined in the CCP lab approximately 6 months post-cleaning to 0.011 µg/m3, just at the level of the ATSDR CREG. Results in the CCP lab were non-detect (<0.0034 µg/m3) in February 2011. No CO_2 levels were taken in the CCP lab; the CO_2 level in the auto shop was 425 ppm. PCB levels in air detected on the 2nd floor, in the auditorium (D-237), were all well below the ATSDR CREG on all sampling dates. MDPH/BEH/IAQ staff measured a CO_2 level in this room (555 ppm) on

April 29-30, 2008) and noted that the auditorium had approximately 50 occupants at the time of testing, indicating adequate ventilation in the room, consistent with the low air levels of PCBs.

Several wipe samples collected from the auto shop and the CCP lab had detectable levels of PCBs, ranging from 0.436 (J) to 8.996 µg/wipe (top of wall heating vent in auto shop) pre-cleaning. However, post-cleaning clearance wipe testing in the auto shop was all non-detect (<0.5 µg/wipe), indicating that the cleaning effort was successful in this area. No follow up clearance wipe testing was conducted in the CCP lab. These areas should be inspected and cleaned frequently, to reduce any potential exposure opportunities from touching or handling multiple work surfaces.

Of note, D-Block contains an indoor shooting range/firing area (room D-143). This room was sampled for PCBs in indoor air in February 2011 and was non-detect (<0.0034 µg/m3). One bulk sample was taken in this room in 2007 and analyzed for lead. This bulk sample was collected from dust in the exhaust duct work of the firing range, with a total lead concentration of 112,000 mg/kg.

E-Block

Two areas in E-Block, which house the boys' and girls' gyms, locker rooms, and weight room, were sampled for PCBs in air over April 2006 – February 2008 (i.e., rooms E-117 and E-136, n=4). Of the 4 samples analyzed in these 2 areas for PCBs in air, 3 samples were less than the CREG (ranging from 0.0043 – 0.0061 µg/m3), and one sample (room E-117) was non-detect (<0.0032 µg/m3). All areas sampled in E-Block by MDPH/BEH/IAQ staff had CO2 levels below 800 ppm (occupancy ranging from 4 – 12 people). While no PCB levels in air were elevated above the ATSDR CREG in the girls' gym (E-117), one wipe sample, collected pre-cleaning from the top of a duct near the ceiling, had a level of 5.363 (J) µg/wipe, well above the CA DTSC clean up guideline but below the U.S. EPA standard. Immediately post-cleaning, clearance wipe testing in this area was non-detect (<0.5 µg/wipe). While inaccessible in terms of exposure opportunities (since it is near the ceiling), it is prudent to inspect and clean all gym areas frequently.

F-Block

F-Block houses the pool and pool locker rooms. No locations were sampled for PCBs in indoor air during April 2006 – February 2008. Results from 3 indoor air samples collected in February 2011 in F-Block were all non-detect (i.e., boys' pool locker room <0.00333 µg/m3; girls' pool locker room <0.00343 µg/m3; and pool filter room <0.00309 µg/m3). One bulk sample, collected pre-cleaning in a pool locker room, indicated a PCB level of 0.1757 (J) mg/kg in wall tile mastic. Locations sampled by MDPH/BEH/IAQ staff for CO2 in air (i.e., F-109 – the girls' pool locker room, and F-Block pool) were both below 800 ppm (458 and 504 ppm, 15 and no occupants, respectively, at time of testing). All 8 wipes samples collected (girls' and boys' pool locker rooms, on locker bottoms, exhaust ducts, supply duct and an air handling unit; and hallway on first floor and pool basement (interior heating ventilator, air handling units, respectively) were non-detect (<0.5 µg/wipe).

Outdoor/Background

Several outdoor/background samples were collected during multiple rounds of testing, both pre- and post-cleaning, from the following areas: 1) outside on the east side, near the A-House 4 (Blue) Cafeteria and auto shop, 2) outside, on the west side, in front of the school's main office, and 3) outside, on the west side near A-House 1 (Green). The majority of outdoor samples were non-detect (lowest DL was <0.000071 µg/m3), and the maximum detect was 0.0015 (J) µg/m3, taken outside of the auto shop immediately post-cleaning, Therefore, it does not appear that outdoor levels of PCBs appreciably contributed to levels observed indoors.

PCB Exposure Assessment

Theoretical Cancer Risk

The U.S. EPA has classified PCBs as a probable human carcinogen (EPA IRIS, 1997). This classification is based on a number of occupational and epidemiological studies in humans, and clear evidence of carcinogenicity in animal studies. Due to their chemical stability, PCBs are persistent organic pollutants in ambient and indoor environments (Hermanson & Hites, 1989), and they are known to be bioaccumulative (accumulate in biological tissue, i.e., fatty tissue) due to their lipophilic properties (Decastro et al., 2006).

The previous section entitled "Methods used to evaluate potential health risks associated with PCBs in NBHS" contains an explanation on screening results using health based comparison values (e.g., CREG). A number of indoor air samples from multiple locations on various testing dates (pre- and post-cleaning) were above the ATSDR CREG (0.01 µg/m3). An exceedance of a CREG does not necessarily mean an unusual cancer risk exists but instead should be further evaluated given the specific situation. Estimated exposure dose and theoretical cancer risk calculations were performed to further evaluate opportunities for exposure or health concerns.

Indoor air sample results for PCBs indicated that room A-1-315 had the highest concentration of PCBs (1.45 J µg/m3) in any location of the school that was sampled on any test date. Assuming a worst case scenario, a PCB concentration of 1.45 µg/m3 was used as a conservative estimate to conduct exposure dose and theoretical cancer risk calculations for students and staff to further evaluate opportunities for exposure or health concerns. The theoretical cancer risk calculation estimates an excess cancer risk in terms of the proportion of the population that may be affected by a carcinogenic substance over a lifetime of exposure (ATSDR, 2005). In other words, an estimated cancer risk of 1 in a million (1 x 10-6) would mean that there is a probability of one additional cancer over background levels in a population of one million people. The U.S. EPA derives cancer slope factors for use in theoretical cancer risk calculations, and these are derived based on conservative models, which extrapolate results from higher experimental doses to low dose environmental exposures.

In order to calculate estimated cancer risks from the levels of PCBs measured in the indoor air (see Appendix D), we assumed a reasonable daily exposure for 180 days per year (school days) for 37 years (number of years of service at the school for the longest serving employee) for adults, and daily exposure for 180 days per year, for 4 years for students. This type of evaluation is to present the worst case scenario in terms of cancer risk, meaning the greatest potential cancer risk. Assuming an 8 hour daily exposure (school/work day) the theoretical excess cancer risk calculated for adults was approximately 5.5 in 100,000 (5.5 x10-5). In other words, for adults the risk estimate would result in approximately 5 - 6 excess cancer diagnoses in a population of 100,000. For high school students the risk estimate was approximately 6.7 in a million (6.7 x10-6). Based on guidance used nationally, the exposure opportunities that resulted in these risk estimates are not expected to result in unusual cancer concerns (CDC, 2011).

A number of important factors should be considered in assessing the estimated cancer risk for adults: 1) ventilation in the building was less than optimal due to age, condition and design; 2) the risk estimate assumes the maximum air concentration over 37 years; and 3) the risk estimate assumes teachers and staff were exposed to this level for the entire work day every work day over 37 years. Regarding points 2) and 3) above, the worst case scenario assumes exposure to the highest level ever measured in the school for the entire exposure duration. Although the highest value of PCB concentration in indoor air is used as a conservative assumption in theoretical cancer risk calculations, it is unlikely that exposure occurred daily to the maximum concentration ever detected in any room in the high school (1.45 µg/m3) over the entire exposure duration (i.e., 37 years), since we know from indoor air testing throughout the school that levels varied over time in relation to bulk sampling, remedial cleaning activities, and HVAC performance. Observations made by MDPH/BEH/IAQ staff during CO2 testing in room A-1-315 (1297 ppm) indicate sub-optimal ventilation conditions, which may have contributed to higher PCB levels measured in indoor air. As mentioned, PCB residues were observed in fluorescent light fixture trays in this room; trays were removed in April 2011 and overall PCB levels declined in April and again in August 2011 sample rounds after the impacted light fixtures were removed.

PCB Blood/Serum Testing

Phase I

One hundred and twenty-four individuals completed the initial exposure assessment questionnaire that was intended to be scored for selection of approximately 100 people who had the greatest likelihood of having high serum PCB levels. Of the 124 individuals, 78 were current or former staff at NBHS or current students at NBHS. The majority of these interviews were completed in June 2008. A small number of interviews were conducted between July 2009 and March 2010 via phone to accommodate late-joining participants.

MDPH had committed to testing approximately 100 people who scored highest on the exposure assessment questionnaire for serum PCB levels. Because the total number of respondents to the interview offer was 124, MDPH decided to offer all interview respondents the opportunity to have their serum PCBs tested, regardless of the score of their questionnaire.

Phase II

As mentioned earlier in this report, MDPH offered to conduct PCB exposure assessment/blood testing for various New Bedford populations concerned about PCB exposures including those associated with residences and/or associated with NBHS and KMS. One hundred and twenty-four individuals completed a screening questionnaire. On January 22, 2009, BEH sent letters to the homes of these individuals offering serum PCB testing. Of the 124 people who completed the screening questionnaire, a total of 91 individuals participated in the serum PCB testing offer.

A second questionnaire was administered at the time of the blood draw and included questions relevant to the blood draw (e.g., weight and height) as well as questions regarding where, in NBHS and/or KMS, participants spent the majority of their time.

MDPH began offering blood draw appointments in February 2009 and SLI completed testing of blood samples in February 2010. Samples were stored frozen pending analysis. According to the National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM), Method 8004, PCBs in serum are stable indefinitely if frozen. Additionally, according to a personal correspondence with CDC's Dioxin and Persistent Organic Pollutants Laboratory, it has been their experience that PCBs in Quality Control samples (serum spiked with known quantities of PCBs) are stable for 2 – 5 years, the amount of time they use these QC samples. Thus, we would not expect any effect related to the time between collection and analysis on serum PCB levels for NBHS participants.

Out of the 91 participants that consented to and submitted blood samples, 64 individuals were current or former staff members at NBHS, KMS, or the former Keith Middle School, and one was a current student at NBHS (Figure 8). Participants are included in this report if, at the time of the exposure assessment interview, they were among the 64 current or former staff members. One current student at NBHS was also included in this analysis. In addition, two former students that did not report living (currently or previously) in the neighborhood around the PSWS were also included, for a total of 67 participants in the evaluation of PCB serum analyzed in relation to indoor PCB exposure concerns. As mentioned earlier, results for individuals that reported living in the neighborhood around the PSWS (including some current and former staff) are included in a separate MDPH/BEH report. A total of 39 participants reported being current NBHS staff and 25 participants reported being former NBHS staff. Twenty-six of the 64 current or former NBHS staff also reported previously working at the former Keith Middle School, 10 reported previously working at KMS, and four reported currently working at KMS.

The participant ages ranged between late teens to mid-70s (Figure 9). Approximately 66% of the participants were female and 34% male. NHANES comparison data are available by age group and by gender, but not by both age group and gender together. Therefore, summary statistics are presented in this report by age group for males and females combined. Tables 6 and 7 contain summary statistics for total serum PCB concentrations as whole weight and lipid-adjusted values, respectively. Historically, when PCBs were measured in serum, the results were reported on a whole weight basis only. Currently, with advances in analytical chemistry, they are also reported on a lipid-adjusted basis. Because different people may have different concentrations of lipids in their blood, PCB concentrations in blood are adjusted (or normalized) based on the lipid content. This adjustment allows for comparisons of blood serum PCB levels among different people and populations (U.S. CDC, 2009).

Serum PCB Levels Measured in Participants 12-19 Years Old

One of the 67 participants was between the ages of 12 and 19 years at the time the blood samples were collected. The NHANES median/50th percentile value for this age group is 0.155 ppb (whole weight) and 30.8 ppb (lipid-adjusted). No PCB congeners were detected in the serum samples collected from this participant. Therefore, the serum PCB result for the one participant between the ages of 12 and 19 years do not indicate unusual PCB exposures.

Serum PCB Levels Measured in Participants 20-39 Years Old

Five of the 67 participants were between the ages of 20 and 39 years at the time the blood samples were collected. The 50th percentile serum PCB level for participants in this age group was 1.053 ppb (whole weight), with concentrations ranging from not detected to 1.200 ppb, and 181.6 ppb (lipid-adjusted), with concentrations ranging from not detected to 216.5 ppb. The NHANES 50th percentile value for this age group is 0.322 ppb (whole weight) with a 95% confidence interval of 0.286 ppb - 0.352 ppb and 53.0 ppb (lipid-adjusted) with a 95% confidence interval of 46.9 ppb - 57.7 ppb (U.S. CDC, 2009). The 95% confidence interval is a range of estimated values that have a 95% probability of including the true value for the population. The median serum PCB levels for the participants in this age group, both whole weight and lipid-adjusted, are higher than the respective NHANES median/50th percentiles for the U.S. population.

The NHANES data indicate that 95% of the U.S. population aged 20 to 39 years has serum PCB levels below 1.211 ppb (whole weight) with a 95% confidence interval of 0.954 ppb – 1.688 ppb and 188.0 ppb (lipid-adjusted) with a 95% confidence interval of 137.4 ppb - 263.6 ppb (Figures 10 and 11). The serum PCB concentrations for participants between the ages of 20 and 39 years are within the 95th percentile of serum PCB levels available from the national NHANES data. As stated previously, according to U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual. Therefore, serum PCB levels for participants between the ages of 20 and 39 years were within typical ranges for this age group in the U.S. population and hence do not indicate unusual exposure opportunities to PCBs.

Serum PCBs Levels Measured in Participants 40-59 Years Old

Thirty-nine of the 67 participants were between the ages of 40 and 59 years at the time the blood samples were collected. The 50th percentile serum PCB level for participants in this age group was 1.496 ppb (whole weight), with concentrations ranging from not detected to 3.519 ppb, and 218.3 ppb (lipid-adjusted), with concentrations ranging from not detected to 477.6 ppb. The NHANES median/50th percentile value for this age group is 0.927 ppb (whole weight) with a 95% confidence interval of 0.840 ppb - 1.058 ppb and 145.3 ppb (lipid-adjusted) with a 95% confidence interval of 128.7 ppb - 157.9 ppb (U.S. CDC, 2009). Therefore, the median serum

PCB levels, both whole weight and lipid-adjusted, for the participants in this age group are higher than the respective NHANES median/50th percentiles for the U.S. population.

The NHANES 95th percentile concentration for this age group is 2.780 ppb (whole weight) with a 95% confidence interval of 2.307 ppb to 3.663 ppb and 402.2 ppb (lipid-adjusted) with a 95% confidence interval of 325.1 to 540.2 ppb (Figures 10 and 11). The serum PCB concentrations for all of the participants in this age group are within the NHANES 95th percentile of serum PCB levels that, according to U.S. CDC, is useful for determining whether serum PCB levels are unusual. Thus, serum PCB levels for participants between the ages of 40 and 59 years were within typical ranges for this age group in the U.S. population and hence do not indicate unusual exposure opportunities to PCBs.

Serum PCBs Levels Measured in Participants 60+ Years Old

Twenty-two of the 67 participants were 60 years of age or older at the time the blood samples were collected. The 50th percentile serum PCB level for participants in this age group was 2.313 ppb (whole weight), with a range of 1.276 ppb to 4.329 ppb, and 333.1 ppb (lipid-adjusted), with a range of 154.6 to 545.1 ppb. The NHANES median/50th percentile value for this age group is 1.805 ppb (whole weight) with a 95% confidence interval of 1.694 ppb - 1.874 ppb and 276.0 ppb (lipid-adjusted) with a 95% confidence interval of 251.2 ppb - 295.4 ppb (U.S. CDC, 2009). Therefore, the median serum PCB levels for the participants, for both whole weight and lipid-adjusted results, are higher than the respective NHANES median/50th percentiles for the U.S. population.

The NHANES 95th percentile concentration for this age group is 5.123 ppb (whole weight) with a 95% confidence interval of 4.131 ppb to 6.556 ppb and 769.4 ppb (lipid-adjusted) with a 95% confidence interval of 600.0 to 1026.5 ppb (Figures 10 and 11). The serum PCB concentrations for all of the participants in this age group are within the 95th percentile of serum PCB levels available from the national NHANES data. As stated previously, according to U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual. Thus, serum PCB levels for participants over 60 years of age were within typical ranges for this age group in the U.S. population and hence do not indicate unusual exposure opportunities to PCBs.

Qualitative Congener Pattern Evaluation

In this report, data have been provided on total PCBs based on summing the most frequently detected 15 congeners. Figure 12 shows the distribution of percent contribution of congeners most commonly seen in serum and analyzed by SLI for all New Bedford participants. Percent contributions are also provided in Figure 13 for all ages from the NHANES data. The congener patterns observed in New Bedford and NHANES are similar, suggesting similarities with what is found in the U.S. population. In addition, individual congener patterns were reviewed and a subset of sample results was submitted to CDC for review to confirm that individual differences noted were within the range typically seen. CDC noted that the congener patterns of NBHS staff and students appeared to be typical, suggesting that exposure in the NBHS participants appeared similar to those of the general U.S. population.

Serum PCBs Levels Compared with Years Worked at NBHS

As mentioned earlier, 64 of the 67 participants analyzed in this report reported being current or former staff at NBHS. These participants reported working at NBHS for between 1 to 37 years. To evaluate whether length of employment at NBHS was associated with higher serum levels, participants were grouped into two approximately equal-sized groups based on the number of years worked at NBHS by determining the median years worked at NBHS for all participants (14 years). The first group contains all participants that worked less than or equal to the median years worked (0-14 years) and the second group contains all participants that worked greater than the median years worked (15-37 years). Mean serum levels were calculated for each group and by age group because PCBs in serum generally increase with age. To allow for comparison to NHANES data, geometric means were calculated. Calculating the geometric mean is a standard way of looking at biological and environmental data. (Geometric means are reported in the U.S. CDC's Fourth National Report on Human Exposure to Environmental Chemicals.) Table 8 summarizes the number of participants by years worked at NBHS and by age group. However, the serum PCB geometric means are not presented for the 12 – 19 year or the 20 – 39 year age groups due to the small number of participants. When these age groups are divided into smaller groups by years worked there are fewer than five participants in each subgroup. It is MDPH/BEH policy not to present statistics for groups with fewer than five individuals due to the instability of the statistic. Thus, this analysis focused on the 40-59 and 60+ year age groups.

Tables 9 and 10 contain summary statistics (geometric means) for total serum PCB concentrations by length-of-employment as whole weight and lipid-adjusted values, respectively. The tables demonstrate little difference between either whole weight or lipid-adjusted geometric mean concentrations between those who worked fewer years versus more years at NBHS. The maximum difference in whole weight concentrations among the four comparisons made was 0.18 ppb, and three of the four comparisons showed slightly higher serum PCB concentrations among those who worked the longest at NBHS (Figure 14). However, for lipid-adjusted values, the maximum difference was 19 ppb, and for three of the four comparisons, the geometric mean concentration was lower for participants who had worked at NBHS the longest (Figure 15). Thus, these data do not show a consistent pattern of higher serum PCB concentrations with more years worked at NBHS, and they suggest that employment at NBHS was not a primary indicator of serum PCB levels. It should be noted that the ability to discern differences between the two groups is difficult because of the small number of participants and the likely contributions to serum PCB levels by other factors (e.g., fish consumption).

Serum PCBs Levels Compared with Building Location

Based on information provided by current and former NBHS staff in response to the MDPH/BEH exposure assessment questionnaire, ten current and former NBHS staff members reported spending most of their time in eight rooms where indoor air PCB results were available. Of these ten participants, eight were between the ages of 40 and 59 years and two were 60 years of age or older at the time of the blood draws. They reported having worked at NBHS for a total of 1 to 37 years. The serum PCB concentrations for these ten participants were within the NHANES 95th percentile for their respective age groups. For these ten individuals, their serum PCB levels (by age group) versus concentrations of PCBs measured in indoor air in the room they reported working in were examined. There was no clear pattern of high serum PCB levels with higher indoor air levels. For example, of the eight participants in the 40-59 year age group, three individuals reported working in a room with higher levels of PCBs in indoor air. Two of these participants had lipid-adjusted serum PCB levels that are less than or approximately equal to the mean level for this age group and one had a lipid-adjusted serum PCB level greater than the mean but less than the 95th percentile. Thus, these data do not suggest that indoor air levels of PCBs are a primary predictor of serum PCB levels.

The majority of participants reported working in multiple locations throughout NBHS; however, 21 current and former NBHS staff members reported that they spend or spent most of their time in one (or in some cases two) specific block(s) or house(s) in NBHS where indoor air PCB results were available, including the A, B, and D Blocks and the Green, Tan, and Blue houses. No air samples have been collected from the C Block, and no participants reported spending the majority of their time in the E Block. Of these 21 participants, one was between the ages of 20 and 39, 14 were between the ages of 40 and 59, and six were 60 years of age or older, and they had worked at NBHS for a total of 1 to 37 years. The serum PCB concentrations for these 21 participants were within the NHANES 95th percentiles for their respective age groups. For these 21 individuals, serum PCB levels (by age group) versus average concentrations of PCBs measured in indoor air in the house or block they reported working in were examined. Again, there was no clear trend of higher serum PCB levels with higher indoor air levels. For example, of the 14 participants in the 40-59 year age group, the individual with the highest serum PCB level reported working in a block/house with one of the lowest average levels of PCBs in indoor air. Also, two participants in this age group reported working in one of the rooms with a higher air concentration of PCBs. The lipid-adjusted serum PCB levels for both participants were below the mean level for their age group. The whole weight serum PCB level for one of these participants was below the mean for their age group, and the level for the other participant was between the mean and 95th percentile values for their age group. Similarly, for the two participants in the 60+ age group, there was no consistent pattern of higher air concentrations of PCBs and higher serum PCB concentrations. It should be noted that the ability to discern differences between the groups is difficult because of the small number of participants and the likely contributions to serum PCB levels by other factors (e.g., fish consumption).

Serum PCBs Levels Compared with Years Worked at the new Keith Middle School (KMS)

Periodic sampling of the indoor air of the new Keith Middle School (KMS) conducted since 2006 indicates that PCB concentrations in air are consistently well below health-based comparison values and remedial work completed prior to construction has eliminated the potential for contact with contaminated soil on the KMS property. However, due to participants' concerns about potential exposures to PCBs while working at KMS, serum PCB levels (by age group) were evaluated based on the number of years worked at KMS. As mentioned earlier, 14 of the 67 participants reported either currently or previously working at the KMS. Of these 14 participants, one was between the ages of 12 and 19 years, two were between the ages of 20 and 39 years, nine were between the ages of 40 and 59 years, and two were 60 years of age or older at the time of the blood draws. They reported having worked at KMS for a total of 1 to 3 years. The serum PCB concentrations for these 14 participants were within the NHANES 95th percentile for their respective age groups. For these 14 individuals, their serum PCB levels (by age group) versus the number of years they reported working at KMS were examined. The geometric means by years worked for the participants are not presented due to the small number of participants. When these groups are divided into smaller groups by age and years worked there are fewer than five participants in each subgroup. It is MDPH/BEH policy not to present statistics for groups with fewer than five individuals due to the instability of the statistic. A qualitative review indicated that there was no clear pattern of high serum PCB levels with more years worked at KMS. It should be noted that the ability to discern differences between participants that worked at KMS for longer versus shorter periods of time is difficult because of the small number of participants, the relatively brief length of time participants worked at KMS (1-3 years), and the likely contributions to serum PCB levels by other factors (e.g., fish consumption).

Serum PCBs Levels Compared with Years Worked at the Former Keith Middle School

No air indoor air samples were collected and analyzed for PCBs during the years the former Keith Middle School operated; and hence, no information is available on possible indoor air concentrations of PCBs. Due to participants' concerns about potential exposures to PCBs while working at the former Keith Middle School, serum PCB levels (by age group) were evaluated based on the number of years worked at the former Keith Middle School. As mentioned earlier, 26 of the 67 participants reported previously working at the former Keith Middle School. Of these 26 participants, one was between the ages of 20 and 39 years, 16 were between the ages of 40 and 59 years, and nine were 60 years of age or older at the time of the blood draws. They reported having worked at the former Keith Middle School for a total of 1 to over 20 years. The serum PCB concentrations for these 26 participants were within the NHANES 95th percentile for their respective age groups. For these 26 individuals, their serum PCB levels (by age group) versus the number of years they reported working at the former Keith Middle School were examined. The geometric means by years worked for the participants are not presented due to the small number of participants. When these groups are divided into smaller groups by age and years worked there are fewer than five participants in each subgroup. It is MDPH/BEH policy not to present statistics for groups with fewer than five individuals due to the instability of the statistic. A qualitative review indicated that there was no clear pattern of high serum PCB levels with more years worked at the former Keith Middle School. For example, the individual in the 40-59 year age group that reported working at the former Keith Middle School the longest had whole weight and lipid-adjusted serum PCB concentrations that were below the mean serum PCB concentration for the individuals in this age group who also reported working at the former Keith Middle School. The individual in the 60 year and over age group that reported working at the former Keith Middle School the longest had the highest whole weight but not the highest lipid-adjusted serum PCB concentration for all individuals in this age group who reported working at the former Keith Middle School. Again, the ability to discern differences between the groups is difficult because of the small number of participants and the likely contributions to serum PCB levels by other factors (e.g., fish consumption).

Serum PCBs Levels Measured in Participants Diagnosed with Cancer

Based on information shared by participants during the exposure assessment interviews and a search of the Massachusetts Cancer Registry database, six of the 67 participants were diagnosed with cancer at some point in the last 20 years. One of these six participants reported working in one of the rooms where indoor air samples were collected for PCB analysis. Indoor air concentrations detected in this room were among the lowest detected in the school. The serum PCB concentrations for all six participants were within the NHANES 95th percentile for their respective age groups. As stated previously, according to U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual. Therefore, serum PCB concentrations for the six participants diagnosed with cancer were within the range of levels measured in the NHANES 2003-2004 survey and are within the typical variation in the U.S. population. (More discussion on the incidence of cancer among NBHS staff is provided later in this report.)

Health Concerns

As mentioned, MDPH/BEH also received reports of staff health concerns at the NBHS. BEH obtained information on these health concerns through the following four sources:

- BEH staff conducted interviews with NBHS staff at the time of the IAQ inspections at the school (April 29 and 30, 2008);
- An MDPH contractor, John Snow Institute, conducted exposure assessment interviews with some current and former NBHS staff as part of the PCB blood serum testing program;
- A petition, signed by NBHS staff, requesting a health assessment and medical testing was sent to the former Director of the NBHD, was forwarded to MDPH;
- Supplemental information collected and distributed by a local advocacy group obtained via a series of emails; the email distribution list included BEH.

As mentioned previously, in addition to information regarding health concerns that some staff shared during the April 29-30, 2008 IAQ inspections, BEH also obtained information about NBHS staff health concerns through both the initial screening exposure assessment questionnaire and the questionnaire administered at the blood draw for participants in the serum PCB testing offer.

To supplement this information, some NBHS employees signed a petition that had been developed by a former NBHS staff member and provided to the former Director of the NBHD who then forwarded it to BEH. The petition, which was signed by 21 NBHS staff members, reported health concerns that staff suspected might be related to indoor air quality conditions at the school. Also included with the petition was a list of 32 current or former high school staff and students who had been diagnosed with cancer. On February 25, 2010, MDPH was one of many parties that received an email with an additional 26 reported cancer diagnoses among current and former NBHS employees/students as well as a diagnosis of Amyotrophic Lateral Sclerosis (or Lou Gehrig's disease) in one individual. Lastly, on several additional occasions (in September 2010, May 2011, November 2011, January 2012, and July 2012) MDPH received updated lists of individuals from NBHS who have been diagnosed with cancer via email from a local environmental group. For the 149 individuals reportedly diagnosed with cancer, a last name was provided. For some individuals, first name and cancer type were also provided. One additional diagnosis was reported to BEH by phone.

Employee Interview Results

Health Effects

Forty-two NBHS employees were interviewed at the time of the IAQ school inspections. Seventy-eight current/former students or staff answered health concern-related questions on the exposure assessment questionnaires as part of the PCB serum testing program. All responses were reviewed to identify the types of symptoms reported, their frequency of occurrence, and whether any unusual patterns emerged that might suggest an association with indoor environmental conditions at the NBHS. For analysis, responses were grouped into one of three categories: respiratory symptoms, allergic responses, and central nervous system (CNS) effects. Respiratory symptoms include: sore or dry throat, stuffy or runny nose, sinus congestion, and other miscellaneous types of symptoms associated with the respiratory tract. Allergic responses include skin or eye irritation and itchiness as well as reported exacerbation of allergies. CNS effects include: headache, dizziness or lightheadedness, difficulty remembering things, or unusual tiredness or fatigue. Under both state and federal regulations, personally-identifying information shared by employees is confidential; thus, the following discussion provides summary information only.

Symptom Discussion

Based on information shared by the 42 employees interviewed at the time of IAQ inspections, thirty-three individuals reported experiencing at least one respiratory effect. The predominant symptoms in this category were sinus congestion/upper respiratory infection and colds. Fifteen of the 33 individuals reported cough or bronchitis, pneumonia, shortness of breath, or asthma. Fourteen of the 42 individuals reported having either allergies (n=12) or allergy-like symptoms (n=2) such as eye irritation and itchiness, with three of them reporting that their symptoms improved when they left the building. Twenty-three of the 42 individuals interviewed reported experiencing at least one CNS symptom. The predominant symptom in this category was headaches. Of those interviewed, three individuals reported no specific health concerns and two of these three individuals also reported no specific environmental concerns related to indoor air quality at the NBHS.

In addition to those interviewed during the IAQ assessment, 67 others reported similar health concerns when completing a questionnaire for the serum PCB testing offer. Nine of the 67 individuals reported experiencing at least one respiratory effect. The predominant symptoms in this category were sinus congestion, runny nose and sore throat. Three individuals reported having asthma. Allergy or allergy-like symptoms were reported by eight individuals. Six of the 67 individuals reported experiencing at least one CNS symptom, with the predominant symptoms being fatigue and/or tiredness.

Symptomology and Building Location

The locations where individuals reported working in the building and their health concerns were evaluated with respect to the results from the environmental testing conducted by BEH/IAQ staff. Thirty-six of the 42 individuals interviewed by MDPH/BEH reported respiratory and/or CNS health symptoms. Of these 36, 26 reported working predominantly in one location during the work day (the other 10 reported working in multiple locations). Carbon dioxide measurements were available for 23 of the 26 rooms. Carbon dioxide levels ranged from about 415 ppm to almost 2400 ppm; in ten of the rooms used by eleven individuals carbon dioxide levels were above the recommended 800 ppm. It is probably worthwhile to note that in all but one of the rooms with an elevated carbon dioxide level, MDPH/BEH noted that the ventilation system was off or blocked at the time of testing.

Accurate room/workplace location was not available for most of the individuals who participated in the exposure assessment interviews that were part of the PCB serum testing program. For those that did provide location-specific information, carbon dioxide levels were above 800 ppm in about half of the rooms. MDPH/BEH noted that the ventilation system was not properly operating in some of these rooms.

These test results are indicative of a lack of fresh air, which can result in the type of respiratory and CNS symptoms reported by NBHS staff.

General Indoor Air Quality

The 42 NBHS employees interviewed at the time of the IAQ inspections were asked about their concerns related to environmental conditions in their work environment. Also, the 67 individuals who participated in the exposure assessment interviews as part of the PCB serum testing offer provided information about their concerns related to general indoor environmental quality at NBHS. The most common responses for the 109 individuals were as follows:

- 24 reported problems with the ventilation
- 13 reported concerns regarding the presence of mold/water damage in the school
- 13 reported the presence of excessive dust

Indoor temperatures and concerns regarding pests in the school were also mentioned to a lesser extent. Although not expressly stated by all participants, it is assumed that the majority of individuals who chose to be part of the PCB serum testing program did so because they were concerned about the levels of PCBs at NBHS. Seven individuals who were interviewed during the IAQ inspections also mentioned concern about the presence of PCBs in the school.

Cancer Diagnoses Reported among Current/Former Employees and Students

A number of employees have expressed concerns about cancer incidence among former employees and students of NBHS. Some of the individuals interviewed for the PCB serum testing program reported having been diagnosed with cancer. Additionally, as discussed earlier, several lists of names reporting a total of 149 current and former NBHS staff members and students who had been diagnosed with cancer were provided to CAP. It is important to note that these lists may not necessarily be complete.

When BEH reviews information on cancer diagnoses, such as that provided for the NBHS, BEH/CAP staff look at several factors to assess whether the pattern of cancer appears to be unusual:

- What types of cancer are involved?
- Do the cancer types share similar etiologies (i.e., causes/characteristics)?
- How the relative frequency of the various types of cancer reported compares to what is known about the occurrence of the different types of cancer in the population of Massachusetts as a whole?
- Are there an unusual number of rare types of cancer?

As mentioned, unless interviewed by MDPH/BEH, information provided to BEH about cancer diagnoses among current and former NBHS employees and students was limited. For example, sometimes MDPH was provided the name of an individual reported to be diagnosed with cancer but not the specific type of cancer he or she had been diagnosed with; searching the Massachusetts Cancer Registry (MCR), it was not always possible to confirm that the individual had been diagnosed with cancer. One possible explanation is that the individual had been diagnosed with cancer before 1982 (the first year when the MCR began collecting data) or had been diagnosed in another state. The MCR does have reciprocal reporting agreements with 15 states including Rhode Island, New Hampshire, New York, Maine, and Vermont so that if a New Bedford resident was diagnosed with cancer in one of the 15 states, their diagnosis would be reported to the MCR. Additional information often not available to MDPH that is helpful in searching the MCR database includes date of birth, residence at diagnosis, and date of diagnosis. CAP staff reviewed the most recent data available from the MCR to obtain as much information as possible about all of the cancer diagnoses (such as cancer type and date of diagnosis) to best assess whether these diagnoses may represent an unusual pattern of cancer incidence.

The MCR, a division within the MDPH Bureau of Health Information, Statistics, Research and Evaluation (BHISRE), is a population-based surveillance system of Massachusetts residents diagnosed with cancer in the state. All new diagnoses of invasive cancer, along with several types of in situ (localized) cancer, occurring among Massachusetts residents are required by law to be reported to the MCR within six months of the date of diagnosis (M.G.L. c.111. s 111b, 1980). This information is collected and kept in a confidential database. Data are collected on a daily basis and reviewed for accuracy and completeness on an annual basis. Information reported to the MCR for an individual is based on their residence at diagnosis and not their workplace.

According to a review of MCR data, 6 individuals who were interviewed as part of the PCB serum testing program had been diagnosed with cancer. Of the 150 individuals reported to BEH as having a cancer diagnosis through any of the lists discussed earlier or the phone call to BEH, CAP staff were able to confirm cancer diagnoses for 82 of the 150 individuals using the MCR[4]. In an effort to obtain cancer incidence information for the remaining 68 individuals, MDPH/BEH staff reviewed the death certificate file for those individuals reported to MDPH as deceased (32 of the 68 individuals). Death certificates are available through BHISRE's Registry of Vital Records and Statistics. Due to the limited information provided to MDPH (for example, no date of birth or death), death certificates could only be found for 10 of the 32 individuals. From the review of death certificates for the ten individuals, it appears that five of them had cancer, as determined by cause of death or other significant conditions that were reported on their death certificate.

The 93 individuals identified as having a cancer diagnosis either through the MCR (from the lists of individuals with cancer or the PCB serum testing program) or the death certificate review were diagnosed with 27 different types of cancer. These cancer types include: cancers of the bladder, bone, brain, breast, cervix, colon, esophagus, eye, gallbladder, kidney, liver, lung, oral cavity, ovary, pancreas, prostate, stomach, thyroid, tongue, and uterus; leukemia; Hodgkin lymphoma; melanoma of the skin; multiple myeloma; soft-tissue sarcoma; testicular; and, non-Hodgkin lymphoma. Two of the 93 individuals were diagnosed with a cancer of an unknown primary site. Although some of these 27 different cancer types share some common risk factors related to their development (for example, cigarette smoking is linked to both bladder and lung cancer), each cancer type is a unique disease with its own set of risk factors.

[4] The diagnoses of three individuals were confirmed by phone or direct contact. MCR data may not include individuals who were recently diagnosed with cancer, were diagnosed with cancer outside of Massachusetts, were diagnosed with a benign tumor, or were diagnosed with cancer before 1982.

Among the 93 individuals, the overall pattern of cancer types appears to be consistent with that of the state as a whole. The most common types of cancer diagnosed among individuals associated with NBHS reported to MDPH were breast cancer (n=27), colorectal cancer (n=7), prostate cancer (n=7), and lung cancer (n=5). These cancers are among the most common in the general population of Massachusetts. Among the other 23 cancer types, there was no unusual pattern noted among the individuals reported. In Massachusetts, for more than a decade, breast cancer has been the most common type of cancer diagnosed among female residents and prostate cancer has been the most common type of cancer diagnosed among male residents. Each of these types of cancer account for approximately 28% of new cancers diagnosed among females and males statewide, respectively. Lung and bronchus and colorectal cancers have been the second and third most common type of cancers diagnosed among males and females, respectively. Cancers of the lung and bronchus accounted for approximately 14% of new cancers statewide among males as well as females during the 2003-2007 period. Cancers of the colon/rectum accounted for approximately 10% of new cancers statewide among males as well as females during this period. Within the NBHS community, these types of cancer – breast, prostate, lung and bronchus, and colo-rectal – constituted approximately half of the total number of diagnoses.

For the majority of the other 23 cancer types, either one or two diagnoses were reported over approximately a 30-year period. The exceptions were pancreatic and stomach cancer. For each of these types of cancer, five diagnoses were reported over the 30-year period. No unusual occurrence of a rare type of cancer was reported from the various sources of information on cancer diagnoses.

The distribution of year at diagnosis among the 88 individuals for whom date of diagnosis was available (date of cancer diagnosis is not reported on death certificates) was spread fairly evenly across approximately 30 years. For example, for all but four years, no more than four cancer diagnoses occurred per year. In 2000, five individuals were diagnosed with five different cancer types. Seven individuals were diagnosed with five different cancer types in 2003, five individuals were diagnosed with three cancer types in 2004, and eight people were diagnosed with seven different cancer types in 2008.

As discussed earlier, individuals are reported to the MCR based on their residence at diagnosis rather than their place of employment. It is the completeness of case ascertainment/reporting to the MCR that allows for the calculation of cancer rates for the city as well as its census tracts. (The MCR typically achieves 95% or higher case ascertainment each year, reflecting a high degree of completeness.) Although the rate of breast cancer among current/former staff and students at NBHS cannot be calculated with available data, information that was provided to MDPH/BEH about breast cancer diagnoses among current/former staff and students at NBHS was reviewed.

MDPH received reports of 27 women diagnosed with breast cancer over approximately 30 years. As mentioned, breast cancer is the most common cancer among women comprising 28% of all new cancer diagnoses in Massachusetts women (MCR 2010). The chance of developing invasive breast cancer at some time in a woman's life is about 1 in 8 (12%). A woman's risk of developing breast cancer increases with age, with age being the strongest risk factor for breast cancer. About 1 out of 8 invasive breast cancers are found in women younger than 45, while about 2 out of 3 invasive breast cancers are found in women age 55 or older (ACS 2010). The average age at diagnosis for the 25 women reported to MDPH with breast cancer whose age at diagnosis is known is about 56 years of age.

In addition to age as a risk factor, approximately 5 to 10% of breast cancer cases are thought to be hereditary, resulting directly from gene changes or mutations inherited from a parent. For women with BRCA1 and BRCA2 mutations, their risk of developing breast cancer may be as high as 80%; these cancers tend to occur in younger women and are more often bilateral (in both breasts) compared to women with breast cancer who are not born with one of these gene mutations. Women with a first degree relative (such as a mother or sister) are at twice the risk of developing breast cancer as other women while women with two first degree relatives are at five times the risk. Seventy to eighty percent of women who develop breast cancer, however, do not have a family history of the disease. Experts estimate that fifty percent of breast cancer diagnoses cannot be explained by known risk factors for the disease (ACS, 2010).

Cumulative exposure of the breast tissue to estrogen is also associated with breast cancer risk. Several factors can influence estrogen levels. Women who started menstruating at an early age (before age 12) and/or went through menopause at a later age (after age 55) have a slightly higher risk of breast cancer. Also, women who have had no children or those whose first pregnancy occurred when they were over the age of 30 have an increased risk for developing breast cancer. Women who have had more children and those who have breast-fed seem to be at lower risk.

Other risk factors include certain benign breast conditions, having dense breast tissue, a previous cancer diagnosis, and previous radiation therapy to the chest. Alcohol consumption has also been associated with increased risk for breast cancer. Women who consumed one alcoholic beverage per day experienced a slight increase in risk (approximately 10%) compared to non-drinkers, however those who consumed 2 to 5 drinks per day experienced a 1.5 times increased risk. Recent studies have indicated that being overweight or obese may put a woman at increased risk of breast cancer, especially after menopause.

A great deal of research has been reported and more is being done to understand possible environmental influences on breast cancer risk. Of special interest are compounds in the environment that have been found in animal studies to have estrogen-like properties, which could in theory affect breast cancer risk. For example, substances found in some plastics, certain cosmetics and personal care products, PCBs, and pesticides (such as DDE) seem to have such properties. To date, however, there is not a clear link between breast cancer risk and exposure to these substances. A more detailed discussion of breast cancer risk factors can be found in Appendix E.

Several studies have found that women who work in professional jobs, including teachers, tend to have an increased risk of developing breast cancer (Rubin et al., 1993; Threlfall et al., 1985; MacArthur et al., 2007; King et al., 1994; Pollan and Gustavsson, 1999) while other studies have not (Calle et al., 1998; Petralia et al., 1999). No occupational exposures have been identified in these studies. Rather, researchers suspect that established risk factors for breast cancer such as later maternal age at first birth and lower parity (the number of times a woman has given birth) may be more prevalent in women working in a professional setting than in women who do not (such as homemakers). Women with more education also are more likely to undergo regular mammograms, increasing the likelihood of earlier detection of breast cancer (NIOSH, 2010).

Non-Cancer Health Discussion

The health symptoms reported are generally those most commonly experienced in buildings with indoor air quality problems. The symptoms most frequently reported by individuals at the NBHS were respiratory/irritant effects including headaches, respiratory infection or sinus congestion. These symptoms are commonly associated with ventilation problems in buildings, although other factors (for example, odors, microbiological contamination) may also contribute (Stolwijk et al., 1991; Burr et al., 1996; Nordstrom et al., 1995).

Twenty-two individuals interviewed reported having allergies. The onset of allergic reactions to mold/moisture can be either immediate or delayed. Allergic responses include hay fever-type symptoms such as runny nose and red eyes. Although it is unknown how many of the individuals were diagnosed with allergies and/or asthma prior to being at the NBHS, exposure to mold/moisture can exacerbate pre-existing symptoms. The symptoms reported among participants of this health investigation are generally those most commonly experienced in buildings with less than optimal indoor air quality.

Based upon the information reviewed by BEH, the respiratory and CNS symptoms reported by some NBHS staff appear to be consistent with indoor air quality problems, and notably less than adequate ventilation.

Conclusions

Environmental Testing

In reviewing all available indoor air results for PCBs conducted by BETA and TRC over years 2006 – 2008, it appears that air levels of PCBs inside the school were at their lowest in the April 2006 round conducted by BETA, ranging from 0.0043 µg/m3 – 0.0519 µg/m3. Over the years 2006 – 2009, multiple bulk samples have been collected throughout the school for PCB analysis, and it is likely that the air levels from August 2006 – February 2008 sampling rounds may have been affected by disturbance of materials for testing. Although indoor air levels of PCBs were generally lower in February 2008 than August 2007, it is unclear whether this decline is attributable to the cleaning effort alone, or whether the lower levels in February 2008 were due to the lack of disturbance of bulk materials for 6 months prior to the 2008 air testing. Twenty of 26 locations that had indoor air sampled for PCBs in February 2008 were re-sampled in February 2011. Of these 20 locations, 15 locations had similar or lower levels of PCBs in indoor air in February 2011, indicating an overall decline in PCB concentrations, further suggesting that earlier disturbance of PCB containing materials for testing may have temporarily increased indoor air levels of PCBs. Ventilation in the school may also be a factor. CO2 data suggest that if ventilation is adequate, then PCB concentrations tend to be lower.

PCB Exposure Assessment

Based upon an exposure assessment using conservative assumptions, exposure to PCBs at levels detected at New Bedford High School does not appear to present unusual cancer concerns for students or teachers/staff in the short or long term (i.e., estimated theoretical cancer risks are 7 in a million and 5-6 in 100,000 excess cancer diagnoses above population background levels for students and staff, respectively). The MDPH, however, believes that steps should be taken to reduce and/or eliminate opportunities for exposure to PCBs (e.g., cleaning, regular operations and maintenance plan, etc.) so that cancer risk does not increase (see the recommendations section for specific steps that can be taken.).

Serum PCB Testing Conclusions

Serum PCB testing conducted by MDPH/BEH showed that all participants who are current or former staff members at NBHS, KMS, or the former Keith Middle School, as well as the current NBHS student and former NBHS students who participated in the serum PCB testing program, had serum PCB levels within the 95th percentile of serum PCB levels available from the national NHANES data. This means that serum PCB levels for these participants were within typical variation seen in the U.S. population. Serum levels of PCBs reflect accumulated exposure and studies have shown that concentrations of PCBs in serum generally increase with age (Miller, 1991; U.S. CDC, 2009). Consistent with national patterns, serum concentrations of PCBs in participants generally increased with age but were within typical concentrations for the U.S. population for each age group evaluated. There was no consistent pattern of increasing serum PCB levels with increasing years of employment at NBHS, suggesting that working at the school was not a primary predictor of serum PCB levels. Finally, the PCB congener pattern for participants is consistent with what is typically seen in the U.S. population, suggestive of dietary sources.

Cancer Evaluation Conclusions

According to American Cancer Society statistics, cancer is the second leading cause of death in Massachusetts and the United States. Not only will one out of three women and one out of two men develop cancer in their lifetime, but cancer will also affect three out of every four families. For this reason, cancers often appear to occur in "clusters," and it is understandable that someone may perceive that there are an unusually high number of cancer cases in their neighborhood, workplace or town. Upon close examination, many of these "clusters" are not unusual increases, as first thought, but are related to such factors as local population density, variations in reporting, or chance fluctuations in occurrence. In other instances, the "cluster" in question includes a high concentration of individuals who possess related behaviors or risk factors for cancer. Some, however, are unusual; that is, they represent a true excess of cancer in a workplace, a community, or among a subgroup of people. A suspected cluster is more likely to be a true cancer cluster if it involves an unusually high number of diagnoses of one type of cancer diagnosed in a relatively short time period rather than several different types diagnosed over a long period of time (i.e., 20 years), a rare type of cancer rather than common types, and/or a large number of cases diagnosed among individuals in age groups not usually affected by that cancer. These types of clusters may warrant further public health investigation.

Based on the information reported to MDPH, the overall pattern of cancer among employees appears to be consistent with the statewide pattern of cancers. It is important to note that the information provided by various community sources may be incomplete. However, there were many different types of cancer diagnosed over more than 30 years, with the most frequent diagnoses among NBHS employees being the most common types of cancer diagnosed in the general population; these include cancers of the breast, prostate, lung and bronchus, and colon/rectum. The most common type of cancer reported among NBHS employees, breast cancer, affects an estimated one of every eight women. Because a school's workforce is often primarily composed of women, as is the case with the NBHS, it is not unusual to have breast cancer be the most frequently diagnosed cancer type in a school population. If the 27 diagnoses of breast cancer among staff that occurred over nearly three decades represent all of the breast cancer diagnoses during this period, the pattern is likely to be consistent with that of other high schools of similar size in the Commonwealth and the population in general. Without more information, however, it is difficult to draw more firm conclusions.

It is important to note that the evaluations of information on cancer diagnoses as well as the estimated cancer risks are based on methods to evaluate risks to a population, not an individual. It is not possible to identify the cause of cancer in an individual in this report. Cancers in general have a variety of risk factors known or suggested to be related to the etiology (cause) of the disease.

Non-Cancer Health Evaluation Conclusions

Based upon the information reviewed by BEH, the respiratory and CNS symptoms reported by some NBHS staff appear to be consistent with indoor air quality problems, and notably less than adequate ventilation.

Recommendations

Below are MDPH recommendations grouped by category, based on the findings of this investigation:

Recommendations Specific to Health and Cancer Evaluations

1. To estimate the actual rate of breast cancer among school staff, additional information would have to be provided to MDPH. Information would be needed on all staff employed at the school beginning in the year of the first diagnosis through the present school year, including name, date of birth, age, home address, start date, end date, any leaves of absence, and workplace location. It is important to note that this type of effort would require substantial resources at the local level and, based upon MDPH's experience, could take a considerable period of time to complete. MDPH recommends a

follow-up meeting with a representative from the City of New Bedford, the New Bedford School Department, the New Bedford Educator's Association, and the New Bedford Health Department to discuss the breast cancer findings and the possibility of additional follow-up.

Recommendations Specific to PCB Exposures

2. Burnt out bulbs in light fixtures that may still contain PCB residues should be replaced as soon as they go out. MDPH has worked with other schools to develop ongoing operations and maintenance plans (O&M) to address cleaning and replacing bulbs (see Appendix F for MDPH 2009 guidance). It is also our understanding that plans were underway to replace all PCB-impacted ballasts during the summer of 2011. Additional bulk sampling in the school is not recommended.*
3. Refer to MDPH guidance concerning PCB-containing materials (see Appendix F).

Recommendations Specific to Lead, Mercury, and Other Chemicals

4. Until further sampling is conducted to characterize lead contamination in the firing range (D-143), access to that room should be restricted to remediation personnel only.*
5. Conduct further lead sampling in Room D-143 to determine lead levels in units of milligrams (mg) of lead dust per square foot of surface area. Remediate lead in conformance with U.S. EPA standards, or if planned for use for food preparation or eating in conformance with DOS guidelines.*
6. Restrict access of D-143 to lead remediation personnel only until remediation is conducted.*
7. Replace mercury-containing thermometers with less toxic alternative (e.g., mineral sprits, alcohol). Conduct a thorough inventory for any other mercury-containing devices and dispose of them in accordance with all local, state and federal regulations.*
8. Use VOC-containing products in a properly vented area. Store all flammable materials in a flameproof cabinet.*

* See Appendix H for an update on actions taken on recommendations made by MDPH in its Public Comment Release draft of this report (dated September 27, 2011). The update is based on comments made by the city of New Bedford and on available reports.

9. Examine current Material Safety Data Sheets (MSDS) for all products that contain hazardous materials used within the building, including office supplies, in conformance with the Massachusetts Right-To-Know Law (M.G.L. c.111F, s.1-21, 1983). Use non-VOC and alkaline-containing materials indoors where feasible.
10. Discontinue the use of air fresheners in classrooms and restrooms in order to avoid respiratory irritation from chemicals contained in the products.*

Recommendations Specific to Science-Related Activities

11. Science department personnel should work with the maintenance department to establish a preventative maintained program/calibration schedule for chemical fume hoods to ensure proper function and safety of removal of vapors as well as fire code compliance.

Recommendations Specific to the Pool Area

12. Operate and maintain pool in accordance with 105 CMR 435.29, Minimum Standards for Swimming Pools (State Sanitary Code: Chapter V).
13. Consult with a ventilation engineer concerning the repair and operation of the pool exhaust system. The pool exhaust system should be operating 24 hours a day to remove water vapor and chlorine odors from the building. If not operable, repair this system to ensure pool moisture and odors are vented out of the building. *
14. Seal all breaches to the exterior wall of the pool area with an appropriate material to prevent stairwell air penetration. Consider consulting a building engineer for advice on the best methods for sealing this wall.*
15. Clean visible surface mold from door frames in pool area (Picture 22) with an appropriate antimicrobial.*
16. Ensure the fire door between C- and D-Block remains closed.[*]

[*] See Appendix H for an update on actions taken on recommendations made by MDPH in its Public Comment Release draft of this report (dated September 27, 2011). The update is based on comments made by the city of New Bedford and on available reports.

Recommendations Specific to the HVAC System

The conditions found at the NBHS present issues that require a variety of remedial steps. The deactivation of univents prevents mechanical supply of fresh air to classrooms, which was clearly indicated by carbon dioxide levels. In addition, the deactivation of exhaust vents prevents removal and results in accumulation of normally occurring indoor environmental pollutants. Under these conditions, other pollutants introduced into the building (e.g., pool treatment odors, VOCs, shop pollutants) do not appear to have a means of exiting the building, which can result in accumulation of these materials within the building. In view of the findings at the time of this visit, the following recommendations are made:

17. Operate all ventilation equipment when the building is occupied. Use openable windows to supplement fresh air in classrooms.
18. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
19. Clear plant debris from subterranean univent air intakes, inspect periodically.
20. Consult a ventilation engineer to ascertain the best method for increasing fresh air supply in classrooms. Operate all ventilation systems throughout the building (e.g., gym, auditorium, classrooms) continuously during periods of occupancy independent of thermostat control to maximize air exchange. To increase airflow in classrooms, set univent controls to "high".*
21. Repair/replace damaged univent air diffusers (Picture 12).*
22. Install pleated disposable filters in univents and AHUs. Clean/change filters in HVAC equipment as per the manufacturer's instructions or more frequently if needed.
23. Ensure ACs have filters. Clean/change filters in ACs as per the manufacturer's instructions or more frequently if needed.*
24. Consider adopting a balancing schedule of every 5 years for mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).*
25. Use openable windows in conjunction with classroom univents and unit 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.*

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* See Appendix H for an update on actions taken on recommendations made by MDPH in its Public Comment Release draft of this report (dated September 27, 2011). The update is based on comments made by the city of New Bedford and on available reports.

26. Inspect classroom/restroom exhaust motors and belts for proper function. Repair and replace as necessary.*
27. Close classroom doors to maximize exhaust capabilities and increase air exchange.*
28. Repair and use exhaust ventilation system for all laboratories and shop activities as needed.
29. Clean expanding mastic between tiles in below grade areas. Monitor for humidity, condensation and further expansion of tile mastic.
30. Remove birds' nests from univent fresh air intake vents and clean with an appropriate antimicrobial. If bird nesting/waste contamination is determined to be extensive, consider contacting a professional cleaning company. Consider installing wire mesh bird screens over air intakes to prevent further roosting.*
31. 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. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).*
32. Ensure water is poured into floor drains several times per week, or as needed, to maintain traps and prevent infiltration of sewer gas odors.
33. Clean chalk dust trays and pencil sharpeners periodically to prevent dust aerosolization.
34. 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.*
35. Clean upholstered furniture on the schedule recommended in this report. If not possible/practical, remove upholstered furniture from classrooms.*
36. Examine school/district policy on space heaters; ensure no flammable materials are in close proximity to constitute a fire hazard. Consider removal if not necessary.*
37. Examine methods to prevent/enforce smoking regulations by students in restrooms.

* See Appendix H for an update on actions taken on recommendations made by MDPH in its Public Comment Release draft of this report (dated September 27, 2011). The update is based on comments made by the city of New Bedford and on available reports.

38. Examine damaged gym mats and determine if they are still functional, discard if moldy or are no longer in useable condition.
39. Clean accumulated dust and debris periodically from the surface of air diffusers, exhaust vents and blades of personal and ceiling fans.
40. Consider adopting the U.S. EPA (2000) document, "Tools for Schools", 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.*
41. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://mass.gov/dph/iaq.*

Recommendations Specific to Moisture and Mold Issues

42. Ensure roof/window leaks are repaired and replace water-damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.*
43. Refrain from storing porous items (boxes, papers, books, etc.) in areas of suspected water leaks.*
44. Contact a building-engineering firm to examine ways to mitigate/prevent water pooling in the mechanical/boiler room.*
45. Ensure all plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Remove plants from univents.[*]
46. Examine sink countertop and backsplash areas for water damage and/or mold growth. Disinfect and replace as necessary. Seal breaches to prevent damage.*
47. Clean and maintain aquariums and terrariums to prevent bacterial/mold growth.
48. Continue to use dehumidifier in below grade areas as needed during the summer months and monitor for floor condensation. Ensure dehumidifiers are cleaned and maintained as per the manufacturer's instructions to prevent microbial growth.

[*] See Appendix H for an update on actions taken on recommendations made by MDPH in its Public Comment Release draft of this report (dated September 27, 2011). The update is based on comments made by the city of New Bedford and on available reports.

49. Inspect and make repairs to kitchen refrigerators/freezers to prevent air leakage and condensation issues.*
50. Remove plant growth against exterior walls to prevent water impingement.
51. Make repairs to damaged exterior brickwork and seal cracks/breaches to prevent moisture intrusion and pest entry.
52. As requested, the MDPH/BEH Indoor Air Quality Program will conduct a follow-up inspection of the NBHS.

* See Appendix H for an update on actions taken on recommendations made by MDPH in its Public Comment Release draft of this report (dated September 27, 2011). The update is based on comments made by the city of New Bedford and on available reports.

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FIGURES

Figure 1: Location of New Bedford High School, Keith Middle School, and the Former Keith Middle School, New Bedford, Massachusetts

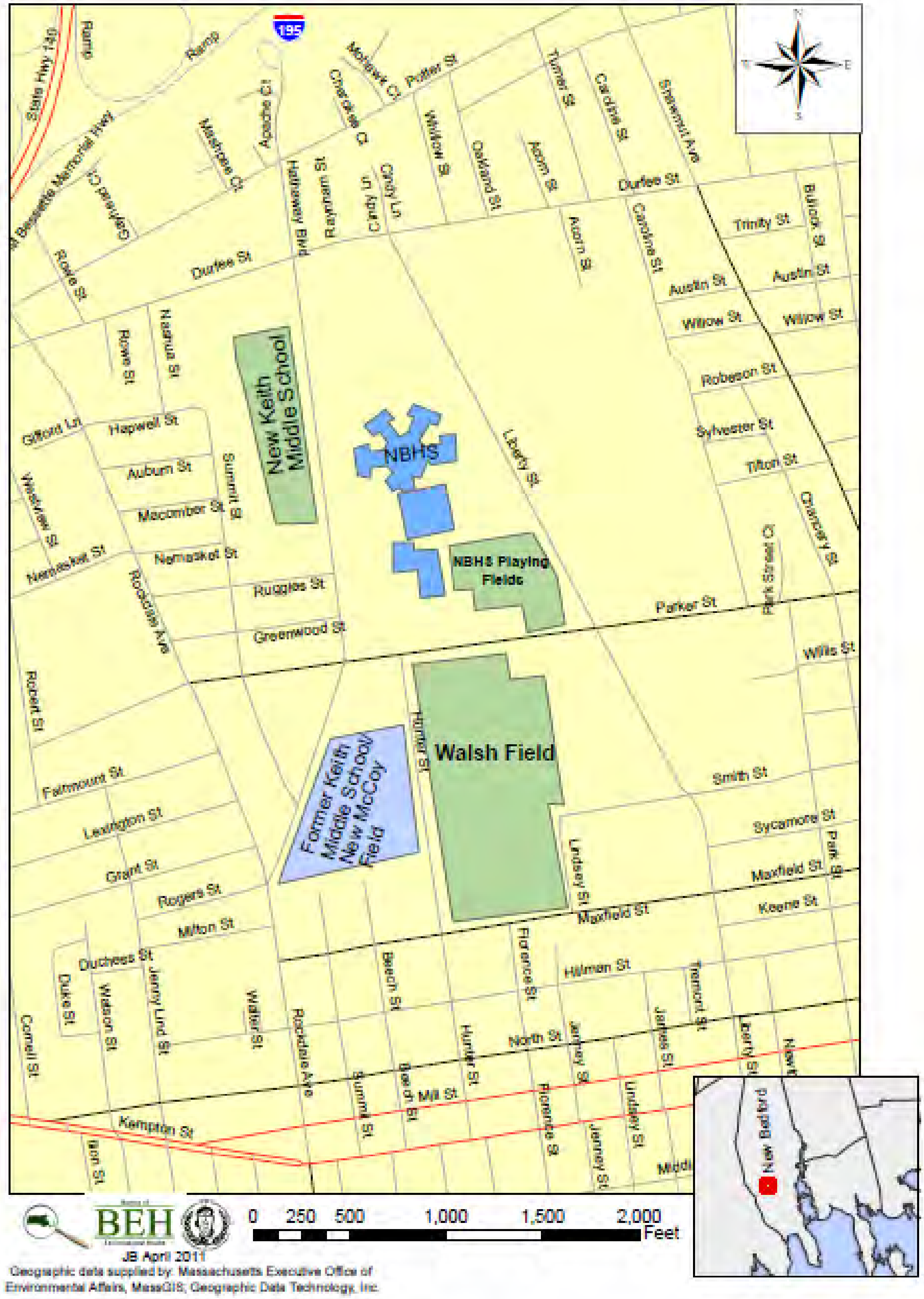
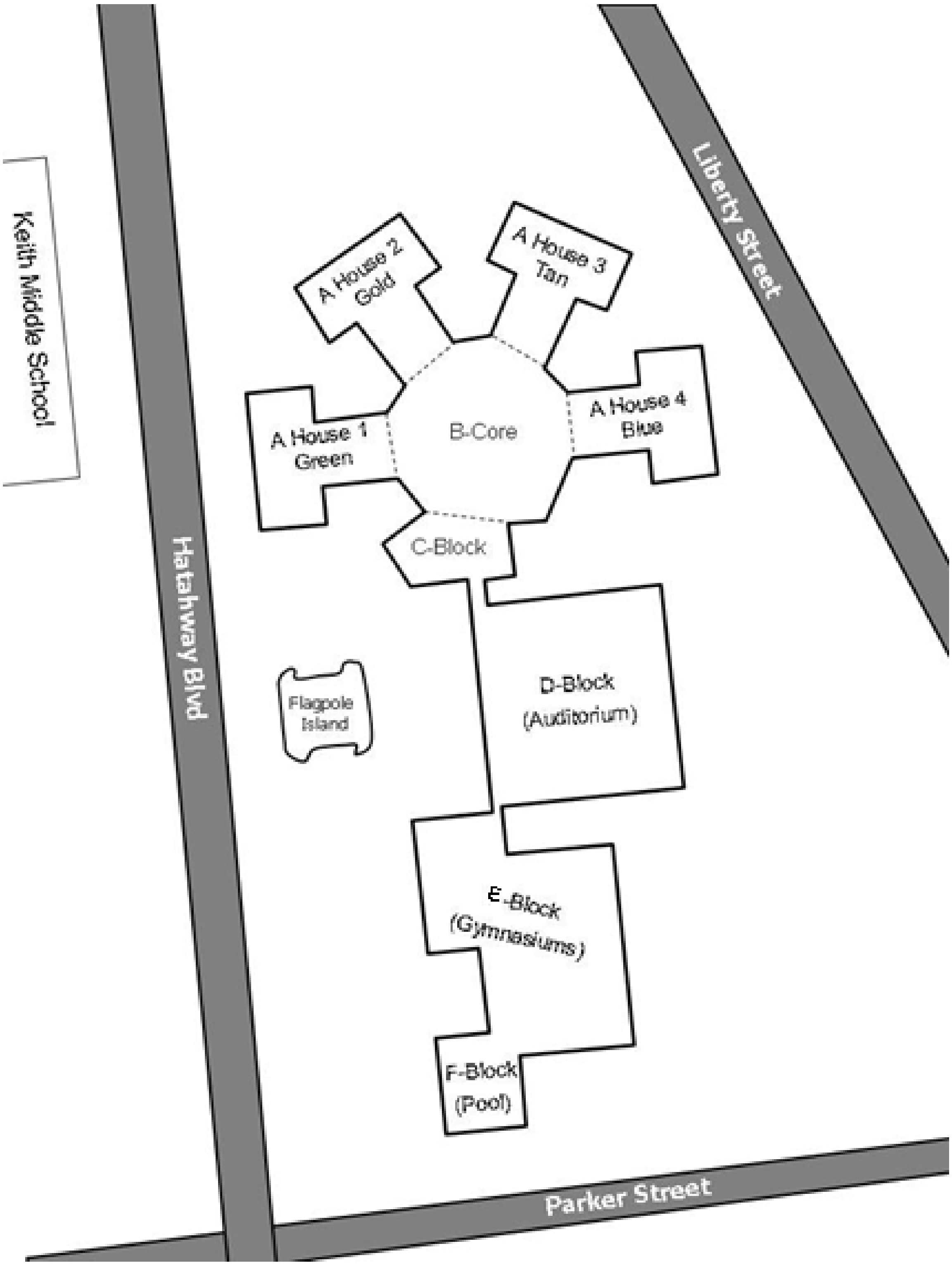


Figure 2: New Bedford High School Building Layout



* Not to scale

Figure 3: Typical Unit Ventilator (Univent) Configuration

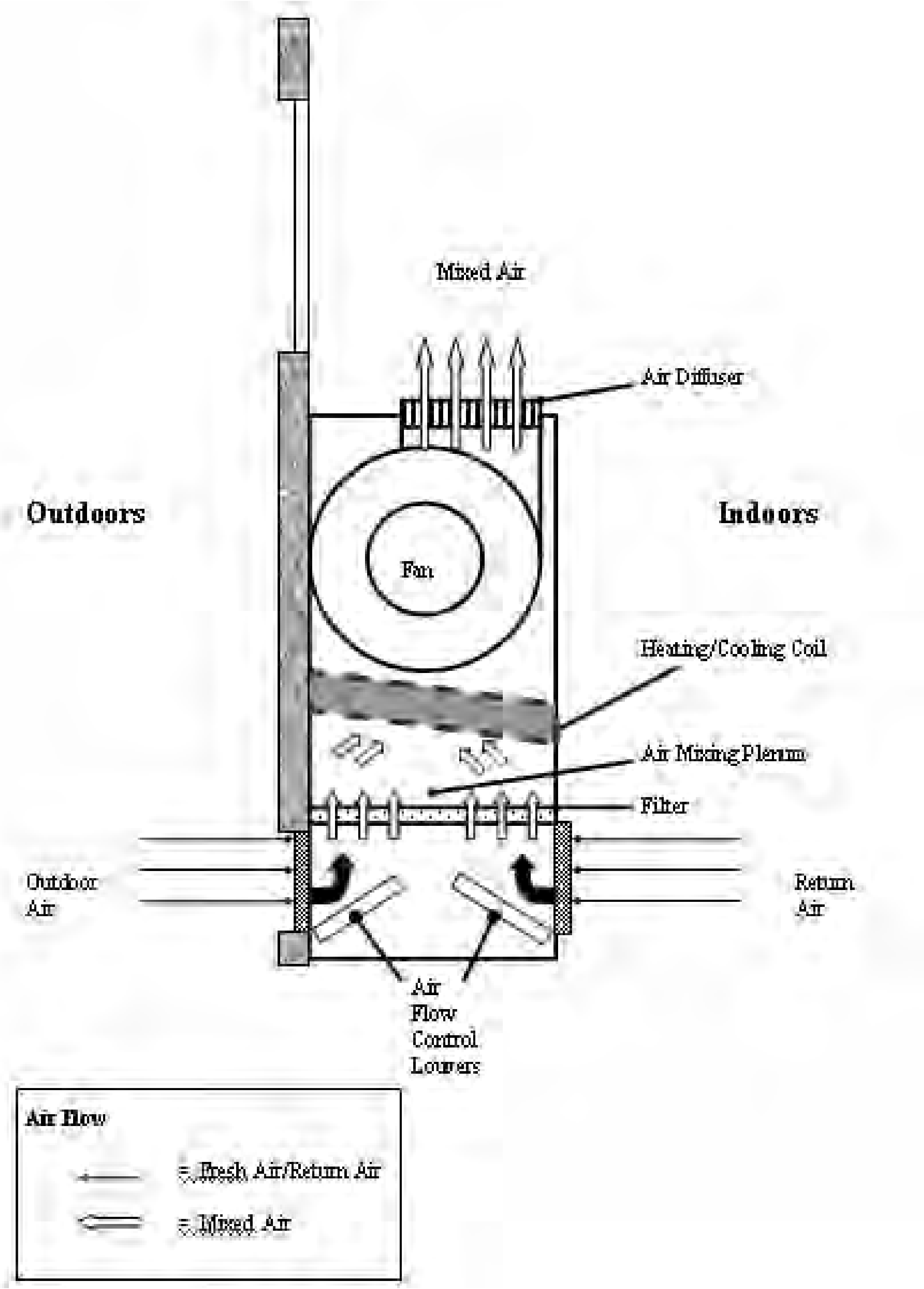


Figure 4: New Bedford High School Ground Floor Univent Configuration

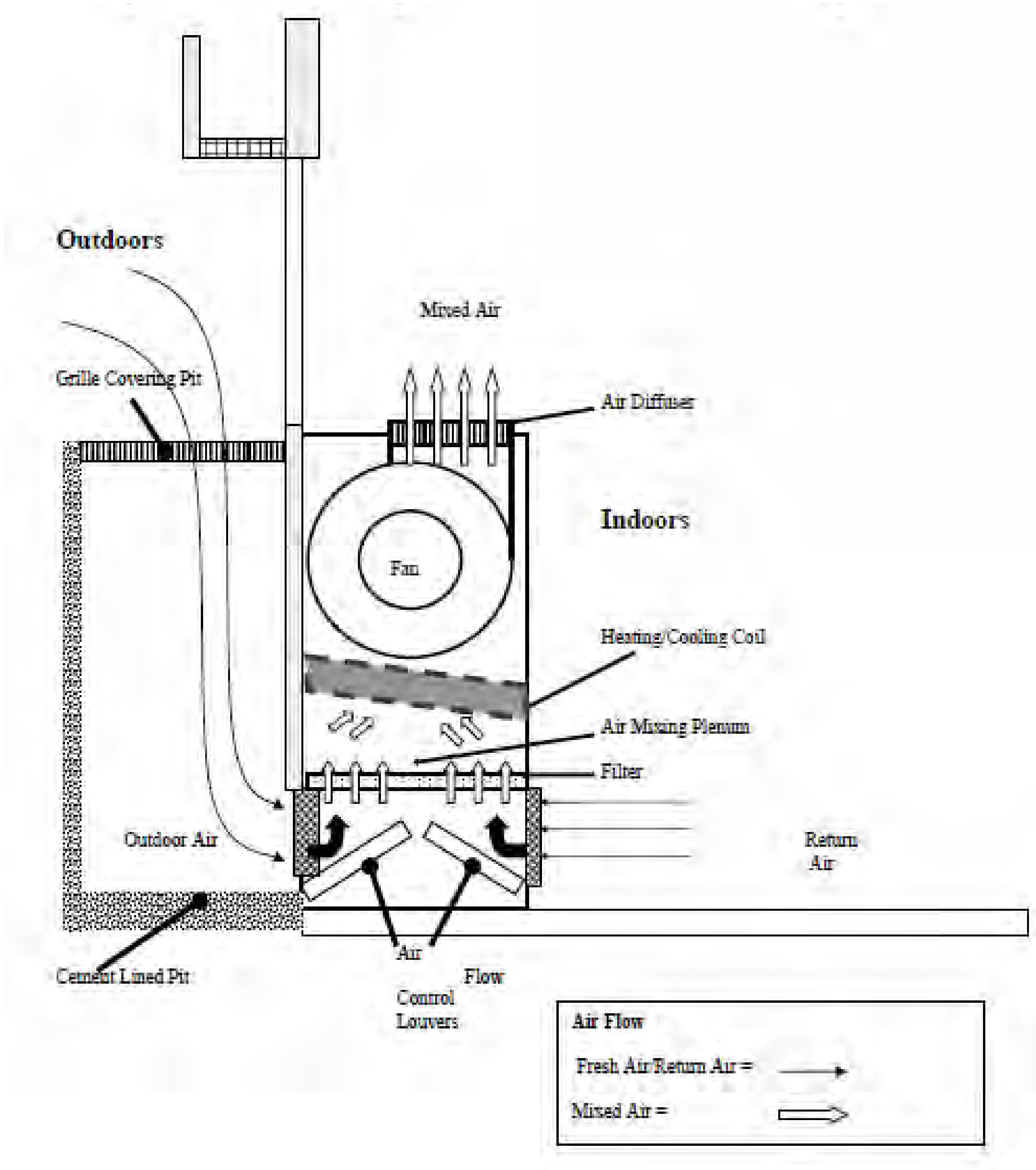


Figure 5: New Bedford High School Second and Third Floors Univent Configuration

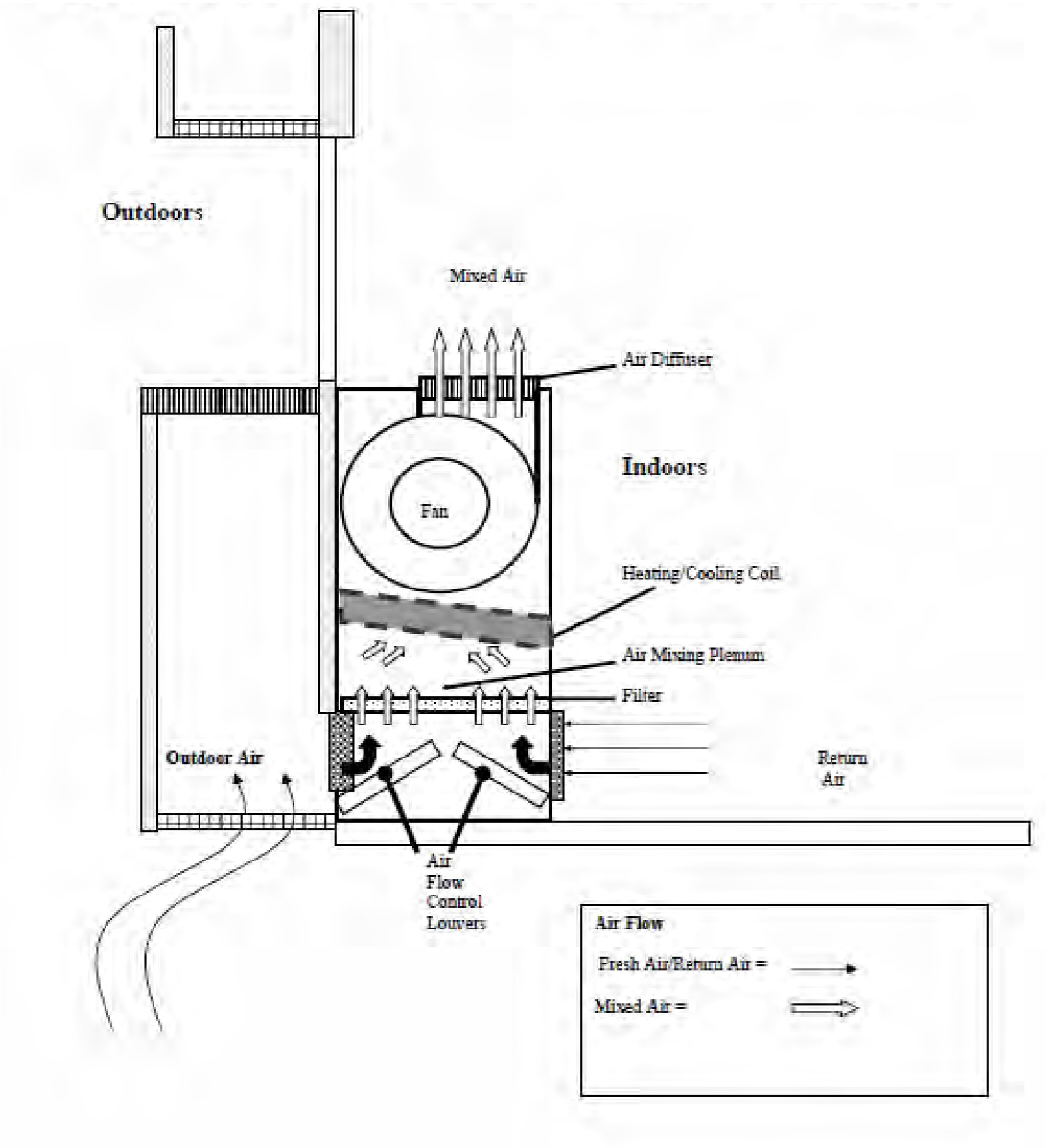
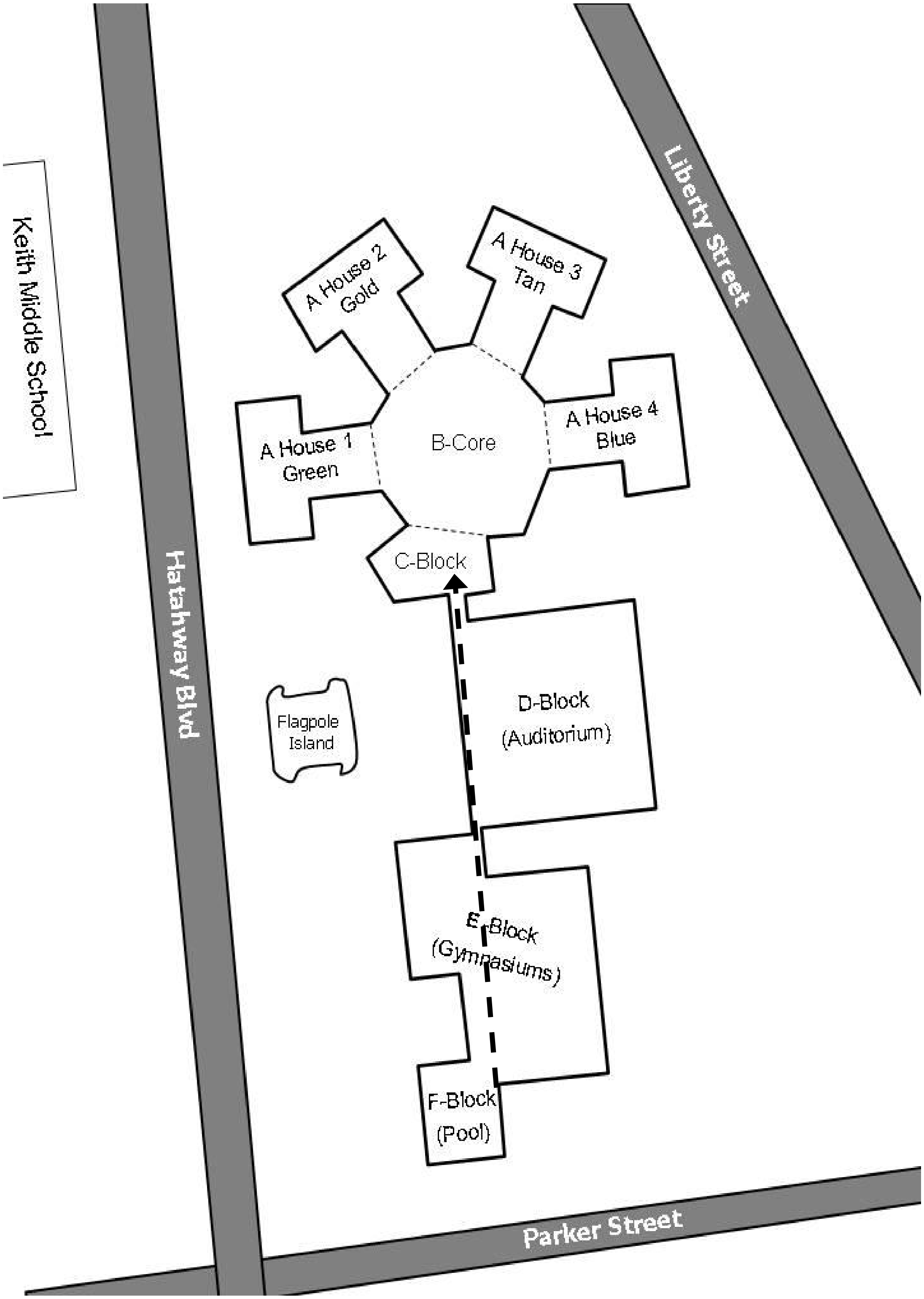


Figure 6: New Bedford High School Building Layout with Dotted Arrow Denoting Areas with Pool Odors



* Not to scale

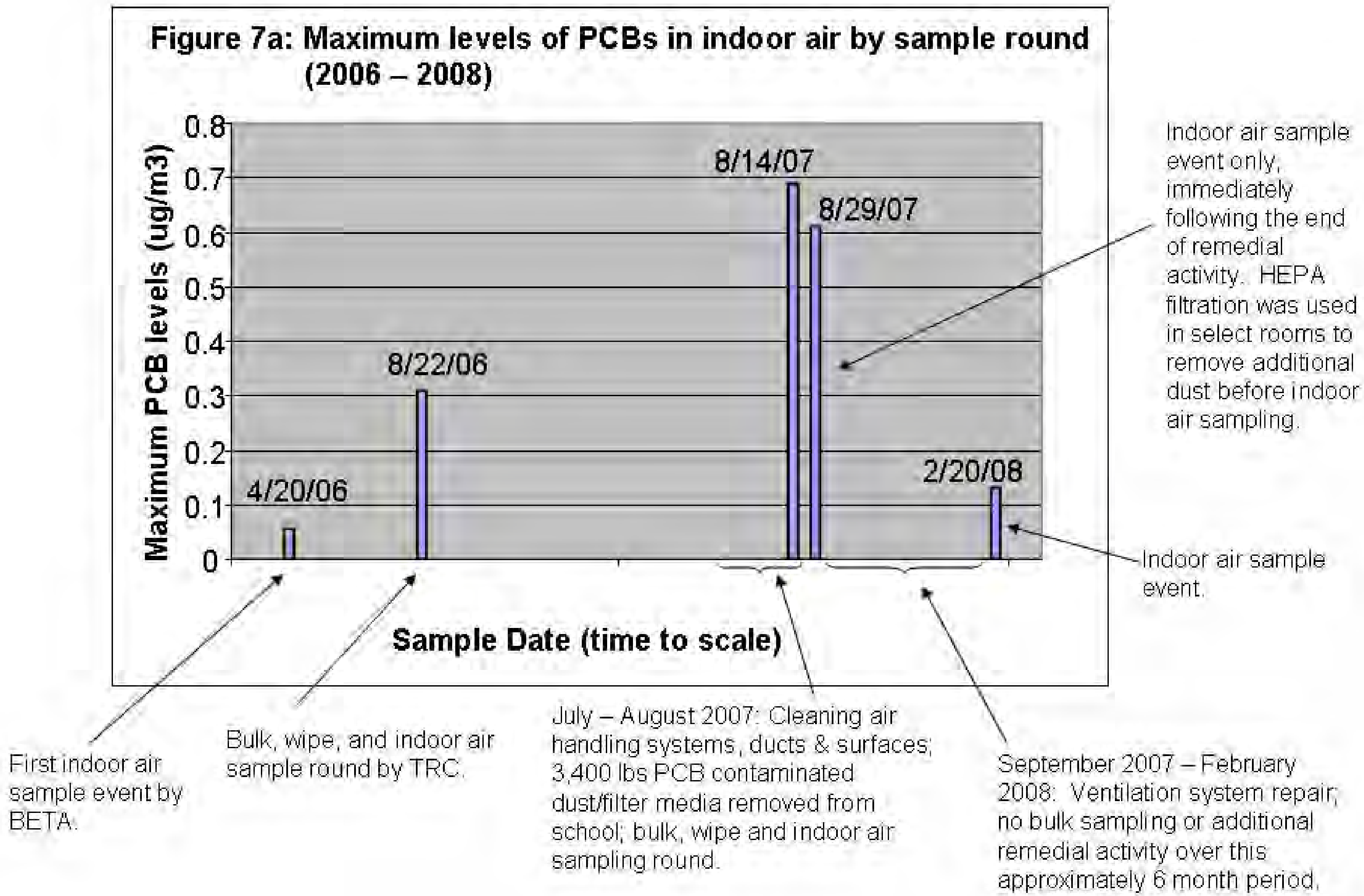
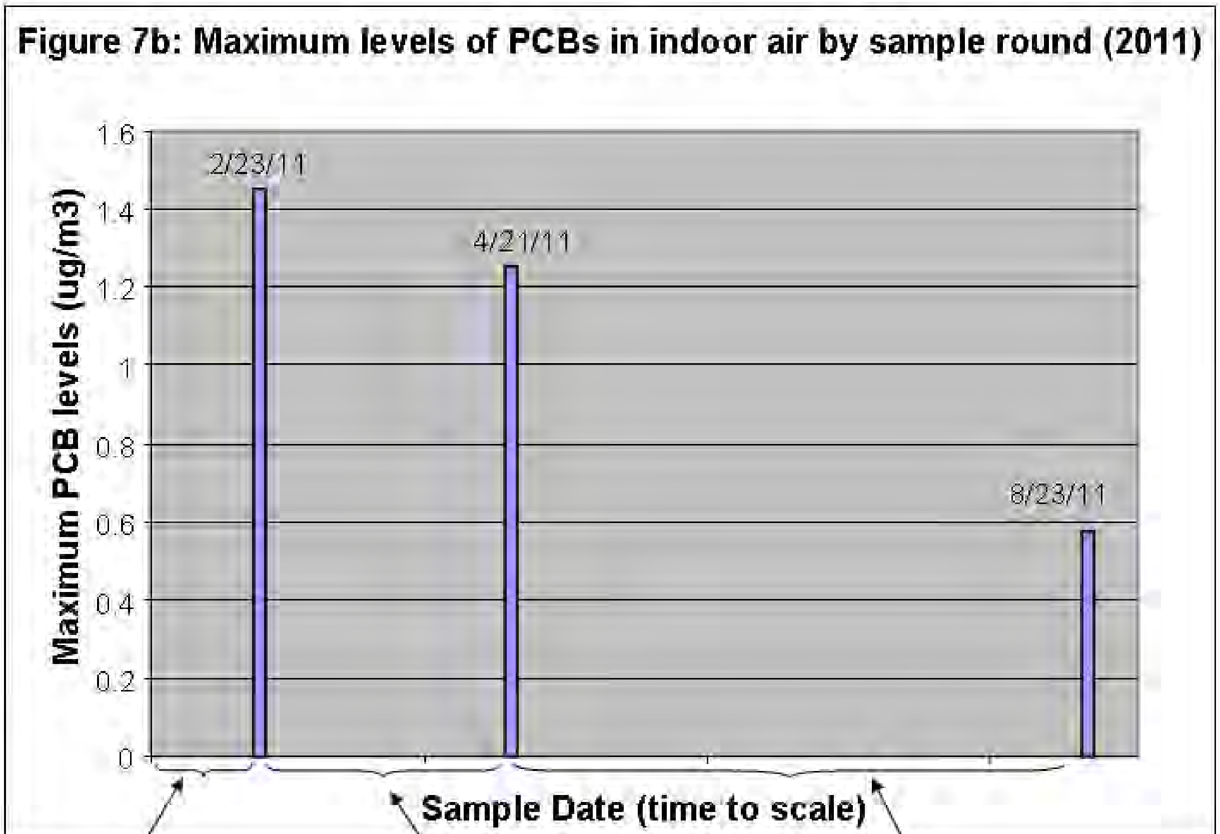


Figure 7a: Maximum levels of PCBs in indoor air by sample round (2006 – 2008)
Maximum PCB levels (ug/m3)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4/20/06
8/22/06
8/14/07
8/29/07
2/20/08
Sample Date (time to scale)
Indoor air sample event only, immediately following the end of remedial activity. HEPA filtration was used in select rooms to remove additional dust before indoor air sampling.
Indoor air sample event.
First indoor air sample event by BETA.
Bulk, wipe, and indoor air sample round by TRC.
July – August 2007: Cleaning air handling systems, ducts & surfaces; 3,400 lbs PCB contaminated dust/filter media removed from school; bulk, wipe and indoor air sampling round.
September 2007 – February 2008: Ventilation system repair; no bulk sampling or additional remedial activity over this approximately 6 month period.



Between February 2008 and 2011 indoor air sample rounds there was additional bulk sampling and bulk material removal in school

Between February and April 2011 indoor air sample rounds, PCB impacted light fixture trays were removed from select rooms

Between April 2011 and the end of July 2011, remaining PCB impacted light fixtures were removed. Over summer 2011 additional bulk materials (e.g., paint, sheetrock, foam seating) were removed from school

Figure 7c: Photos depicting walls and baseboard areas typical of bulk sampling activities (e.g., adhesives, vinyl cove, paint)

Figure 8: School Affiliation

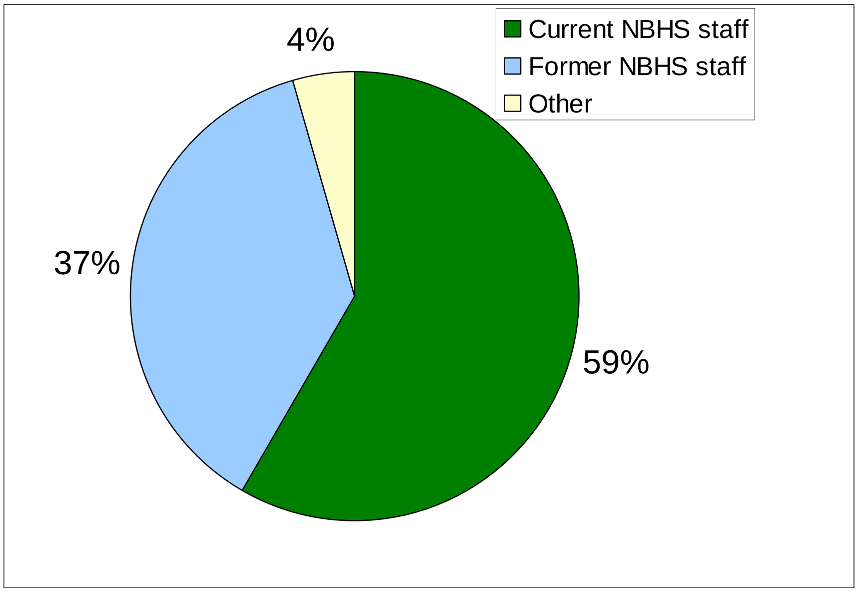


Figure 9: Participant Age Groups

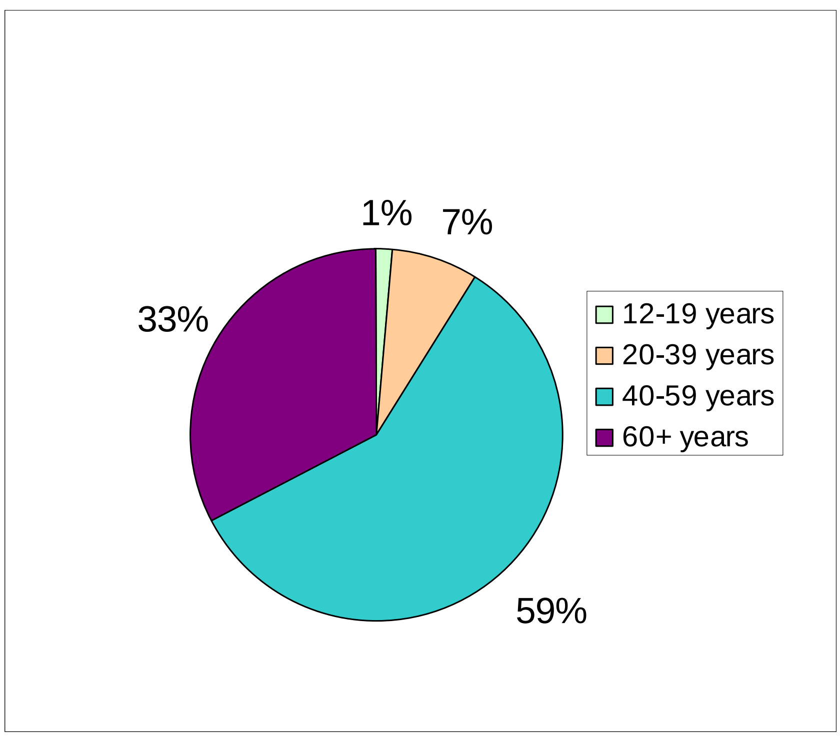


Figure 10: Serum PCB Concentrations (Whole Weight, ppb)

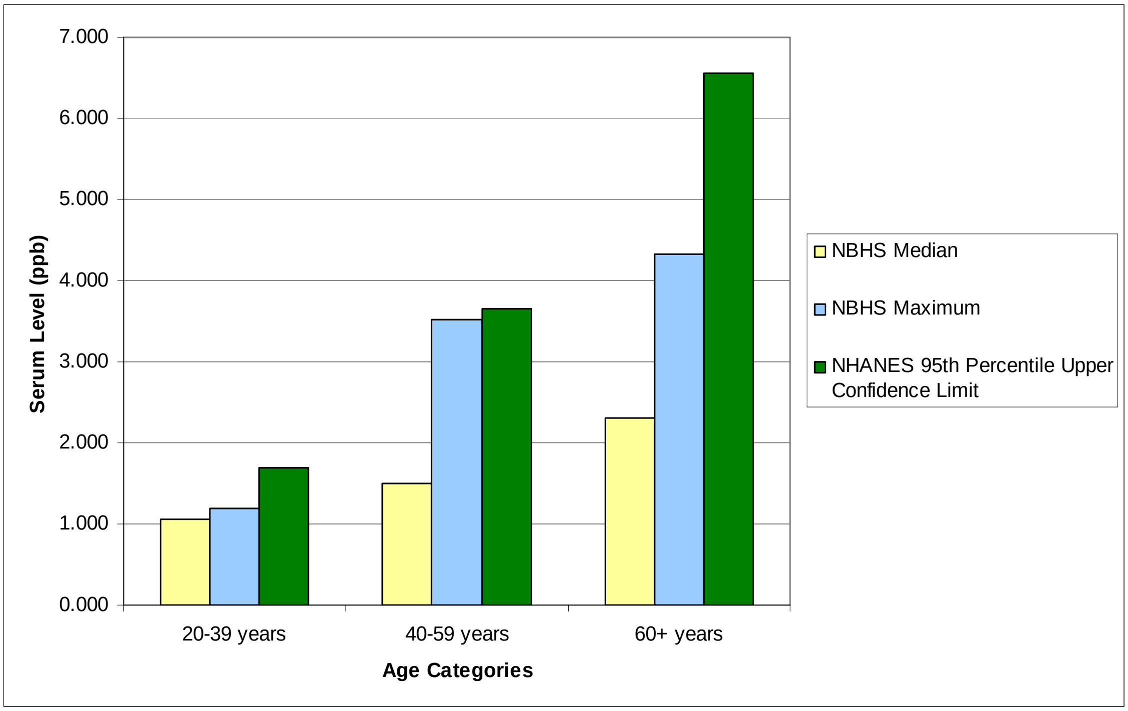


Figure 11: Serum PCB Concentrations (Lipid-Adjusted, ppb)

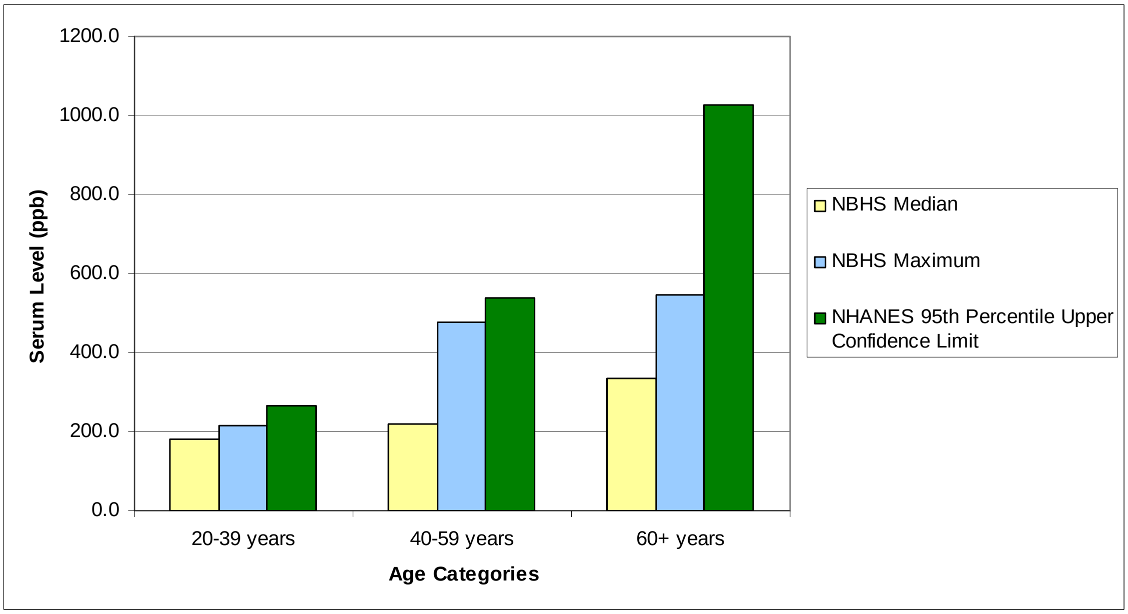


Figure 12: Serum PCB Congener Pattern for New Bedford Participants (All Ages, n=91)

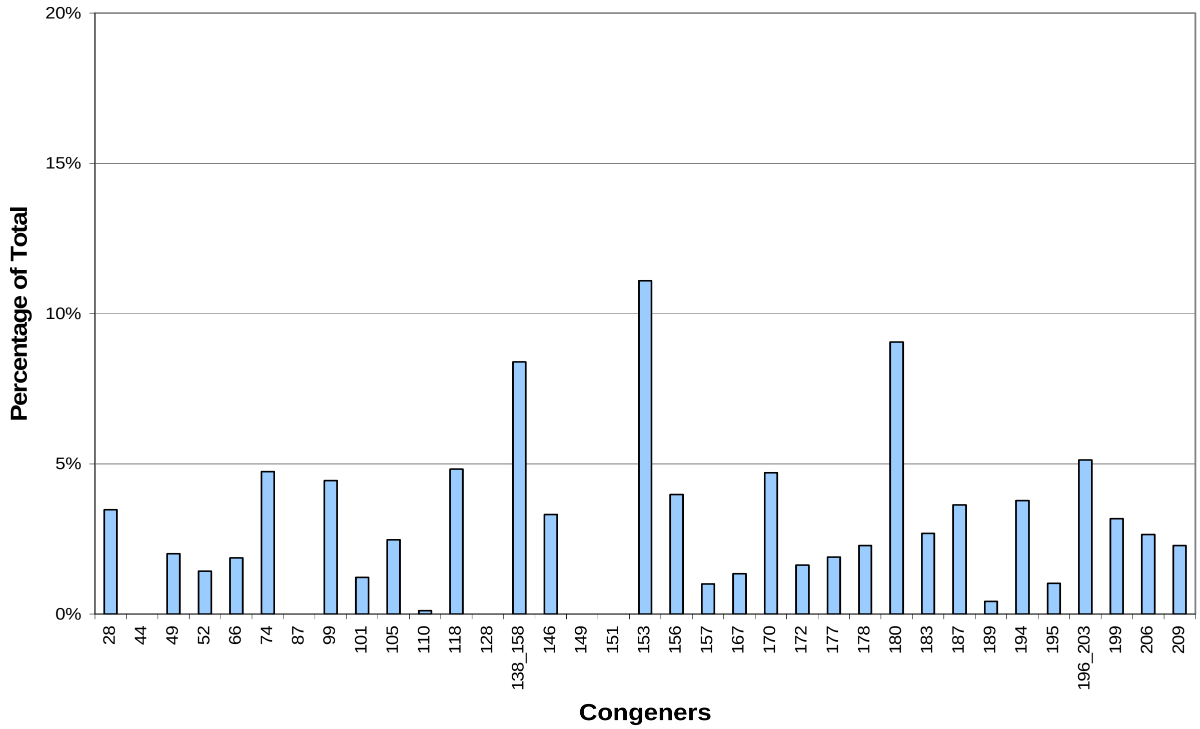


Figure 13: Serum PCB Congener Pattern for NHANES 2003-2004 (All Ages)

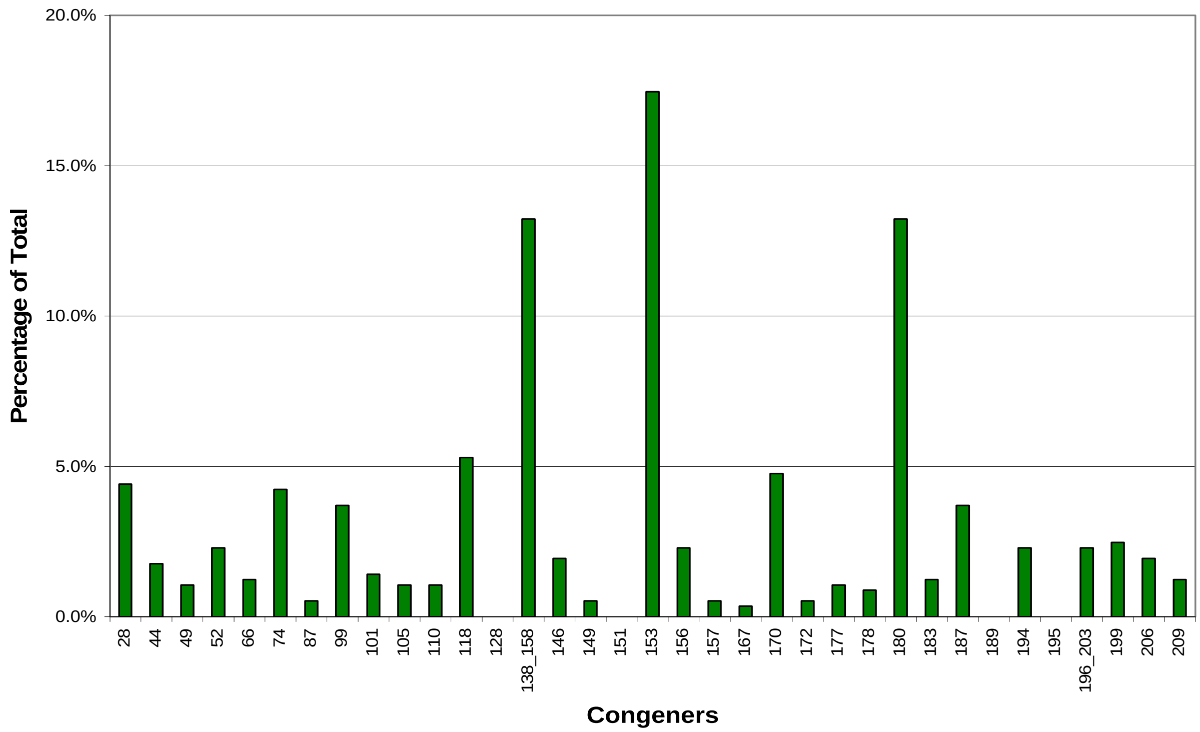


Figure 14: Geometric Mean Whole Weight Serum PCB Levels (ppb) by Years Worked at NBHS

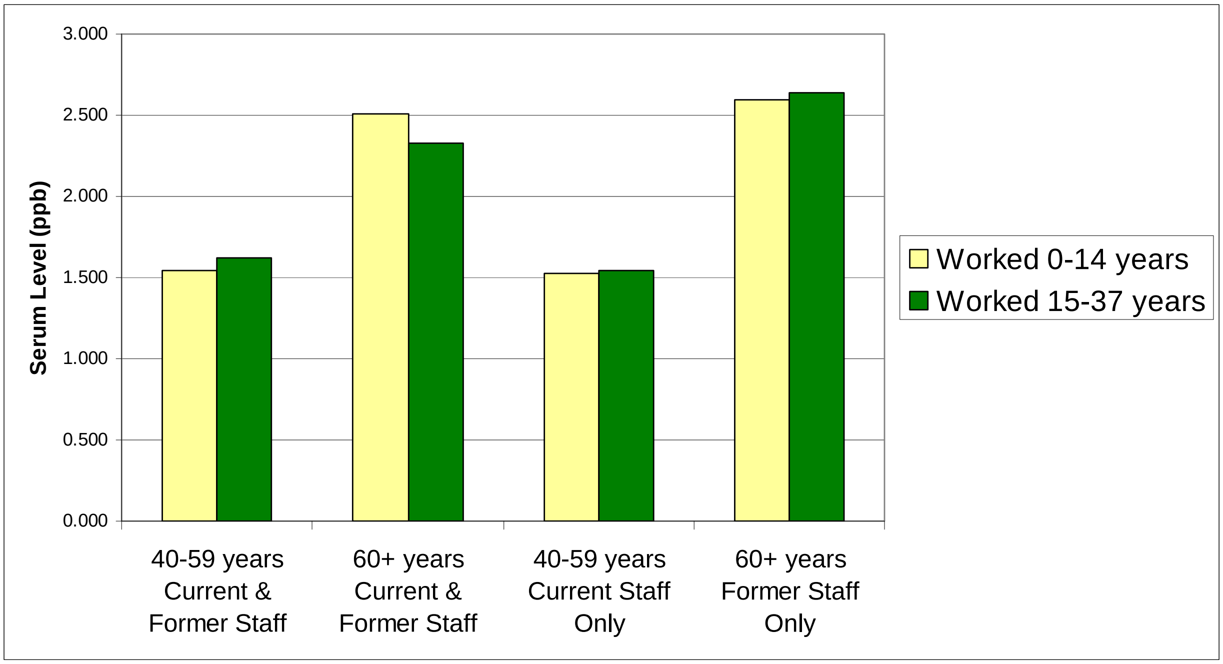
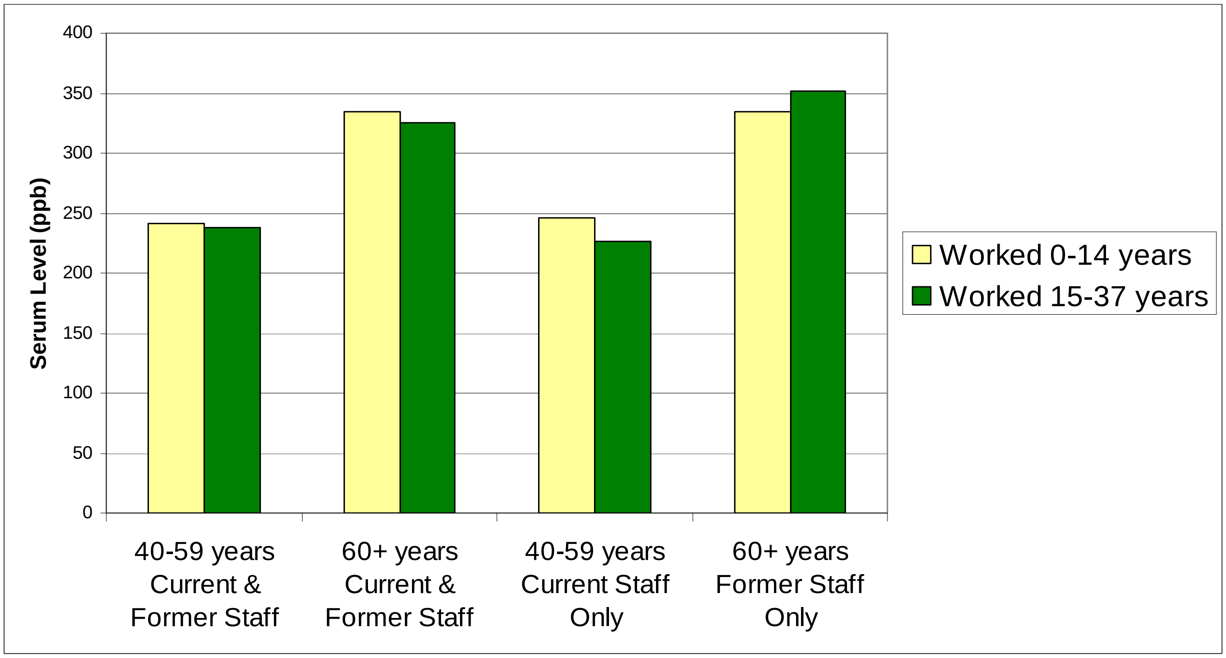


Figure 15: Geometric Mean Lipid-Adjusted Serum PCB Levels (ppb) by Years Worked at NBHS



Pictures

Picture 1

Classroom univent

Picture 2

Univent air flow obstructed by books

Picture 3

Obstructions to univent

Picture 4

Typical univent fresh air intake

Picture 5

Fresh air intake for some ground floor classrooms

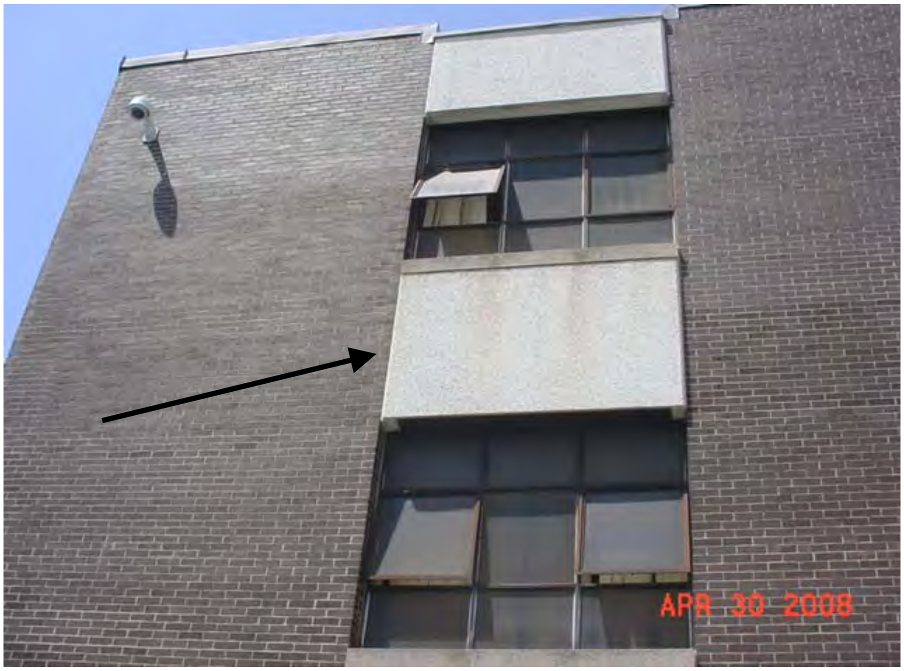
Picture 6

Pine needles, debris and moss growth in/around ground floor classroom fresh air intake

Picture 7

Tree growth in fresh air intake

Picture 8

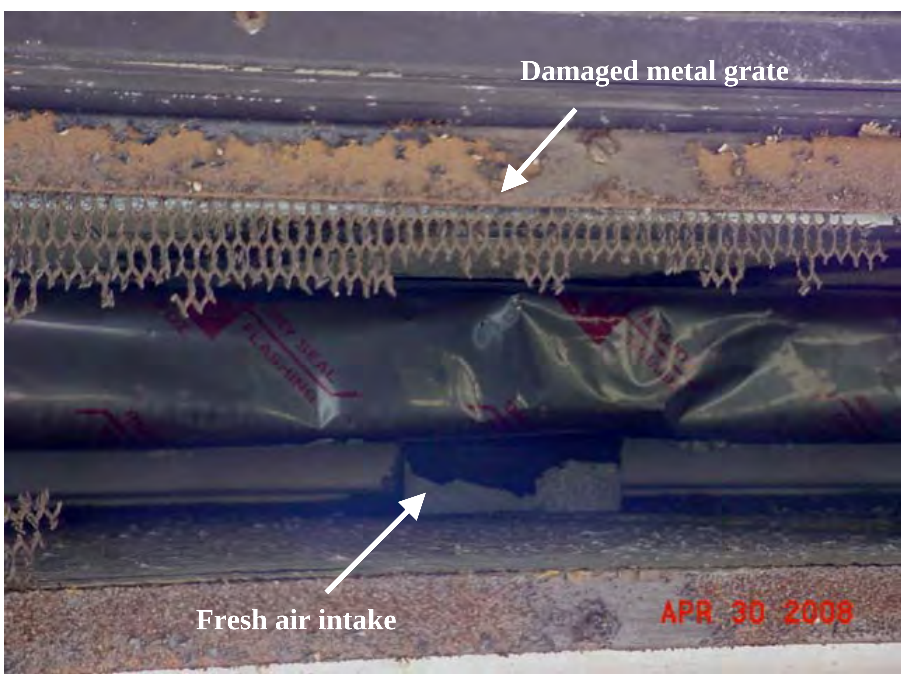


Spandrel wall panel

Picture 9

Metal grate between spandrel panel wall and building's exterior wall that allows airflow into univent fresh air intake

Picture 10



Damaged metal grate

Picture 11

Bird nesting materials in damaged metal grate

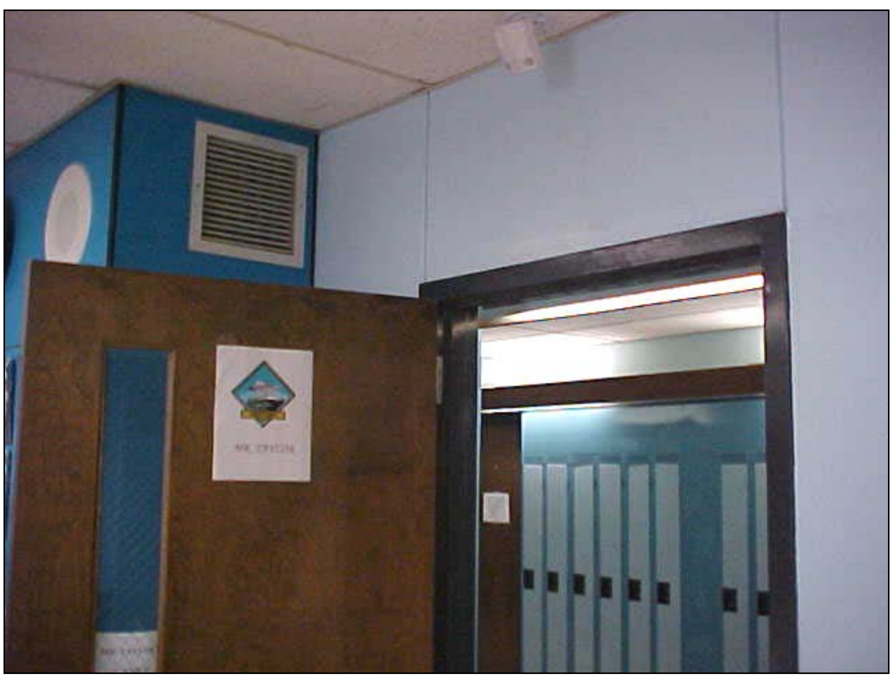
Picture 12

Damaged univent diffuser

Picture 13

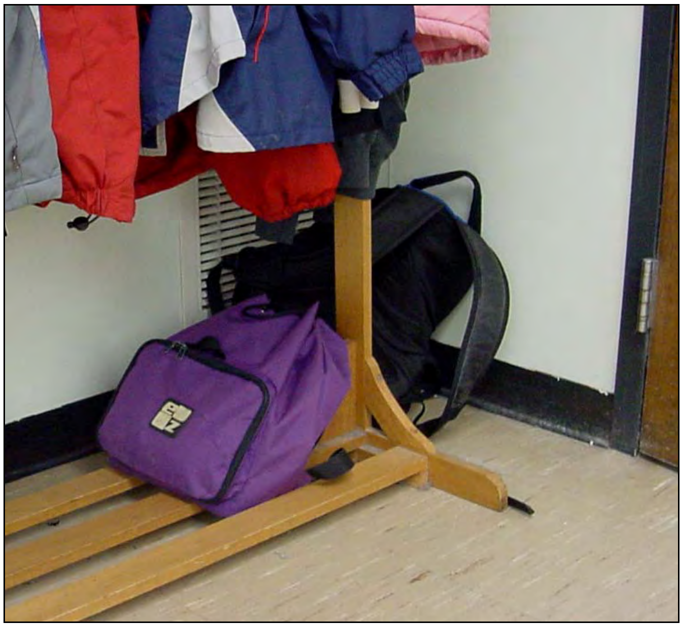
Univent filter (cut to fit media)

Picture 14



Proximity of classroom exhaust vent to open hallway door

Picture 15

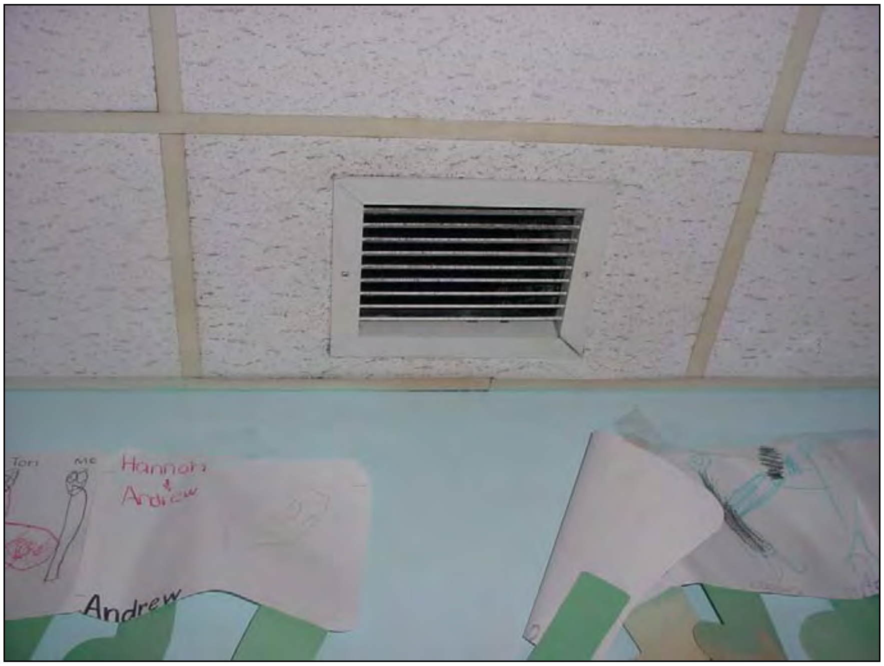


Classroom exhaust vent blocked by items

Picture 16

Fresh air supply diffuser

Picture 17



Exhaust vent

Picture 18

Pool return vent

Picture 19

Supply duct for dehumidified air

Picture 20

Slotted supply diffuser on supply duct

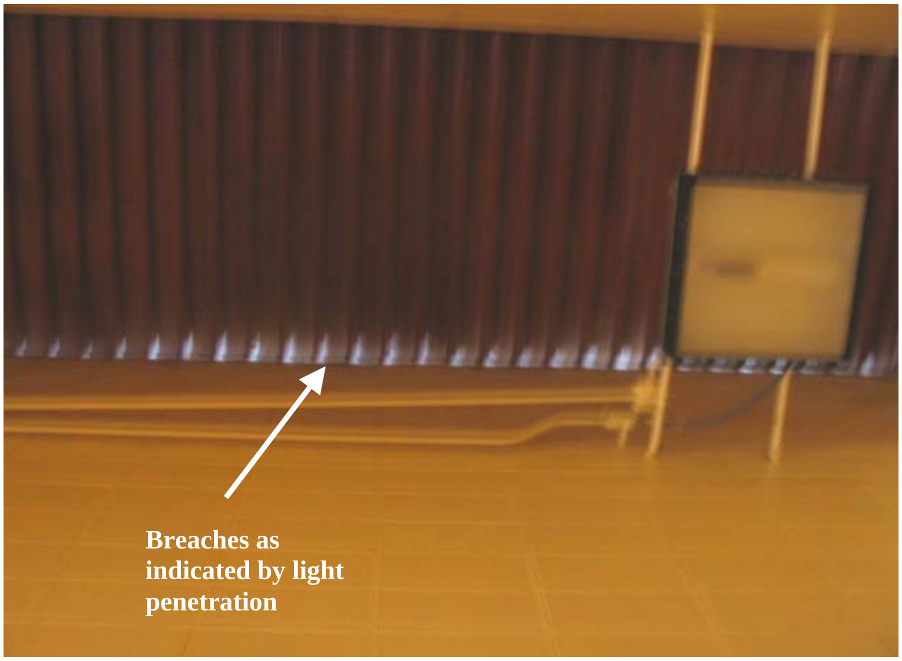
Picture 21

Passive vent on chemical hood adjacent to exhaust vent

Picture 22

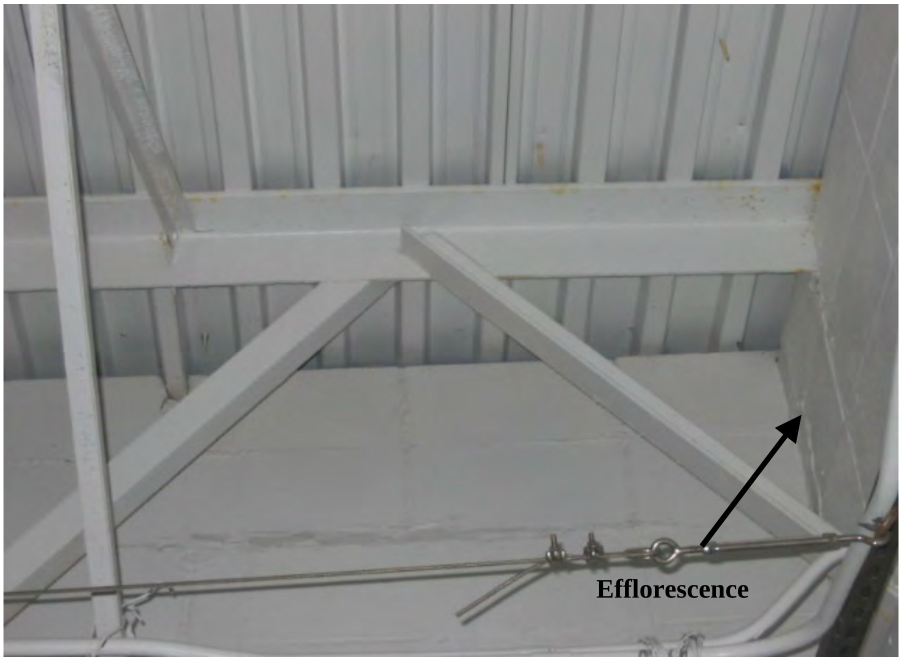
Mold growth on door frame (as indicated by dark spots) between hallway and pool area

Picture 23



Breaches between wall/ceiling shared by pool and stairwell, as indicated by light penetration

Picture 24



Efflorescence on wall and rust stains on beam, indicating moisture

Picture 25

Exterior wall to pool area, note efflorescence line

Picture 26

Floor mastic expanding between floor tiles

Picture 27

Deteriorating floor near kitchen freezer

Picture 28

Water in close proximity to electrical panels

Picture 29

Water around pipes to utility box

Picture 30

Water-damaged ceiling tile

Picture 31

Bucket collecting water from leak

Picture 32

Breach between sink countertop and backsplash with mold growth

Picture 33

Plants on univent

Picture 34

Algal growth in aquarium

Picture 35

Plant growth around building exterior, also note breach/damaged brickwork

Picture 36

Moss growth resulting from incomplete drying

Picture 37

Damaged gym mats

TABLES

Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Date: 4-29-2008**

Table 1

Location/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
background		64	66	435	ND	3				Rainy, steady drizzle
A-1-103, Green Cafeteria	12	69	66	947	ND	12	Y	Y	Y	10 WD CT
A-1-105	4	68	64	766	ND	5	Y	Y	Y off	PC, microwave, refrigerator
A-1-110	6	68	67	1629	ND	15	Y	Y off	Y off	CD, PF
A-1-111	17	70	72	2159	ND	17	Y	Y off	Y off	CD, dehumidifier
A-1-112	0	68	66	773	ND	5	Y	Y	Y off	Dehumidifier
A-1-113	9	68	72	2391	ND	8	Y	Y off, damaged air diffuser	Y	paper/styrofoam art near UV
A-1-114	15	67	70	1609	ND	5	Y	Y off	Y	CD, 3 MT, dehumidifier
A-1-115	13	69	73	2141	ND	8	Y	Y off	Y off	DO, dehumidifier

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect

AC = AIR CONDITIONER
AD = air deodorizer
AT = ajar ceiling tile

CD = CHALK DUST
CT = ceiling tile
DEM = dry erase materials

DO = DOOR OPEN
MT = missing ceiling tile
PC = photocopier

PF = PERSONAL FAN
UV = univent
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/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	
A-1-116	0	66	69	544	ND	4	Y open	Y	Y off	Wall AC, DO, 9 WD CT
A-1-117	20	69	68	1729	ND	6	N	Y	Y off	Wall AC, DO
A-1-203	2	73	60	1005	ND	3	Y	Y off	Y	2 WD CT
A-1-205	2	70	61	934	ND	4	Y	Y blocked	Y	3 WD CT
A-1-208 faculty lounge	0	68	66	924	ND	10	Y	Y blocked	Y	
A-1-209	6	66	66	842	ND	9	Y	Y off	Y	Damaged window
A-1-210	12	67	69	982	ND	9	Y	Y off, plants	Y	DO
A-1-211	17	69	67	1114	ND	8	Y	Y off	Y	
A-1-212	28	69	62	842	ND	5	Y	Y blocked	Y	PF
A-1-213	0	69	63	776	ND	9	Y	Y	Y	DEM

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Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Date: 4-29-2008**

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 Supply	Ventilation Exhaust	Remarks
A-1-214	15	68	65	1053	ND	9	Y	Y off	Y	CD
A-1-217	10	68	67	1202	ND	6	Y	Y off	Y weak	Space between sink and backsplash, CD, 1 WD CT
A-1-218	3	71	63	858	ND	ND	Y	Y	Y	Copy machine, PF, 1 WD CT
A-1-225	4	73	69	1003	ND	3	N	Y	Y	7 WD CT
A-1-227	10	72	66	1201	ND	4	Y	Y off	Y	WD, visible mold growth in sink
A-1-228	8	71	68	1202	ND	6	Y	Y off	Y	UV deactivated by occupant
A-1-303	0	68	68	598	ND	4	Y	Y off	Y	
A-1-304	0	68	66	657	ND	5	Y	Y	Y	
A-1-306	15	68	66	825	ND	3	Y	Y off	Y	
A-1-307	25	67	68	1140	ND	4	Y open	Y off	Y	Water leaking from roof beams into bucket

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

Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

Location/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
A-1-308	14	68	67	1029	ND	7	Y open	Y off	Y	DEM, CD
A-1-309	19	69	53	688	ND	1	Y open	Y	Y	CD
A-1-310	15	67	68	1059	ND	8	Y	Y off, blocked	Y	water leaking from roof beams into bucket, 6 MT, CD
A-1-311	1	68	67	740	ND	7	Y	Y off	Y	DEM, PF, DO
A-1-312	0	68	63	576	ND	6	Y	Y off	Y	PF, AD
A-1-315	19	67	67	1297	ND	9	Y open	Y off	Y	DEM
A-1-316	0	67	65	797	ND	7	Y	Y off	Y	CD
A-1-318	21	71	65	1245	ND	2	Y	Y off	Y weak	CD, 3 WD CT
A-1-319	18	70	64	1166	ND	1	Y	Y	Y	CD, 4 WD CT, space between sink and backsplash
A-1-Green Food Serving Area	4	70	68	945	ND	19	N	Y	Y	

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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/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
A-1-Green Kitchen	7	68	65	631	ND	10	N	Y	Y	PF
A-1-Guidance Area Office 1	0	71	60	735	ND	ND	N	Y	Y	Copy machine, 1 WD CT
A-1-Guidance Area Office 3	0	71	60	735	ND	ND	N	Y	Y	Copy machine
A-2-103, Gold Cafeteria	4	69	64	841	ND	7	Y open	Y	Y	
A-2-105	2	69	65	736	ND	3	Y	Y	Y off	PF
A-2-111	7	68	70	1166	ND	4	Y	Y	Y off	DO, dehumidifier, 3 WD CT
A-2-112	22	71	71	2482	ND	5	Y	Y off	Y weak	CD
A-2-113	13	68	71	1485	ND	8	Y	Y	Y off	dehumidifier
A-2-114	12	68	72	1804	ND	13	Y	Y off	Y off	
A-2-115	15	68	66	1303	ND	12	Y	Y off, blocked	Y off	PF, dehumidifier, CD

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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	
A-2-116	16	68	69	1397	ND	8	Y	Y	Y off	PF, DO, CD, dehumidifier
A-2-117	16	69	73	2377	ND	12	N	Y	Y	CD, dehumidifier
A-2-203	3	70	62	882	ND	15	Y	Y plants	Y	3 WD CT
A-2-205	8	71	62	1100	ND	14	Y	Y off	Y	5 WD CT
A-2-208	1	69	63	921	ND	20	Y	Y	Y off	
A-2-209	6	68	62	863	ND	22	Y	Y noisy	Y off	Dusty windows, odors
A-2-210	11	69	68	1521	ND	11	Y	Y	Y off	
A-2-211	14	70	66	1244	ND	8	Y	Y off	Y off	
A-2-212	27	71	70	2106	ND	15	Y	Y off	Y off	
A-2-213	15	70	62	1175	ND	9	Y	Y	Y off	Items hanging from CT

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Particle matter 2.5 < 35 ug/m³

Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

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	
A-2-214	0	69	68	1282	ND	15	Y	Y off	Y	
A-2-217	15	70	63	1044	ND	1	Y	Y musty odor	Y	PF, CD, 1 WD CT
A-2-218	4	70	66	860	ND	5	Y	Y	Y	DO, 1 WD CT
A-2-227	19	69	68	1636	ND	10	Y	Y	Y off	
A-2-303	27	69	67	1054	ND	6	Y	Y	Y	1 WD CT
A-2-304	5	70	70	1298	ND	10	Y	Y	Y	
A-2-306	30	69	68	1380	ND	15	Y	Y	Y	DO
A-2-307	3	68	69	1189	ND	9	Y	Y	Y	4 WD CT, stain on wall, active leaks along windows
A-2-308	0	69	64	975	ND	5	Y	Y	Y	CD
A-2-309	0	69	63	706	ND	6	Y	Y	Y	DO

ppm = parts per million	**AC = AIR CONDITIONER**	**CD = CHALK DUST**	**DO = DOOR OPEN**	**PF = PERSONAL FAN**
$\mu g/m^3$ = micrograms per cubic meter	AD = air deodorizer	CT = ceiling tile	MT = missing ceiling tile	UV = univent
ND = non detect	AT = ajar ceiling tile	DEM = dry erase materials	PC = photocopier	WD = water-damaged

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/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	
A-2-310	12	69	66	1051	ND	10	Y	Y plants, debris	Y	CD, aquarium
A-2-311	16	67	66	1861	ND	11	Y	Y	Y	DEM, CD
A-2-312	13	67	64	701	ND	6	Y	Y debris	Y	CD
A-2-315	29	66	67	713	ND	6	Y open	Y	Y	CD, DO
A-2-316	12	69	67	907	ND	12	Y	Y	Y	Plants, pencil shavings, DO
A-2-318	15	69	61	692	ND	1	Y open	Y	Y	CD, objects hanging from ceiling, chemicals on sink, space between sink and backsplash
A-2-319	18	70	62	832	ND	2	Y	Y	Y	art objects with fur near UV, CD, 1 WD CT, dirt under light fixture
A-2-Gold Food Serving Area	5	69	68	881	ND	6	N	Y	Y	
A-2-Gold House Master	10	71	65	793	ND	2	N	Y	Y	DO, 1 WD CT
A-3-103, Tan Cafeteria	~ 100	69	56	988	ND	13	Y	Y	Y	

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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

Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

Location/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (μg/m^3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
A-3-105	4	68	56	559	ND	8	Y	Y	Y	Dehumidifier
A-3-110	0	67	64	585	ND	11	Y	Y blocked	Y off	Vent location, CD
A-3-111	13	68	58	1028	ND	11	Y	Y damaged air diffuser, fan exposed	Y	Dehumidifier
A-3-112	26	70	70	1766	ND	19	Y	Y	Y	Dehumidifier, CD
A-3-113	19	69	69	1639	ND	15	Y	Y	Y off	Dehumidifier, CD
A-3-114	26	69	68	1689	ND	19	Y	Y off, blocked	Y off	dehumidifier, CD, 2 WD CT
A-3-115	0	70	60	938	ND	6	Y	Y blocked	Y	2 WD CT, 1 AT
A-3-116	10	69	69	1258	ND	7	Y	Y	Y	CD, 3 WD CT, dehumidifier
A-3-117	17	70	62	1796	ND	18	N	Y	Y	PF, dehumidifier in interior room

ppm = parts per million
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Carbon Dioxide: < 600 ppm = preferred
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Temperature: 70 - 78 °F
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Particle matter 2.5 < 35 ug/m^3

Location/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
A-3-1st floor Girls Bathroom	0	70	68	1088	ND	65	N	N	Y off	Cigarette smoke in bathroom
A-3-1st floor men's room	2	69	75	1242	ND	732	N	N	Y off	PM2.5 due to cigarette smoke
A-3-203	2	70	62	753	ND	3	Y	Y blocked	Y	2 WD CT, 1 MT
A-3-205	8	71	63	769	ND	7	Y	Y	Y	1 WD CT, 1 AT, plants
A-3-208	5	70	62	1087	ND	14	Y	Y blocked	Y off	
A-3-209	0	68	63	618	ND	13	Y	Y	Y off	CD
A-3-210	16	69	68	1242	ND	13	Y	Y off, blocked	Y	2 WD CT along window
A-3-211	0	68	65	630	ND	13	Y	Y off	Y	3 WD CT along windows, pencil shavings
A-3-212	28	70	70	1495	ND	27	Y	Y off	Y	pencil shavings
A-3-213	14	71	62	1137	ND	13	Y	Y damaged air diffuser	Y off	CD

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Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

Location/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
A-3-214	15	70	63	1137	ND	12	Y	Y off	Y off	CD, pencil shavings
A-3-217	8	71	61	895	ND	9	Y	Y	Y	CD, 2 WD CT
A-3-218	4	71	64	639	ND	5	Y	Y	Y	DO
A-3-227	0	69	66	795	ND	6	Y	Y	Y	DO
A-3-228	18	68	54	860	ND	6	Y	Y	Y	Ducted dryer, 1 WD CT
A-3-303	1	66	69	472	ND	5	Y open	Y	Y	Occupants at lunch
A-3-304	1	66	65	603	ND	8	Y	Y	Y	DO, occupants at lunch
A-3-306	0	67	63	545	ND	13	Y	Y	Y	PF
A-3-307	10	67	64	782	ND	8	Y	Y	Y	CD, DEM, DO
A-3-308	0	68	65	618	ND	9	Y	Y	Y	DO

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Particle matter 2.5 < 35 ug/m^3

Location: New Bedford High School

Address: 230 Hathaway Blvd., New Bedford, MA

Indoor Air Results

Date: 4-29-2008

Table 1 (continued)

Location/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (μg/m^3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
A-3-309	12	70	63	813	ND	9	Y	Y	Y	CD
A-3-310	7	68	64	697	ND	15	Y	Y	Y	DO
A-3-311	1	68	65	721	ND	18	Y	Y	Y	DO
A-3-312	0	69	60	604	ND	17	Y	Y off	Y	
A-3-315	0	68	61	665	ND	10	Y	Y	Y	PF-dusty
A-3-316	0	68	64	576	ND	13	Y	Y	Y	PF-dusty
A-3-318	2	67	66	670	ND	2	Y	Y plants	Y	CD, personal heater
A-3-319	0	68	60	538	ND	3	Y	Y	Y	CD, objects hanging from ceiling
A-3-Guidance Office	4	71	64	695	ND	6	N	Y	Y	
A-3-Tan Hall										Strong chlorine smell from pool

ppm = parts per million
μg/m^3 = micrograms per cubic meter
ND = non detect

AC = AIR CONDITIONER
AD = air deodorizer
AT = ajar ceiling tile

CD = CHALK DUST
CT = ceiling tile
DEM = dry erase materials

DO = DOOR OPEN
MT = missing ceiling tile
PC = photocopier

PF = PERSONAL FAN
UV = univent
WD = water-damaged

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: New Bedford High School | **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA | **Table 1 (continued)** | **Date: 4-29-2008**

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	
A-4-103, Blue Cafeteria	7	69	68	1015	ND	11	Y	Y	Y	Approx. 200 students left a few moments prior to the assessment
A-4-105	4	70	61	1031	ND	11	Y	Y off	Could not locate	16 computers, WD CT, PF
A-4-110	0	66	60	911	ND	18	Y	Y Off	Y	Room closed for cleaning, dehumidifier
A-4-111	14	66	60	911	ND	18	Y	Y off, plants	Y	PF
A-4-112	1	69	63	954	ND	6	Y	Y plants	Y	CD, objects hanging from ceiling, dehumidifier
A-4-113	29	69	66	1156	ND	12	Y	Y clutter	Y	CD, PF, dehumidifier
A-4-114	20	70	63	1214	ND	10	Y	Y	Y	CD, PF, 3 WD CT, dehumidifier
A-4-115	29	68	64	1073	ND	11	Y	Y	Y	CD, DEM, DO, dehumidifier
A-4-116	0	67	66	774	ND	10	Y	Y	Y	CD, PF, DEM, CD
A-4-117	0	67	66	745	ND	13	N	Y	Y	Dehumidifier, CD, DEM

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Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
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Location: New Bedford High School | Indoor Air Results

Address: 230 Hathaway Blvd., New Bedford, MA | Date: 4-29-2008

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	
A-4-203	2	68	66	688	ND	13	Y	Y clutter	Y	1 WD CT
A-4-205	7	67	65	672	ND	13	Y	Y off	Y	1 WD CT, 1 MT
A-4-208	2	67	67	744	ND	19	Y	Y off, debris	Y	
A-4-209	0	67	65	510	ND	16	Y	Y	Y	CD
A-4-210	0	67	69	815	ND	23	Y	Y damaged air diffuser, debris	Y	Univent re-activated, PF-dusty, CD
A-4-211	0	67	71	888	ND	17	Y	Y	Y	
A-4-212	0	66	65	481	ND	10	Y	Y	Y	Room closed, cleaning in progress
A-4-213	0	65	66	495	ND	11	Y	Y	Y	CD
A-4-214	5	66	68	534	ND	14	Y	Y	Y	Plants on univent, WD CT along windows

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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: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

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	
A-4-217	0	68	70	829	ND	19	Y	Y off	Y	1 WD CT, DO
A-4-227	30	69	72	1256	ND	28	Y open	Y	Y	Dusty exhaust vent, cooking cupcakes
A-4-303	0	70	57	609	ND	6	Y	Y	Y	CD, 1 WD CT, pencil shavings, PF
A-4-304	0	68	66	918	ND	9	Y	Y	Y	CD
A-4-306	23	70	67	1150	ND	11	Y	Y	Y	CD
A-4-307	29	70	68	1406	ND	13	Y	Y	Y	CD, DO
A-4-308	0	68	66	999	ND	8	Y	Y	Y	DO
A-4-309	19	70	68	1218	ND	11	Y	Y blocked	Y	WD CTs, DO
A-4-310	0	69	63	711	ND	14	Y	Y off, blocked, debris	Y	items hanging from CT

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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/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
A-4-311	11	69	63	1008	ND	16	Y	Y off, debris	Y	plants, CD, PF, pencil shavings, AT
A-4-312	10	69	65	1148	ND	15	Y	Y blocked	Y	clutter, CD, DEM, AT
A-4-315	24	69	67	1417	ND	16	Y	Y blocked, debris	Y	CD, 1 WD CT, DEM, pencil shavings
A-4-316	8	69	65	1064	ND	16	Y	Y blocked	Y	PF, pencil shavings, CD, 1 WD CT
A-4-318	0	67	68	617	ND	15	Y open	Y off	Y	Occupants at lunch
A-4-319	0	68	67	793	ND	18	Y	Y blocked	Y	Occupants at lunch
A-4-Guidance	4	67	67	555	ND	15	Y open	Y	Y	DO
A-4-House Office	4	70	63	660	ND	18	N	Y	Y	DO, AD
B-114 (Chiller Deck/ Mechanical Room)										Standing water, water infiltration, electrical panel-wiring/standing water
B-210	0	68	68	475	ND	18	Y	Y	Y	DO, PF, 1 WD CT

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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: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Date: 4-29-2008**

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	
B-211	5	70	69	905	ND	17	Y	Y off	Y	3 WD CT
B-212	27	72	62	931	ND	20	Y	Y off	Y	4 WD CT
B-213	2	71	62	653	ND	17	Y	Y off	Y	
B-217 Nurses' Office	2	72	66	604	ND	8	N	Y	Y	4 WD CT, PF
B-217 Nurses' Suite	4	72	63	513	ND	8	N	Y	Y	5 WD CT
B-226	0	71	68	447	ND	10	N	Y	Y	
B-229	1	71	68	488	ND	9	Y	Y	Y	Occupants gone ~ 1 hour, 2 WD CT, DO
B-230	20	71	57	755	ND	9	Y	Y	Y	
B-240	0	69	56	500	ND	9	Y	Y	Y	1 WD CT, room closed for cleaning
B-242	7	72	57	669	ND	8	Y	Y blocked	Y weak	CD, washer/dryer

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Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
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Temperature: 70 - 78 °F
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	
B-253	0	73	56	692	ND	6	Y	Y	Y blocked	CD, PFs, 30 computers, 4 WD CT
B-254	0	71	63	947	ND	9	Y	Y plants	Y blocked	CD, 3 WD CT
B-267	0	69	60	509	ND	6	Y open	Y	Y	CD, 4 WD CT, AT, 30 computers
B-279	0	73	54	492	ND	5	N	Y	Y	AD (infusion oil)
B-280	2	73	55	520	ND	6	N	Y	Y	
B-281	0	74	56	415	ND	5	N	Y	Y	1 WD CT, refrigerator on carpet
B-285	1	73	55	451	ND	7	N	Y	Y	CD, space between sink and backsplash
B-287	0	74	54	474	ND	7	N	Y	Y	PF, clutter, CD
B-288	0	73	55	444	ND	8	N	Y	Y weak/off	
B-290 (TV studio)	0	73	53	391	ND	6	N	Y	Y	Exhaust damper closed, DEM

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Carbon Dioxide: < 600 ppm = preferred
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%
Particle matter 2.5 < 35 ug/m^3

Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

Location/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (μg/m^3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
B-291 (TV studio)	0	75	52	384	ND	7	N	Y	N	10 WD CT, 2 MT, PF, AC in window, studio equipment
B-292	28	73	57	638	ND	13	N	Y	Y	Carpeting, PFs, PC
B-293	9	70	61	494	ND	12	N	Y	Y	Clutter
B-293 (Office)	5	71	61	570	ND	11	N	off	N	DO
B-295 (library)	0	74	52	418	ND	7	N	Y	Y	PF, WD plaster
B-309	19	69	70	520	ND	16	Y open	Y damaged air diffuser	Y off/weak	DO, sewer gas odors – dry trap in eye wash station and floor drain, teacher poured water down both, passive door vents, 5 MT
B-311	19	71	62	902	ND	2	Y	Y	Y	Blocked drain
B-311 Prep Room	0							Y	Y	1 mercury thermometer
B-312 Computers	0	71	62	902	ND	2	Y	Y	Y	26 computers

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Carbon Dioxide: < 600 ppm = preferred
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%
Particle matter 2.5 < 35 ug/m^3

Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

Location/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
B-313	2	73	57	519	ND	2	N	Y	N	PC, 2 cans Lysol
B-318	10	71	60	725	ND	3	Y	Y	Y	
B-320	20	72	61	946	ND	7	Y	Y	Y	
B-320 Prep Room								Y	Passive door vent	
B-330	21	72	59	1085	ND	8	Y	Y off	Y	5 WD CT
B-332	0	72	59	864	ND	7	Y	Y	Y	
B-332 Prep Room	0								Passive door vent	
B-342	11	72	55	750	ND	5	Y	Y blocked	Y	
B-344	13	73	57	800	ND	5	Y	Y	Y	
B-354	20	73	60	960	ND	5	Y	Y	Y	Passive door vent, 5 WD CT

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Carbon Dioxide: < 600 ppm = preferred
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%
Particle matter 2.5 < 35 ug/m^3

Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

Location/Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
B-356	16	71	68	1084	ND	11	Y	off	Y	CD
B-362	19	71	61	572	ND	2	N	Y	Y	2 WD CT
B-363	0	73	56	428	ND	1	N	Y	Y	WD CT, PFs
B-367	22	71	59	638	ND	2	N	Y	Y	Blocked sinks, 2 chemical hoods, no calibration stickers
B-369	15	73	56	601	ND	3	N	Y	Y	2 chemical hoods, no calibration stickers, dry drain traps, barometer
B-369 Prep Room								Y	Y	2 vented chemical storage cabinets, 2 fume hoods
B-371	0	71	57	456	ND	5	N	Y	Y	4 chemical hoods, no calibration stickers; hood passive vent adjacent to classroom exhaust vent
B-371 Chemical Storage								Y	Y	Passive door vent (2)
B-Attendance	4	72	57	574	ND	5	N	Y	N	PF
B-Bank	5	73	57	689	ND	5	N	Y	N	Copier, nail polish remover odor

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

Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

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	
B-Science Resource Center										
D-106	0	67	61	620	ND	18	N	Y	N	Wood shop, spray booth unused
D-110	0	67	63	726	ND	14	N	Y	N	Wood shop
D-112	15	68	66	830	ND	ND	N	Y	Y	15 computers
D-116	0	64	69	425	ND	2	Y	Y	Y	Automotive exhaust vent not working, flame proof cabinet needs to be replaced, arc welding, need proper vents
D-124 Shop	10	67	68	744	ND	ND	Y	Y	Y	Fume hood, not working, 4 WD CT
D-205	17	70	66	630	ND	3	Y	Y	Y	24 computers, PC, old printing press equipment
D-208	2	73	68	644	ND	3	N	N	N	PC, 1 computer, 1 WD CT
D-213	0	71	63	583	ND	1	Y	Y	Y	10 computers

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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

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 Supply	Ventilation Exhaust	Remarks
D-214	0	72	64	612	ND	2	N	Y	N	PC, 1 computer, DEM
D-214 A	0	72	64	586	ND	1	N	Y	Y	DEM
D-215	12	72	62	839	ND	2	Y	Y	Y	9 computers
D-216	0	72	61	650	ND	1	Y	Y off	Y	Blueprint machine, 18 computers
D-217	0	72	64	578	ND	3	N	Y	N	2 computers
D-218	23	71	63	976	ND	1	Y	Y	Y	
D-219	0	72	63	572	ND	1	N	Y	N	PC, computer, microwave
D-220	2	70	60	610	ND	2	Y	Y	Y	1 WD CT, cabinet with paint thinner
D-221 storage								Y	N	Art supply storage
D-222	16	71	62	1563	ND	9	Y	Y	Y	Photo chemicals, microwave

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Carbon Dioxide: < 600 ppm = preferred
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%
Particle matter 2.5 < 35 ug/m^3

Location: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 1 (continued)** **Date: 4-29-2008**

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	
D-222 Dark Room	3	70	57	815	ND	1	N	Y	Y	
D-224	21	71	67	755	ND	ND	Y	Y	Y	2 WD CT, MT
D-225	16	72	61	930	ND	ND	Y	Y	N	30 computers, 2 CFs
D-230	17	72	66	1250	ND	1	Y	Y	Y	Fume hood, 2 WD CT
D-235	5	68	57	595	ND	1	Y	Y	Y	3 WD CT
D-240 Ensemble room										Water leak, sound proofing
D-245	6	69	60	680	ND	4	Y	Y	Y	
D-250	0	68	61	492	ND	1	N	Y	Y	Musty odor
D-Auditorium	50+	71	59	555	ND	1	N	Y	Y	
D-Block, Music Room Practice										2 WD CT, MT

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

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	
D-Stage	0	70	56	536	ND	1	N	Y	Y	

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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: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Date: 4-30-2008**

Table 2

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		63	27	380	ND	16				Sunny, windy
E-117 (Girl's Gym 1)	10	68	29	488	ND	12	N	Y	Y	
E-117 (Girl's Gym 2)	15	69	30	520	ND	11	N	Y	Y	Partially subdivided from other 2 gyms
E-117 (Girl's Gym 3)	23	67	29	485	ND	12	N	Y	Y	
E-118	0	70	62	473	ND	9	N	off	Y	DO, CD
E-136 (Boy's Gym, center)	12	68	28	451	ND	9	N	Y	Y	Exterior doors open
E-136 (Boy's Gym, left)	21	69	29	500	ND	8	N	Y	Y	
E-136 (Boy's Gym, right)	11	69	28	468	ND	10	N	Y	Y	

	AD = air deodorizer	CT = ceiling tile	PC = photocopier	UV = univent
r cubic meter	aqua. = aquarium	DEM = dry erase materials	PF = personal fan	AC = air conditioner
	AT = ajar ceiling tile	DO = door open	PS = pencil shavings	WD = water-damaged
	CD = chalk dust	MT = missing ceiling tile		

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: New Bedford High School

Address: 230 Hathaway Blvd., New Bedford, MA

Indoor Air Results

Date: 4-30-2008

Table 2 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (μg/m^3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
E-Block (Girls Gym Locker)	0	69	33	561	ND	10	N	Y	Y	
E-Block Gym Main Hallway	0	68	74	524	ND	9				Spaces in ceiling, light could be seen, space around doors
E-Block Ramp Hallway	0	70	58	456	ND	8	N			
E-Block, Boy's Locker Room	0	72	62	485	ND	5	N	Y	Y	Visible mold CT entry, MT, rusted ceiling tracks, doors open to hallway
E-Block, Boy's Locker Room	0	69	37	617	ND	11	N	Y	Y	
E-Block, Corrective Gym Yoga	0	69	36	657	ND	8	N	Y	N	5 WD CT, 6 MT
E-Block, Instructors Office	4	71	42	689	ND	10	N	Y passive door vent	Y	Exhaust in rest room
E-Block, Weight Room	0	68	37	557	ND	9	N	Y	Y	
E-Block, Weight Room Hallway	0	68	32	496	ND	12	N	N	N	WD CT, MTs, damaged pipe inside, leaks

ppm = parts per million
μg/m^3 = micrograms per cubic meter
ND = non detect
VL = vent location
AD = air deodorizer
aqua. = aquarium
AT = ajar ceiling tile
CD = chalk dust
CT = ceiling tile
DEM = dry erase materials
DO = door open
MT = missing ceiling tile
PC = photocopier
PF = personal fan
PS = pencil shavings
UV = univent
AC = air conditioner
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: New Bedford High School **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA **Table 2 (continued)** **Date: 4-30-2008**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m^3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
F Block, Pool	0	72	60	504	ND	5	N	Y	Y	
F-Block, Girl's Locker Pool Room	15	71	68	458	ND	8	N	Y	Y weak	8 WD CT, 7 MT, DO

ppm = parts per million
µg/m^3 = micrograms per cubic meter
ND = non detect
VL = vent location
AD = air deodorizer
aqua. = aquarium
AT = ajar ceiling tile
CD = chalk dust
CT = ceiling tile
DEM = dry erase materials
DO = door open
MT = missing ceiling tile
PC = photocopier
PF = personal fan
PS = pencil shavings
UV = univent
AC = air conditioner
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: New Bedford High School | **Indoor Air Results**

Address: 230 Hathaway Blvd., New Bedford, MA | **Table 3** | **Date: 7-9-2008**

Location/ Room	Room Temperature (°F)	Relative Humidity (%)	Floor Temperature (°F)	Dew Point (°F) calculated	Condensation	Ventilation		Remarks
						Supply	Exhaust	
background	82	78		76				windy, hot, hazy, humid
1-110	79	77	55	71	Y	Univent off	Y	Dehumidifier
1-111	79	74	57	70	Y	Univent off	Y	Dehumidifier
1-112	79	69	63	68	Y	Univent off	Y	Dehumidifier-off
1-112 hallway	76	78	63	69	Y			
1-113	79	66	59	67	Y	Univent off	Y	Dehumidifier
1-114	79	64	55	66	Y	Univent off	Y	
1-115	72	66		60	N	Univent off	Y	Dehumidifier, gypsum wallboard moisture reading = low/normal
1-116	71	64		58	N	Univent off	Y	7 WD CTs
1-117 computer room	73	56	54	56	Y	Y	Y	WD CTs-mold growth
1-Cafeteria	80	76	72	71	Y	Y	Y	Dehumidifier
2-110	79	55	58	62	Y	Y	Y	Dehumidifier
2-111	79	55	62	62	Y	Y	Y	Dehumidifier
2-112	80	56	62	62	Y	Univent off	Y	Dehumidifier

Table 3 (continued)

Location/ Room	Room Temperature (°F)	Relative Humidity (%)	Floor Temperature (°F)	Dew Point (°F) calculated	Condensation	Ventilation		Remarks
						Supply	Exhaust	
2-112 hallway	81	63	66	67	Y			
2-113	79	60	61	64	Y	Y	Y	Dehumidifier
2-114	79	60	57	64	Y	Y	Y	Dehumidifier
2-115	82	59	59	66	Y	Univent off	Y	Dehumidifier
2-116	81	68	64	69	Y	Y	Y	Dehumidifier
2-117	80	63	68	65	N	Y	Y	Dehumidifier
2-Cafeteria	80	75	70	71	Y			Windows open, dehumidifier, air mover on floor
3-110	80	70	59	69	Y	Y	Y	DO
3-111	80	74	60	71	Y	Y	Y	DO, dehumidifier
3-112	80	72	61	70	Y	Y	Y	Dehumidifier
3-113	80	73	60	71	Y	Y	Y	DO, dehumidifier

AC = air conditioner DO = door open

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/ Room	Room Temperature (°F)	Relative Humidity (%)	Floor Temperature (°F)	Dew Point (°F) calculated	Condensation	Ventilation		Remarks
						Supply	Exhaust	
3-114	80	72	60	70	Y	Univent off	Y	DO, dehumidifier
3-115	80	72	62	70	Y	Univent off	Y	DO, dehumidifier
3-116	80	73	66	71	Y	Y	Y	DO, dehumidifier
3-117	80	73	66	71	Y	Y	Y	Dehumidifier-full/off
3-Cafeteria	81	75	72	72	Y			Air mover on floor
4-110	81	58	59	65	Y	Univent off	Y	dehumidifier
4-111	83	52	64	64	Y	Y	Y	dehumidifier
4-112	81	57	63	64	Y	Y	Y	2 dehumidifiers
4-113	83	55	64	65	Y	Univent off		2 dehumidifiers
4-114	83	62	65	68	Y	Y	Y	Dehumidifier, floor tile mastic
4-115	81	68	65	69	Y	Univent off	Y	Dehumidifier

AC = air conditioner DO = door open

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%

Table 3 (continued)

Location/ Room	Room Temperature (°F)	Relative Humidity (%)	Floor Temperature (°F)	Dew Point (°F) calculated	Condensation	Ventilation		Remarks
						Supply	Exhaust	
4-116	81	68	65	69	Y	Y	Y	
4-117	80	67	67	68	Y	Y	Y	2 dehumidifiers
4-117 hallway	79	73	69	69	Y			
4-217	78	65	69	65	N			wall temperature 68°F
4-218	77	45	60	54	N	Y	Y	AC-rooftop, wall temperature 59°F
4-218 hallway	81	70	73	70	N			
Auditorium	82	71	66	72	Y	Y	Y	
D-111	79	72	64	69	Y	Y	Y	Mastic around floor tiles
D-112	79	69	71	68	N	Y	Y	Dehumidifier
D-116	79	74	59	70	Y	Y	Y	
D-hallway outside auditorium	83	73	71	74	Y			

AC = air conditioner DO = door open

Comfort Guidelines

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

Table 3 (continued)

Location/ Room	Room Temperature (°F)	Relative Humidity (%)	Floor Temperature (°F)	Dew Point (°F) calculated	Condensation	Ventilation		Remarks
						Supply	Exhaust	
D-Woodshop	81	68	69	69	Y	Y	Y	
D-Woodshop hallway	80	77	73	72	N			Musty odors-sound proofing, elevated moisture readings vinyl wall covering-recommend removal
Kitchen	82	75	32 near freezer 75 center 58	73	Y			2 Large freezers
Pool hallway	82	81	68	76	Y			

AC = air conditioner DO = door open

Comfort Guidelines

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

Table 4: Summary of PCBs in Indoor Air

House/Block	Floor	Maximum PCBs in air µg/m3	Test Date for max.	Room/location where max was sampled	Value above ATSDR CREG (0.01 µg/m3)
A1 (Green)	1	1.1 (J)	2/23/2011	1-110	Y
A1 (Green)	2	0.095	8/22/2006	locker 1579	Y
A1 (Green)	3	**1.45 (J)**	2/23/2011	1-315	Y
A2 (Gold)	1	0.0811 (J)	2/23/2011	2-112	Y
A2 (Gold)	2	0.441 (J)	2/23/2011	2-203	Y
A2 (Gold)	3	0.11	8/22/2006	2-311	Y
A3 (Tan)	1	0.26	8/22/2006	3-114	Y
A3 (Tan)	2	0.064 (J)	8/14/2007	3-205	Y
A3 (Tan)	3	0.167 (J)	4/21/2011	3-307	Y
A4 (Blue)	1	0.69 (J)	8/14/2007	4-110	Y
A4 (Blue)	2	0.62 (J)	8/14/2007	4-212	Y
A4 (Blue)	3	0.23 (J)	8/14/2007	4-315	Y
B Core	1	0.075	8/22/2006	B-114 (chiller deck)	Y
B Core	2	0.31	8/22/2006	B-240	Y
B Core	3	0.0149	4/20/2006	B-309	Y
C Block	1 and 2	N/A	N/A	N/A	N/A
D Block	1	0.066 (J)	8/29/2007	D-122 (CCP lab)	Y
D Block	2	0.0063 (J)	2/23/2011	D Block 2nd floor hallway	N
E Block	N/A	0.0061 (J)	8/29/2007	E-117 (Girl's Gym 2)	N
F Block	N/A	N/A	N/A	N/A	N/A
Outdoor/Background	N/A	0.0015	8/22/2006	outdoor playground (near Blue house and autoshop)	N

Table 5: PCB Data Summary by Report

Sampling Date	Report	Media	Number/Location	Results* (Note: *wipe samples not all uniform, generally units of ug/100cm2)	Method	Pre/Post Cleaning	# Indoor Air Values above ATSDR CREG (0.01 µg/m3)	# wipes above CA DTSC (0.1 µg/wipe*) (*wipe surface areas generally 100cm2)	PCB Bulk Product Waste (>50 mg/kg)
April 19-21, 2006	BETA 2006	air	6 indoor air, 2 outdoor air	Indoor air: 0.0043 - 0.052 µg/m3; Outdoor air: 0.0009 - 0.001 µg/m3	Air: EPA TO-4A, analysis for congeners	Pre-cleaning	4	N/A	N/A
August 22-23, 2006	TRC 2006	air, wipe, bulk	23 indoor air (includes 1 co-located pair), 2 outdoor air locations; 22 wipes (includes 1 field duplicate); 33 bulk	Indoor air: 0.0024 - 0.31 µg/m3; Wipes: 13 of 22 detectable (DL = 0.5 µg/wipe) ranging from 0.419 - 8.996 µg/wipe, max wipe in D-116; Bulk: PCBs detected in 27 of 33 samples (various DLs), ranging from 0.2 mg/kg - 36.5 (J)mg/kg (dust).	Air: EPA TO-4A (outdoor only) and EPA TO-10A, analysis for homologues; Wipes: EPA SW-846, Method 8082, analysis for Aroclors; Bulk: EPA SW-846, Method 8082, analysis for Aroclors	Pre-cleaning	20	10	No
July - August, 2007	TRC 2008a	air, wipe, bulk	33 indoor air (includes 6 co-located pairs), 6 outdoor air; 207 wipes; 14 bulk	Indoor air: 33/33 detects ranging from 0.0025 (J) - 0.69 (J) µg/m3; Wipes: 3 detects out of 207 wipes (DL = 0.5 µg/wipe), ranging from 0.613 - 0.989 µg/wipe; Bulk: 14 detects out of 14 samples, ranging from 0.2 - 14.9 mg/kg.	Air: EPA TO-4A (outdoor only) and EPA TO-10A, analysis for homologues; Wipes: EPA SW-846, Method 8082, analysis for Aroclors; Bulk: EPA SW-846, Method 8082, analysis for Aroclors	Immediately post-cleaning	29	3	No

Table 5: PCB Data Summary by Report

Sampling Date	Report	Media	Number/Location	Results* (Note: *wipe samples not all uniform, generally units of ug/100cm2)	Method	Pre/Post Cleaning	# Indoor Air Values above ATSDR CREG (0.01 µg/m3)	# wipes above CA DTSC (0.1 µg/wipe*) (*wipe surface areas generally 100cm2)	PCB Bulk Product Waste (>50 mg/kg)
February, 2008	TRC 2008b	air	28 indoor air (includes 4 co-located pairs), 3 outdoor air	Indoor air: 23/28 detects ranging from 0.0014 - 0.13 µg/m3	Air: EPA T0-10A, analysis for homologues	post-cleaning	14	N/A	N/A
July, 2008	TRC 2008c	wipes, bulk	8 wipes, 63 bulk	Wipes: PCBs detected in 5 of 8 samples ranging from 1.35 - 7.07 µg/wipe, all "J" values; Bulk: PCBs detected in 58 of 63 samples, all "J" values, ranging from 0.158 to 230 mg/kg	Wipes: EPA SW 846 Method 8082, analysis for Aroclors; Bulk: EPA SW 846 Method 8082, analysis for Aroclors	post-cleaning	N/A	5	Yes
December 2008 - March 2009	TRC 2009a	wipes, bulk	8 wipes, 290 bulk (includes 13 duplicates)	Wipes: PCBs detected in 2 of 8 samples (1.02 J and 0.91 J); Bulk: PCBs detected in 259 of 290 samples ranging from 0.113 - 255 mg/kg)	Wipes: EPA SW 846 Method 8082, analysis for Aroclors; Bulk: EPA SW 846 Method 8082, analysis for Aroclors	post-cleaning	N/A	2	Yes
August 25, 2010	TRC 2011a	air	1 indoor air sample plus duplicate taken from daycare room (A-4-227)	Indoor air: 0.00763 J µg/m3 (0.0054 J µg/m3 duplicate)	Air: EPA TO-10A, analysis for homologues	post-cleaning	None	N/A	N/A
February, 2011	TRC 2011e, f	air	48 indoor air samples, including 3 duplicates; 2 outdoor air samples	Indoor air: 25/48 detects ranging from 0.00252 (J) µg/m3 to 1.45 (J) µg/m3.	Air: EPA TO-10A, analysis for homologues (48 samples)	post-cleaning	17	N/A	N/A

Table 5: PCB Data Summary by Report

Sampling Date	Report	Media	Number/Location	Results* (Note: *wipe samples not all uniform, generally units of ug/100cm2)	Method	Pre/Post Cleaning	# Indoor Air Values above ATSDR CREG (0.01 µg/m3)	# wipes above CA DTSC (0.1 µg/wipe*) (*wipe surface areas generally 100cm2)	PCB Bulk Product Waste (>50 mg/kg)
April, 2011	TRC 2011h	air	9 indoor air samples, including 1 duplicate	Indoor air: 8/9 detects, ranging from 0.048 µg/m3 to 1.25 µg/m3	Air: EPA TO-10A analysis for homologues	post-cleaning	8	N/A	N/A
August, 2011	TRC 2011h	air	15 indoor air samples, including 3 duplicates	Indoor air: 15/15 detects, ranging from 0.00536 µg/m3 to 0.577 µg/m3	Air: EPA TO-10A analysis for homologues	post-cleaning	14	N/A	N/A

Table 6: Summary of Serum PCB Concentrations (Whole Weight)

	New Bedford School Staff Median and Range (ppb)[1]	NHANES Median/50th Percentile (ppb)	NHANES 95th Percentile (ppb)
Participants 20-39 yo (n=5)	1.053 (ND to 1.200)	0.322 (0.286, 0.352)	1.211 (0.954, 1.688)
Participants 40-59 yo (n=39)	1.496 (ND to 3.519)	0.927 (0.840, 1.058)	2.780 (2.307, 3.663)
Participants 60+ yo (n=22)	2.313 (1.276 to 4.329)	1.805 (1.694, 1.874)	5.123 (4.131, 6.556)

Notes:
yo = years old
n = number of participants
ppb = parts per billion
NHANES = National Health and Nutrition Examination Survey
The total of the 15 most frequently detected PCB congeners is presented.

The 95% confidence intervals (CI) for the NHANES median value for each age group are presented in parentheses. The 95% CI is the range of estimated values that has a 95% probability of including the true 50th percentile value for the population.

1. A median concentration could not be calculated for the 12-19 year age group because there is only one participant in this age group.

Table 7: Summary of Serum PCB Concentrations (Lipid-Adjusted)

	New Bedford School Staff Median and Range (ppb) [1]	NHANES Median/50th Percentile (ppb)	NHANES 95th Percentile (ppb)
Participants 20-39 yo (n=5)	181.6 (ND to 216.5)	53.0 (46.9, 57.7)	188.0 (137.4-263.6)
Participants 40-59 yo (n=39)	218.3 (ND to 477.6)	145.3 (128.7, 157.9)	402.2 (325.1, 540.2)
Participants 60+ yo (n=22)	333.1 (154.6 to 545.1)	276.0 (251.2, 295.4)	769.4 (600.0, 1026.5)

Notes:
yo = years old
n = number of participants
ppb = parts per billion
NHANES = National Health and Nutrition Examination Survey
The total of the 15 most frequently detected PCB congeners is presented.

The 95% confidence intervals (CI) for the NHANES median value for each age group are presented in parentheses. The 95% CI is the range of estimated values that has a 95% probability of including the true 50th percentile value for the population.

1. A median concentration could not be calculated for the 12-19 year age group because there is only one participant in this age group.

Table 8: Number of Individuals at NBHS by Years Worked and Age

Age [1] (years)	0-14 Years at NBHS (less than or equal to the median)	15-37 Years at NBHS (greater than the median)	Total
12-19	1	0	1
20-39	5	0	5
40-59	25	14	39
60+	7	15	22
Total	38	29	67

1. Three individuals included in this table are not current or former staff at NBHS. The one individual in the 12-19 years age group is a current student, one of the individuals in the 20-39 years age group is a former student, and one individual in the 40-59 year age group is a former student.

Table 9: Geometric Mean and Range of Serum PCB Concentrations (ppb; Whole Weight) by Years Worked at NBHS

Age Group	**0-14 Years at NBHS**	**15-37 Years at NBHS**
All participants[1, 2, 3]		
Participants 40-59 yo (n=23, 14)	1.542 (1.000 to 3.519)	1.622 (0.944 to 3.065)
Participants 60+ yo (n=7, 15)	2.510 (1.703 to 4.329)	2.327 (1.276 to 4.161)
Current NBHS staff [4]		
Participants 40-59 yo (n=16,13)	1.522 (1.000 to3.519)	1.545 (0.944 to 3.045)
Former NBHS Staff [4]		
Participants 60+ yo (n=5, 10)	2.592 (1.703 to 4.329)	2.641 (1.276 to 4.161)

Notes:
yo = years old
n = number of participants
ppb = parts per billion
The total of the 15 most frequently detected PCB congeners is presented.

1.The Geometric Means by years worked at NBHS could not be calculated for the 12-19 year age group because there is only one participant in this age group.

2.Some of the five participants between the ages of 20 and 39 years of age were not included in the Geometric Mean calculations because no PCB congeners were detected in these samples. Thus, geometric means are not presented for the remaining individuals in this age group due to the small number of participants. Summary statistics are not presented for groups of less than five participants because of the instability of the statistic.

3.Two participants out of 38 between the ages of 40 and 59 years of age were not included in the Geometric Mean calculations because no PCB congeners were detected in these samples.

4. The geometric means for current NBHS staff in the 60+ year age group and former NBHS staff in the 40-59 year age group are not presented due to the small number of participants in these age groups. Summary statistics are not calculated for groups of less than five participants due to the instability of the statistic.

Table 10: Geometric Mean and Range of Serum PCB Concentrations (ppb; Lipid-Adjusted) by Years Worked at NBHS

Age Group	0-14 Years at NBHS	15-37 Years at NBHS
All participants[1, 2, 3]		
Participants 40-59 yo (n=23, 14)	241.2 (164.1 to 460.6)	237.8 (153.6 to 477.6)
Participants 60+ yo (n=7, 15)	335.0 (242.7 to 472.7)	325.3 (154.6 to 545.1)
Current NBHS staff [4]		
Participants 40-59 yo (n=16,13)	245.6 (170.7 to 460.6)	226.6 (153.6 to 477.6)
Former NBHS Staff [4]		
Participants 60+ yo (n=5, 10)	334.4 (242.7 to 472.7)	352.2 (154.6 to 545.1)

Notes:
yo = years old
n = number of participants
ppb = parts per billion
The total of the 15 most frequently detected PCB congeners is presented.

1.The Geometric Means by years worked at NBHS could not be calculated for the 12-19 year age group because there is only one participant in this age group.

2.Some of the five participants between the ages of 20 and 39 years of age were not included in the Geometric Mean calculations because no PCB congeners were detected in these samples. Thus, geometric means are not presented for the remaining individuals in this age group due to the small number of participants. Summary statistics are not presented for groups of less than five participants because of the instability of the statistic.

3.Two participants out of 38 between the ages of 40 and 59 years of age were not included in the Geometric Mean calculations because no PCB congeners were detected in these samples.

4. The geometric means for current NBHS staff in the 60+ year age group and former NBHS staff in the 40-59 year age group are not presented due to the small number of participants in these age groups. Summary statistics are not calculated for groups of less than five participants due to the instability of the statistic.

Table 11: Number of Individuals that currently work/previously worked at the Keith Middle School by Years Worked and Age

Age[1] (years)	0-1 Years at Keith Middle School (less than or equal to the median)	2-3 Years at Keith Middle School (greater than the median)	Total
12-19	1	0	1
20-39	2	0	2
40-59	5	4	9
60+	0	2	2
Total	8	6	14

1. One individual included in this table is not current or former staff at KMS. The one individual in the 12-19 years age group is a former student.

Table 12: Number of Individuals that previously worked at the former Keith Middle School by Years Worked and Age

Age [1] (years)	0-3 Years at former Keith Middle School (less than or equal to the median)	4-22 Years at former Keith Middle School (greater than the median)	Total
12-19	0	0	0
20-39	1	0	1
40-59	11	5	16
60+	2	7	9
Total	14	12	26

1. One individual included in this table is not current or former staff at KMS. The one individual in the 12-19 years age group is a former student.

APPENDICES

APPENDIX A

Consent Forms

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

AN EVALUATION OF POTENTIAL PCB EXPOSURE AT NEW BEDFORD HIGH SCHOOL, KEITH MIDDLE SCHOOL AND SURROUNDING NEIGHBORHOOD, NEW BEDFORD, MA

ADULT CONSENT FORM FOR PARTICIPANT INTERVIEW

Purpose: The Massachusetts Department of Public Health (MDPH) is offering to administer an exposure assessment questionnaire to school administration, faculty and staff as well as to surrounding residents of the New Bedford High School and Keith Middle School who are concerned about exposure to polychlorinated biphenyls (PCBs). PCB blood serum testing will be offered to individuals who are determined to have the greatest potential for exposure to PCBs by virtue of working in the schools and/or living in the surrounding neighborhood. The serum PCB results will allow MDPH to assess the magnitude of PCB exposure among participants and to address the concerns of the community. You have requested to participate in this effort.

Procedure: Your participation in the interview stage of this evaluation is voluntary and you may withdraw at any time. If you participate in the interview stage of this evaluation, you will be asked to give approximately 45 minutes of your time to respond to an interview by the Massachusetts Department of Public Health. Interviewers will ask questions regarding your residential history, occupational history, affiliation with the two schools, dietary consumption and personal contact information. These questions will be used to identify individuals with the greatest potential for exposure to PCBs.

Risks: There are no risks involved in participating in the interview stage of this evaluation.

Benefits: There are no direct benefits to you for participating in the interview phase of this evaluation other than learning more about your opportunities for exposure to PCBs. Your participation may lead to your being contacted to provide a blood sample for serum PCB analysis. Only individuals identified through this interview as having the greatest potential for exposure to PCBs by virtue of working in the schools and/or living in the surrounding neighborhood will be contacted to participate in the measurement of serum PCB levels in the blood.

Alternatives: This evaluation is being conducted by the Massachusetts Department of Public Health as a public health service to the community of New Bedford, MA. You may choose not to participate in this evaluation.

Payment for Participation: You will not receive payment for your time or participation in this evaluation.

No Additional Costs: There will be no financial charge to you for your participation in this evaluation.

Confidentiality: Every effort will be made to maintain participant confidentiality. The Commissioner of the Massachusetts Department of Public Health has approved this study under the provisions outlined in M.G.L. c. 111, s. 24A, which protects the confidentiality of all information collected as part of this evaluation. Under the provisions of that statute, the Department and all of its employees and agents involved in the *Evaluation of Potential PCB Exposure at New Bedford High School, Keith Middle School, and Surrounding Neighborhood, New Bedford, MA* are prohibited from releasing any individually identifying information provided by you. Furthermore, Section 24A prohibits the disclosure or release through a public records request, court subpoena or any other legal process, of any personal or medical information you provide. Your information will be assigned a random identification number and all personally identifying data will be kept in locked storage files.

I have read the description of this evaluation or have had it explained to me. I have been informed of the risks and benefits involved and all of my questions have been answered to my satisfaction. I will receive a copy of this consent form.

I understand that I am free to withdraw this consent and discontinue participation in this evaluation at any time.

I voluntarily consent to participate in the interview phase of the *Evaluation of Potential PCB Exposure at New Bedford High School, Keith Middle School, and Surrounding Neighborhood, New Bedford, MA* with the Massachusetts Department of Public Health.

____

Signature of Participant   Print Name   Date

In addition, I agree to be re-contacted if I am selected to participate in the PCB blood serum testing phase of this evaluation.

Yes ☐ No ☐ Initial __________

____

Signature of Interviewer   Print Name   Date

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
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AN EVALUATION OF POTENTIAL PCB EXPOSURE AT NEW BEDFORD HIGH SCHOOL, KEITH MIDDLE SCHOOL AND SURROUNDING NEIGHBORHOOD, NEW BEDFORD, MA

ADULT CONSENT FORM FOR SERUM PCB ANALYSIS

Purpose: The Massachusetts Department of Public Health (MDPH) is offering polychlorinated biphenyl (PCB) serum testing as a public service to select school administration, faculty and staff as well as to surrounding residents of the New Bedford High School and Keith Middle School. Blood testing for serum PCB analysis is being offered to select individuals, identified in the interview stage of the evaluation, who are determined to have the greatest potential for exposure to PCBs by virtue of working in the schools and/or living in the surrounding neighborhood. Blood testing for serum PCB analysis is also being offered as a public service to other participants interviewed. The serum PCB results will allow MDPH to assess the magnitude of PCB exposure among study participants, which may help guide future activities at the two school sites as well as to address the concerns of the community. You have requested to participate in this effort.

Procedure: Your participation in the blood testing phase of this evaluation is voluntary and you may withdraw at any time. If you participate in this stage of the evaluation, a blood sample will be taken to determine the level of PCBs in your blood. The blood will be taken from a vein in your arm and will require the use of a hypodermic needle and vacutainer. Approximately 20 ml of blood will be drawn. Your blood sample will be tested for PCBs and lipids. PCB results are reported on a lipid-adjusted basis because PCBs tend to concentrate in lipid (fatty) tissue. The sample will be destroyed after the analysis and quality control measures are completed. MDPH staff will administer a short questionnaire (approximately 5 to 10 minutes) at the time of the blood draw. The purpose of the questionnaire is to collect important information that may be associated with an individual's PCB exposure and that may help with the interpretation of the results.

Risks: The blood collection procedure usually involves little pain or discomfort, but occasionally some discomfort may occur after the blood sample is obtained. Other risks, while unlikely, will be explained by the staff from Favorite Healthcare Staffing, Inc., who will be taking the blood samples.

ADULT CONSENT FORM FOR SERUM PCB ANALYSIS

Benefits: By participating in the blood serum testing stage of this evaluation, you will be notified of the results of your PCB blood test after all laboratory testing and quality control measures have been completed. If your test results indicate you have elevated serum PCBs, you understand there is no medical treatment to reduce your current PCB levels. MDPH will however offer to counsel you on behaviors to reduce your risk of future exposure.

Alternatives: This evaluation is being conducted by the Massachusetts Department of Public Health as a public health service to the community of New Bedford, MA. You may choose not to participate in this evaluation.

Payment for Participation: You will not receive payment for your time or participation in this evaluation.

No Additional Costs: There will be no financial charge to you for the blood collection and serum PCB analysis.

Confidentiality: Every effort will be made to maintain participant confidentiality. The Commissioner of the Massachusetts Department of Public Health has approved this study under the provisions outlined in M.G.L. c. 111, s. 24A, which protects the confidentiality of all information collected as part of this evaluation. Under the provisions of that statute, the Department and all of its employees and agents involved in the *Evaluation of Potential PCB Exposure at New Bedford High School, Keith Middle School, and Surrounding Neighborhood, New Bedford, MA* are prohibited from releasing any individually identifying information provided by you. Furthermore, Section 24A prohibits the disclosure or release through a public records request, court subpoena or any other legal process, of any personal or medical information you provide. Your information will be assigned a random identification number and all personally identifying data will be kept in locked storage files.

ADULT CONSENT FORM FOR SERUM PCB ANALYSIS

I have read the description of this evaluation or have had it explained to me. I have been informed of the risks and benefits involved and all of my questions have been answered to my satisfaction. I will receive a copy of this consent form.

I understand that I am free to withdraw this consent and discontinue participation in this evaluation at any time.

I voluntarily consent to participate in the PCB blood serum testing phase of the *Evaluation of Potential PCB Exposure at New Bedford High School, Keith Middle School, and Surrounding Neighborhood, New Bedford, MA* with the Massachusetts Department of Public Health.

Signature of Participant	Print Name	Date

Signature of Interviewer	Print Name	Date

APPENDIX B

Fact Sheet

The Commonwealth of Massachusetts

Executive Office of Health and Human Services
Department of Public Health
Bureau of Environmental Health
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DEVAL L. PATRICK
GOVERNOR

TIMOTHY P. MURRAY
LIEUTENANT GOVERNOR

JUDYANN BIGBY, M.D.
SECRETARY

JOHN AUERBACH
COMMISSIONER

Questions and Answers

New Bedford Blood Serum PCB Testing Program
New Bedford High School/ Keith Middle School and Neighborhood Surrounding the Schools

1. Who will analyze my blood sample for PCBs?

The Environmental Chemistry Lab at the Massachusetts Department of Public Health's (MDPH) William A. Hinton State Laboratory Institute will analyze the samples for PCBs and MDPH's Lemuel Shattuck Hospital will analyze the samples for lipids. Lipid adjustment is important because PCBs tend to concentrate in lipid (fatty) tissue.

2. When will I obtain the results of my blood test for PCBs?

Once blood sample results have been analyzed, those who gave blood samples will be sent individual letters with only their own serum PCB results. According to the State Laboratory Institute, all of the analyses will be completed by December 2009. However, MDPH will be reviewing results as they are analyzed and if an individual's serum PCB level raises any immediate health concerns, they will be contacted immediately. A final report summarizing the results of all blood samples analyzed will be prepared; however, it will not identify any individual's results.

3. How will the blood test results be evaluated?

Your results will be compared to Centers for Disease Control (CDC) National Health and Nutrition Examination Survey (NHANES) biomonitoring data for the civilian U.S. population for the period 2003-2004. NHANES is a nationally representative survey and these data provide health professionals with a reference range so that they can determine if any specific individuals have been exposed to higher levels of PCBs than the general U.S. population. Most people in the U.S. have low but detectable levels of PCBs in their serum due to diet or the general environment.

4. If I have questions, who should I contact?

You can call the MDPH Bureau of Environmental Health, Community Assessment Program at 617-624-5757 if you have additional questions.

APPENDIX C

Carbon Dioxide and its Use in Evaluating Adequacy of Ventilation in Buildings

Carbon Dioxide and its Use in Evaluating Adequacy of Ventilation in Buildings

The Bureau of Environmental Health's (BEH) Indoor Air Quality (IAQ) Program examines indoor air quality conditions that may have an effect on building occupants. The status of the ventilation system, potential moisture problems/microbial growth and identification of respiratory irritants are examined in detail, which are described in the attached report. In order to examine the function of the ventilation system, measurements for carbon dioxide, temperature and relative humidity are taken. Carbon dioxide measurements are commonly used to assess the adequacy of ventilation within an indoor environment.

Carbon dioxide is an odorless, colorless gas. It is found naturally in the environment and is produced in the respiration process of living beings. Another source of carbon dioxide is the burning of fossil fuels. Carbon dioxide concentration in the atmosphere is approximately 250-600 ppm (Beard, 1982; NIOSH, 1987).

Carbon dioxide measurements within an occupied building are a standard method used to gauge the adequacy of ventilation systems. Carbon dioxide is used in this process for a number of reasons. Any occupied building will have normally occurring environmental pollutants in its interior. Human beings produce waste heat, moisture and carbon dioxide as by-products of the respiration process. Equipment, plants, cleaning products or supplies normally found in any building can produce gases, vapors, fumes or dusts when in use. If a building has an adequately operating mechanical ventilation system, these normally occurring environmental pollutants will be diluted and removed from the interior of the building. The introduction of fresh air both increases the comfort of the occupants and serves to dilute normally occurring environmental pollutants.

An operating exhaust ventilation system physically removes air from a room and thereby removes environmental pollutants. The operation of supply in conjunction with the exhaust ventilation system creates airflow through a room, which increases the comfort of the occupants. If all or part of the ventilation system becomes non-functional, a build up of normally occurring environmental pollutants may occur, resulting in an increase in the discomfort of occupants.

The MDPH approach to resolving indoor air quality problems in schools and public buildings is generally two-fold: 1) improving ventilation to dilute and remove environmental pollutants and 2) reducing or eliminating exposure opportunities from materials that may be adversely affecting indoor air quality. In the case of an odor complaint of unknown origin, it is common for BEH staff to receive several descriptions from building occupants. A description of odor is subjective, based on the individual's life experiences and perception. Rather than test for a potential series of thousands of chemicals to identify the unknown material, carbon dioxide is used to judge the adequacy of airflow as it both dilutes and removes indoor air environmental pollutants.

As previously mentioned, carbon dioxide is used as a diagnostic tool to evaluate air exchange by building ventilation systems. The presence of increased levels of carbon dioxide in indoor air of buildings is attributed to occupancy. As individuals breathe, carbon dioxide is exhaled. The greater the number of occupants, the greater the amount of carbon dioxide produced. Carbon dioxide concentration build up in indoor environments is attributed to inefficient or non-functioning ventilation systems. 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).

Carbon dioxide can be a hazard within enclosed areas with **no air supply**. These types of enclosed areas are known as confined spaces. Manholes, mines and sewer systems are examples of confined spaces. An ordinary building is not considered a confined space. Carbon dioxide air exposure limits for employees and the general public have been established by a number of governmental health and industrial safety groups. Each of these standards of air concentrations is expressed in parts per million (ppm). *Table 1* is a listing of carbon dioxide air concentrations and related health effects and standards.

The MDPH uses a guideline of 800 ppm for publicly occupied buildings (Burge et al., 1990; Gold, 1992; Norback, 1990; OSHA, 1994; Redlich, 1997; Rosenstock, 1996; SMACNA, 1998). 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. Several sources indicate that indoor air problems *are significantly reduced* at 600 ppm or less of carbon dioxide (ACGIH, 1998; Bright et al., 1992; Hill, 1992; NIOSH, 1987). Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Air levels for carbon dioxide that indicate that indoor air quality may be a problem have been established by the American Society of Heating, Refrigerating and Air-conditioning

Engineers (ASHRAE). Above 1,000 ppm of carbon dioxide, ASHRAE recommends adjustment of the building's ventilation system (ASHRAE, 1989). In 2001, ASHRAE modified their standard to indicate that no more than 700 ppm above the outdoor air concentration; however 800 ppm is the level where further investigation will occur.

Carbon dioxide itself has no acute (short-term) health effects associated with low level exposure (below 5,000 ppm). The main effect of carbon dioxide involves its ability to displace oxygen for the air in a confined space. As oxygen is inhaled, carbon dioxide levels build up in the confined space, with a decrease in oxygen content in the available air. This displacement of oxygen makes carbon dioxide a simple asphyxiant. At carbon dioxide levels of 30,000 ppm, severe headaches, diffuse sweating, and labored breathing have been reported. No **chronic** health effects are reported at air levels below 5,000 ppm.

Air testing is one method used to determine whether carbon dioxide levels exceed the comfort levels recommended. If carbon dioxide levels are over 800-1,000 ppm, the MDPH recommends adjustment of the building's ventilation system. The MDPH recommends that corrective measures be taken at levels above 800 ppm of carbon dioxide in office buildings or schools. (Please note that carbon dioxide levels measured below 800 ppm may not decrease indoor air quality complaints). Sources of environmental pollutants indoors can often induce symptoms in exposed individuals regardless of the adequacy of the ventilation system. As an example, an idling bus outside a building may have minimal effect on carbon dioxide levels, but can be a source of carbon monoxide, particulates and odors via the ventilation system.

Therefore, the MDPH strategy of adequate ventilation coupled with pollutant source reduction/removal serves to improve indoor air quality in a building. Please note that each table included in the IAQ assessment lists BEH comfort levels for carbon dioxide levels at the bottom (i.e., carbon dioxide levels between 600 ppm to 800 ppm are acceptable and <600 ppm is preferable). While carbon dioxide levels are important, focusing on these air measurements in isolation to all other recommendations is a misinterpretation of the recommendations made in these assessments.

Table 1: Carbon Dioxide Air Level Standards

Carbon Dioxide Level	Health Effects	Standards or Use of Concentration	Reference
250-600 ppm	None	Concentrations in ambient air	Beard, R.R., 1982 NIOSH, 1987
600 ppm	None	Most indoor air complaints eliminated, used as reference for air exchange for protection of children	ACGIH, 1998; Bright et al., 1992; Hill, 1992; NIOSH 1987
800 ppm	None	Used as an indicator of ventilation inadequacy in schools and public buildings, used as reference for air exchange for protection of children	Mendler, 2003 Bell, A. A., 2000; NCOSP. 1998; SMACNA, 1998; EA, 1997; Redlich, 1997; Rosenstock, 1996; OSHA, 1994; Gold, 1992; Burge et al., 1990; Norback, 1990 ; IDPH, Unknown
1000 ppm	None	Used as an indicator of ventilation inadequacy concerning removal of odors from the interior of building.	ASHRAE, 1989
950-1300 ppm*	None	Used as an indicator of ventilation inadequacy concerning removal of odors from the interior of building.	ASHRAE, 1999
700 ppm (over background)	None	Used as an indicator of ventilation inadequacy concerning removal of odors from the interior of building.	ASHRAE, 2001
5000 ppm	No acute (short term) or chronic (long-term) health effects	Permissible Exposure Limit/Threshold Limit Value	ACGIH, 1999 OSHA, 1997
30,000 ppm	Severe headaches, diffuse sweating, and labored breathing	Short-term Exposure Limit	ACGIH, 1999 ACGIH. 1986

* outdoor carbon dioxide measurement +700 ppm

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APPENDIX D

Exposure Calculations and Cancer Risk Assessment

Exposure Calculations and Cancer Risk Assessment

In order to further assess contaminants, such as PCBs, and possible health related concerns, calculations are made to estimate the amount of a contaminant that people may come into contact with each day (i.e., exposure dose). These calculations account for several factors that are specific to the location and the medium being analyzed. The maximum concentration is the highest amount of the contaminant found during sampling for indoor air (i.e., 1.45 (J) for students and staff). This is a conservative assumption since it is unlikely that an individual would be continuously exposed to the highest concentration. Exposure frequency is the rate of exposure within a given time period. For New Bedford High School, it is estimated that students and staff are exposed to the highest concentration ever detected at the school in a single location for 180 days per year for 8 hours per day. Exposure duration is the length of time of a continuous exposure. For students and staff, this is estimated to be 4 and 37 years, respectively. The averaging time is the number of days in which an exposure is averaged. For cancer concerns, the default value is the number of days in a 70-year lifespan. Once the exposure dose is calculated, it is multiplied by the cancer slope factor to produce a theoretical cancer risk (e.g., 1 in a million, or 1 x 10^{-6}). The cancer slope factor for PCBs is 2 $(mg/kg/day)^{-1}$ (U.S. EPA 1997a).

Air exposures include inhalation rates, which are the volume of air that students and adults breathe each day. The average inhalation rate for high school students (ages 11 - 21) is approximately 15.8 cubic meters per day (15.8 m^3/day) or 5.27 m^3 per 8 hour school day (EPA 2008). For adults, the average inhalation rate is 15.2 m^3/day or 5.1m^3 per 8 hour work day (U.S. EPA 1997). The average body weight for high school students was estimated as 64.2 kg using the U.S. EPA Child-Specific Exposure Factors Handbook (2008). For adults, the average body weight used in the exposure calculation is 70 kg (ATSDR, 2005).

Using the maximum total measured PCB concentration in air detected in any indoor air sample, 1.45 (J) µg/m^3, the following is the exposure dose and theoretical cancer risk calculations for adults and high school students:

Adult

Maximum Concentration of PCBs:	**1.45 μg/m^3**
Inhalation Rate (8 hour):	**5.1 m^3/day**
Exposure Frequency:	**180 days/year**
Exposure Duration:	**37 years**
Conversion Factor (CF):	**0.001 mg/μg**
Body Weight:	**70 kg**
Averaging Time (70 years):	**25,550 days**
Cancer Slope Factor:	**2 mg/kg/day^{-1}**

$$ExposureDose = \frac{Concentration * InhalationRate * ExposureFrequency * ExposureDuration * CF}{BodyWeight * AveragingTime}$$

Exposure Dose = 2.8 x 10-5 mg/kg/day

Theoretical Cancer Risk = Exposure Dose x Cancer Slope Factor

Theoretical Cancer Risk = 5.51 x 10^{-5}

Student (11-21 years old)

Maximum Concentration of PCBs: **1.45 µg/m^3**

Inhalation Rate (8 hours): **5.27 m^3/day**

Exposure Frequency: **180 days/year**

Exposure Duration: **4 years**

Conversion Factor (CF) **0.001 mg/µg**

Body Weight: **64.2 kg**

Averaging Time (70 years): **25,550 days**

Cancer Slope Factor: **2 mg/kg/day^{-1}**

$$ExposureDose = \frac{Concentration * InhalationRate * ExposureFrequency * ExposureDuration * CF}{BodyWeight * AveragingTime}$$

Exposure Dose = 3.35 x 10^{-6} mg/kg/day

Theoretical Cancer Risk = Exposure Dose x Cancer Slope Factor

Theoretical Cancer Risk = 6.71 x 10^{-6}

APPENDIX E

Risk Factor Information for Breast Cancer

How to Use this Factsheet

This risk factor summary was developed to serve as a general fact sheet. It is an overview and should not be considered exhaustive. For more information on other possible risk factors and health effects being researched, please see the References section.

A risk factor is anything that increases a person's chance of developing cancer. Some risk factors can be controlled while others cannot. Risk factors can include *hereditary conditions*, *medical conditions or treatments*, *infections*, *lifestyle factors*, or *environmental factors*. Although risk factors can influence the development of cancer, most do not directly cause cancer. An individual's risk for developing cancer may change over time due to many factors and it is likely that multiple risk factors influence the development of most cancers. Knowing the risk factors that apply to specific concerns and discussing them with your health care provider can help to make more informed lifestyle and health-care decisions.

For cancer types with environmentally-related risk factors, an important factor in evaluating cancer risk is the route of exposure. This is particularly relevant when considering exposures to chemicals in the environment. For example, a particular chemical may have the potential to cause cancer if an individual breathes the chemical in. That same chemical may not increase the risk of cancer similarly if an individual comes into contact with the chemical by touching it. In addition, an individual must generally be exposed to a chemical at a sufficient dose and for a sufficient duration of time for an adverse health effect to occur.

Gene-environment interactions are another important area of cancer research. An individual's risk of developing cancer may depend on a complex interaction between their genetic make-up and exposure to an environmental agent (for example, a virus or a chemical contaminant). This may explain why some individuals have a fairly low risk of developing cancer as a result of an environmental factor or exposure, while others may be more vulnerable.

Key Statistics

Breast cancer is the most frequently diagnosed cancer among women in the United States, except for skin cancers. The American Cancer Society estimates that in 2010, approximately 207,090 women in the U.S. and 5,320 women in Massachusetts will be diagnosed with breast cancer and the disease will account for approximately 28% of all cancer diagnoses in females. Between 2003 and 2007, breast cancer accounted for 28% of cancer diagnoses in females in Massachusetts.

After increasing from 1994 to 1999, the incidence of breast cancer in females in the United States decreased from 1999 to 2006 by 2.0% per year. In Massachusetts, the incidence of invasive breast cancer in females remained stable during the period 2003-2007.

The chance of developing invasive breast cancer at some time in a woman's life is about 1 in 8. Women are 100 times more likely than men to develop this disease and risk increases with age. Men can also develop breast cancer, but male breast cancer is rare, accounting for less than 1%

of all breast cancer cases. For more information on breast cancer in men, visit the American Cancer Society website at www.cancer.org.

A woman's risk of developing breast cancer increases with age. About 12-13% invasive breast cancers are found in women younger than 45, while about 66% are found in women age 55 or older. White women are slightly more likely to develop breast cancer than women of other races and ethnicities.

Types of Breast Cancer

The term "cancer" is used to describe a variety of diseases associated with abnormal cell and tissue growth. Cancers are classified by the location in the body where the disease originated (the primary site) and the tissue or cell type of the cancer (histology).

There are several types of breast cancer, although some of them are quite rare. In some cases a single breast tumor can have a combination of these types or have a mixture of invasive and *in situ* cancer.

In situ breast cancers are considered the earliest stage of cancer, when it is confined to the layer of cells where it began. They have not invaded into deeper tissues in the breast or spread to other organs in the body, and are sometimes referred to as non-invasive breast cancers. The remainder of this risk factor summary pertains to invasive breast cancers. Additional information on *in situ* breast cancers and other benign breast conditions can be found at www.cancer.org (American Cancer Society).

An invasive, or infiltrating, cancer is one that has already grown beyond the layer of cells where it started (as opposed to carcinoma *in situ*). Most breast cancers are invasive carcinomas -- either invasive ductal carcinoma or invasive lobular carcinoma.

Invasive ductal carcinoma (IDC) is the most common type of breast cancer and accounts for 75%–80% of all breast cancers. IDCs begin in the cells lining the milk duct of the breast, break through the wall of the duct, and grow into the fatty tissue of the breast. Once this occurs, IDCs may spread (metastasize) to other parts of the body through the lymphatic system and bloodstream.

Invasive lobular carcinoma (ILC) starts in the milk-producing glands (lobules) and account for approximately 10% of invasive breast cancers. Like IDC, it can metastasize to other parts of the body. Invasive lobular carcinoma may be harder to detect by a mammogram than invasive ductal carcinoma.

Other less common types of invasive breast cancer include:

- inflammatory breast cancer
- triple-negative breast cancer
- medullary carcinoma
- metaplastic carcinoma
- mucinous carcinoma
- Paget's disease
- tubular carcinoma
- papillary carcinoma
- adenoid cystic carcinoma or adenocystic carcinoma
- Phyllodes tumor
- angiosarco

Established Risk Factors

Hereditary Conditions

Having a family history of breast cancer increases a woman's risk of developing the disease. Women who have a first-degree relative (e.g., mother, sister) with breast cancer have about twice the risk of developing breast cancer themselves. Having two first-degree relatives with this disease increases a woman's risk by five-fold. Overall, about 20-30% of woman with breast cancer have a family member with the same disease. Therefore, 70-80% of women who have breast cancer have no familial link to the disease.

About 5-10% of breast cancer diagnoses are thought to be due to an inherited genetic mutation. Most of these mutations occur in the *BRCA1* and *BRCA2* genes. Other genes that may lead to an increased risk for developing breast cancer include *ATM*, *CHEK2*, *p53* and *PTEN*. Women who inherit these gene mutations have up to an 80% chance of developing breast cancer during their lifetime.

Medical Conditions and Treatments

Certain benign breast conditions may increase one's risk for breast cancer. Women with proliferative lesions without atypia (i.e., abnormal or unusual cells), which have excessive growth of cells in the ducts or lobules of breast tissue have a slight increased risk of developing breast cancer. Proliferative lesions with atypia, when the cells are excessively growing and no longer appear normal, raise one's risk by 4 to 5 times. Women with denser breast tissue (as seen on a mammogram) have more glandular tissue and less fatty tissue, and have a higher risk of breast cancer.

A woman with cancer in one breast is 3 to 4 times more likely to develop a new cancer in the other breast or in another part of the same breast. In addition, a previous diagnosis of an *in situ* breast cancer puts a woman at increased risk for an invasive breast cancer.

Cumulative exposure of the breast tissue to estrogen is associated with breast cancer risk. Several factors can influence estrogen levels. Women who started menstruating at an early age (before age 12) and/or went through menopause at a later age (after age 55) have a slightly higher risk of breast cancer. Also, women who have had no children or those whose first pregnancy occurred when they were over the age of 30 have an increased risk for developing breast cancer. Women who have had more children and those who have breast-fed seem to be at lower risk.

Use of hormone replacement therapy is another factor that may affect breast cancer risk. Long-term use (several years or more) of combined post-menopausal hormone therapy (PHT) increases the risk of breast cancer. The increased risk from combined PHT appears to apply only to current and recent users. A woman's breast cancer risk seems to return to that of the general population within 5 years of stopping combined PHT. The use of estrogen-only replacement therapy (ERT) does not appear to increase the risk of breast cancer significantly but when used long term (for more than 10 years), ERT has been found to increase the risk of both ovarian and breast cancer in some studies.

Women who had radiation therapy to the chest area as treatment for another cancer are at significantly increased risk for breast cancer. This risk appears to be highest if the radiation is given during adolescence or puberty, when the individual’s breasts are developing.

From the 1940s through the 1960s some pregnant women were given the drug diethylstilbestrol (DES) because it was thought to lower their chances of miscarriage. These women have a slightly increased risk of developing breast cancer. A woman whose mother took DES while pregnant may also have a slightly higher risk of breast cancer.

Lifestyle Factors

Alcohol consumption has also been associated with increased risk for breast cancer. Compared with non-drinkers, women who consume one alcoholic drink a day have a very small increase in risk whereas those who have 2 to 5 drinks daily have about 1½ times the risk of women who drink no alcohol.

Possible Risk Factors

Environmental Exposures

A great deal of research has been reported and more is being done to understand possible environmental influences on breast cancer risk. Of special interest are compounds in the environment that have been found in animal studies to have estrogen-like properties, which could in theory affect breast cancer risk. For example, substances found in some plastics, certain cosmetics and personal care products, pesticides (such as DDE), and PCBs (polychlorinated biphenyls) seem to have such properties. To date, however, there is not a clear link between breast cancer risk and exposure to these substances.

Lifestyle Factors

Recent studies have indicated that being overweight or obese may put a woman at increased risk of breast cancer, especially after menopause. Similarly, women who are physically inactive throughout life may have an increased risk of breast cancer. Being active may help reduce risk by preventing weight gain and obesity.

Studies have found that women using oral contraceptives (birth control pills) have a slightly greater risk of breast cancer than women who have never used them, but this risk seems to decline once their use is stopped. Women who stopped using oral contraceptives for more than 10 years do not appear to have any increased breast cancer risk. When thinking about using oral contraceptives, women should discuss their other risk factors for breast cancer with their physician.

Lifetime risk of breast cancer is increased in women of higher socioeconomic status (SES) (e.g., income, education, etc.). Research suggests that this may be due to reproductive and lifestyle factors (age at first full-term birth, physical activity, diet, cultural practices, etc.).

Other Risk Factors That Have Been Investigated

Lifestyle Factors

Though links have been suggested, antiperspirants, bras, and breast implants have all been investigated as possible risk factors for breast cancer but no associations have been found.

The role of cigarette smoking in the development of breast cancer is unclear. Overall, data do not provide strong evidence for an association between active cigarette smoking and breast cancer risk. Some studies suggest a relationship between passive smoking and increased risk for breast cancer; however, confirming this relationship has been difficult due to the lack of consistent results from studies investigating first-hand smoke exposure.

Dietary fat intake is another factor that has been suggested to increase a woman’s risk for breast cancer. Though studies have found decreased breast cancer rates in countries with a diet typically lower in fat, studies in the U.S. have not shown an association between the amount of fat in the diet and increased risk of breast cancer.

References/For More Information

Much of the information contained in this summary has been taken directly from the following sources. This material is provided for informational purposes only and should not be considered as medical advice. Persons with questions regarding a specific medical problem or condition should consult their physician.

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APPENDIX F

An Information Booklet Addressing PCB-Containing Materials in the Indoor Environment of Schools and Other Public Building

An Information Booklet Addressing PCB-Containing Materials in the Indoor Environment of Schools and Other Public Buildings

Prepared by

Bureau of Environmental Health
Massachusetts Department of Public Health
December 2009

INTRODUCTION

The purpose of this information booklet is to provide assistance to school and public building officials and the general public in assessing potential health concerns associated with polychlorinated biphenyl (PCB) compounds in building materials used in Massachusetts and elsewhere. Recently, the U.S. Environmental Protection Agency (EPA) provided broad guidance relative to the presence of PCBs in building materials, notably PCBs in caulking materials. The most common building materials that may contain PCBs in facilities constructed or significantly renovated during the 1950s through the 1970s are fluorescent light ballasts, caulking, and mastic used in tile/carpet as well as other adhesives and paints.

This information booklet, developed by the Massachusetts Department of Public Health's Bureau of Environmental Health (MDPH/BEH), is designed to supplement guidance offered by EPA relative to potential health impacts and environmental testing. It also addresses managing building materials, such as light ballasts and caulking, containing PCBs that are likely to be present in many schools and public buildings across the Commonwealth. This is because the Northeastern part of the country, and notably Massachusetts, has a higher proportion of schools and public buildings built during the 1950s through 1970s than many other parts of the U.S. according to a 2002 U.S. General Accounting Office report. The Massachusetts School Building Authority noted in a 2006 report that 53 percent of over 1,800 Massachusetts school buildings surveyed were built during the 1950s through 1970s. This information booklet contains important questions and answers relative to PCBs in the indoor environment and is based on the available scientific literature and MDPH/BEH's experience evaluating the indoor environment of schools and public buildings for a range of variables, including for PCBs as well as environmental data reviewed from a variety of sources.

1. What are PCBs?

Polychlorinated biphenyl (PCB) compounds are stable organic chemicals used in products from the 1930s through the late 1970s. Their popularity and wide-spread use were related to several factors, including desirable features such as non-flammability and electrical insulating properties. Although the original use of PCBs was exclusive to closed system electrical applications for transformers and capacitors (e.g., fluorescent light ballasts), their use in other applications, such as using PCB oils to control road dust or caulking in buildings, began in the 1950s.

2. When were PCBs banned from production?

Pursuant to the Toxic Substance Control Act (TSCA) of 1976 (effective in 1979), manufacturing, processing, and distribution of PCBs was banned. While the ban prevented production of PCB-containing products, it did not prohibit the use of products already manufactured that contained PCBs, such as building materials or electrical transformers.

3. Are PCBs still found in building materials today?

Yes. Products made with PCBs prior to the ban may still be present today in older buildings. In buildings constructed during the 1950s through 1970s, PCBs may be present in caulking, floor mastic, and in fluorescent light ballasts. Available data reviewed by MDPH suggests that caulking manufactured in the 1950s through 1970s will likely contain some levels of PCBs. Without testing it is unclear whether caulking in a given building may exceed EPA's definition of PCB bulk product waste of 50 parts per million (ppm) or greater. If it does, removal and disposal of the caulk is required in accordance with EPA's TSCA regulations (40 CFR § 761).

4. Are health concerns associated with PCB exposure opportunities?

Although the epidemiological evidence is sometimes conflicting, most health agencies have concluded that PCBs may reasonably be anticipated to be a carcinogen, i.e., to cause cancer.

PCBs can have a number of non-cancer effects, including those on the immune, reproductive, neurological and endocrine systems. Exposure to high levels of PCB can have effects on the liver, which may result in damage to the liver. Acne and rashes are symptoms typical in those that are exposed to high PCB levels for a short period of time (e.g., in industry / occupational settings).

5. If PCBs are present in caulking material, does that mean exposure and health impacts are likely?

No. MDPH/BEH's review of available data suggests that if caulking is intact, no appreciable exposures to PCBs are likely and hence health effects would not be expected. MDPH has conducted indoor tests and reviewed available data generated through the efforts of many others in forming this opinion.

6. How can I tell if caulking or light ballasts in my building may contain PCBs?

If the building was built sometime during the 1950s through 1970s, then it is likely that the caulking in the building and/or light ballasts may contain some level of PCBs. Light ballasts manufactured after 1980 have the words "No PCBs" printed on them. If the light ballast does not have this wording or was manufactured before 1980, it should be assumed that it contains PCBs.

7. What are light ballasts?

A light ballast is a piece of equipment that controls the starting and operating voltages of fluorescent lights. A small capacitor within older ballasts contains about one ounce of PCB oil. If light bulbs are not changed soon after they go out, the ballast will continue to heat up and eventually result in the release of low levels of PCBs into the indoor air.

8. Does the presence of properly functioning fluorescent light ballasts in a building present an environmental exposure concern?

No appreciable exposure to PCBs is expected if fluorescent light ballasts that contain PCBs are intact and not leaking or damaged (i.e., no visible staining of the light lenses), and do not have burned-out bulbs in them.

9. Should I be concerned about health effects associated with exposure to PCBs as a result of PCB-containing light ballasts?

While MDPH has found higher PCB levels in indoor air where light bulbs have burned-out, the levels are still relatively low and don't present imminent health threats. A risk assessment conducted recently at one school did not suggest unusual cancer risks when considering a worst case exposure period of 35 years for teachers in that school. Having said this, MDPH believes that facility operators and building occupants should take prompt action to replace bulbs and/or ballasts as indicated to reduce/eliminate any opportunities for exposure to PCBs associated with PCB-containing light ballasts.

10. When should PCB-containing light ballasts be replaced?

If ballasts appear to be in disrepair, they should be replaced immediately and disposed of in accordance with environmental regulatory guidelines and requirements. However, if light bulbs burn out, the best remedy is to change them as soon as possible. If light bulbs are not changed soon after they go out, the ballast will continue to heat up and eventually result in the release of low levels of PCBs into the indoor air. Thus, burned-out bulbs should be replaced promptly to reduce overheating and stress on the ballast. As mentioned, ballasts that are leaking or in any state of disrepair should be replaced as soon as possible.

It should be noted that although older light ballasts may still be in use today, the manufacturers' intended lifespan of these ballasts was 12 years. Thus, to the extent feasible or in connection with repair/renovation projects, the older light ballasts should be replaced consistent with the intended lifespan specified by the manufacturers.

11. Does MDPH recommend testing of caulking in buildings built during the 1950s - 1980?

Caulking that is intact should not be disturbed. If caulking is deteriorating or damaged, conducting air and surface wipe testing in close proximity to the deteriorating caulking will help to determine if indoor air levels of PCBs are a concern as well as determining the need for more aggressive cleaning. Results should be compared with similar testing done in an area without deteriorating caulking. In this way, a determination can be made regarding the relative contribution of caulking materials to PCBs in the general indoor environment.

12. What if we determine that caulking in our building is intact and not deteriorating?

Based on a review of available data collected by MDPH and others, the MDPH does not believe that intact caulking presents appreciable exposure opportunities and hence should not be disturbed for testing. As with any building, regular operations and maintenance should include a routine evaluation of the integrity of caulking material. If its condition deteriorates then the steps noted above should be followed. Consistent with EPA advice, if buildings may have materials that contain PCBs, facility operators should ensure thorough cleaning is routinely conducted.

13. Should building facilities managers include information about PCB-containing building materials in their Operations and Maintenance (O&M) plans?

Yes. All buildings should have an O&M plan that includes regular inspection and maintenance of PCB building materials, as well as thorough cleaning of surfaces not routinely used. Other measures to prevent potential exposure to PCBs include increasing ventilation, use of HEPA filter vacuums, and wet wiping. These O&M plans should be available to interested parties.

14. Are there other sources of PCBs in the environment?

Yes. The most common exposure source of PCBs is through consumption of foods, particularly contaminated fish. Because PCBs are persistent in the environment, most residents of the U.S. have some level of PCBs in their bodies.

15. Where can I obtain more information?

For guidance on replacing and disposing of PCB building materials, visit the US EPA website: http://www.epa.gov/pcbsincaulk/. For information on health concerns related to PCBs in building materials, please contact MDPH/BEH at 617-624-5757.

APPENDIX G

Response to Public Comments

Response to Public Comments on

Public Comment Release, Health Consultation, Evaluation of Indoor Environmental Conditions and Potential Health Impacts, New Bedford High School

INTRODUCTION

The New Bedford High School report was released as a public comment draft on September 28, 2011, and a 6-week public comment period was established (i.e., through November 9, 2011). Comments were received from the City of New Bedford (n=93); the Law Office of Sarah Gibson on behalf of the New Bedford Educators Association (n=21); and EPA's Technical Assistance Services for Communities (TASC) program on behalf of Citizens Leading Environmental Action Network Inc. (CLEAN) (n=52). A number of comments were related to minor clarifications or corrections, and thus are not specifically listed here but were clarified or corrected in the final report. In addition, comments that were similar in nature were grouped together for response. MDPH also updated the main body of the report in three areas. The first area includes an update to the *Health Concerns* section of the public comment draft, specifically the subsection titled *Cancer Diagnoses Reported among Current/Former Employees and Students*. Since the September 2011 release of the Public Comment Draft Report, MDPH has received three updates via email from CLEAN related to seven additional cancer diagnoses among current and former staff of the NBHS. This information includes newly reported diagnoses as well as clarification on individuals previously reported, e.g., changed spelling of individuals' names previously reported. These emails were received in November 2011, January 2012, and July 2012. Despite receiving this information after the formal comment period, MDPH updated the report to incorporate the new cancer-related information provided by CLEAN. The second area includes the review and evaluation of indoor air sampling data for PCBs that were not available at the time of the Public Comment Release (i.e., data released after September 28, 2011). These new data include results of April and August 2011 (released on October 5, 2011) as well as April and July 2012 (released August 16, 2012) indoor air sampling rounds at the NBHS. The third area where MDPH has revised the report relates to Appendix H. Appendix H provides a summary of the current status of indoor environmental actions taken by the City of New Bedford and/or their consultants since the September 2011 report was released.

BACKGROUND/INTRODUCTION

Comment: "Paragraph 1: It may help reduce confusion to readers if the school building which previously existed at 70 Hathaway Boulevard is referenced as the former Keith Junior High School rather than the former Keith Middle School. The school was renamed to a "middle school" with the new construction at 225 Hathaway Boulevard (note: this comment applies to multiple references throughout the report)."

Response: This comment refers to the school formerly located at 70 Hathaway Boulevard that has been demolished and is now the location of McCoy Field, a City-owned athletic field. This school initially operated as a junior high school under the name Keith Junior High School and it is our understanding that it became a middle school and changed its name to the Keith Middle School in its last year of operation. Thus, the report refers to this school as the former Keith Middle School and references throughout the report to the former Keith Middle School were not changed; however, in the first paragraph of the introduction, a statement was added indicating that the former Keith Middle School is also known as the former Keith Junior High School to address this comment.

Comment: "Page 1, Paragraph I: References to the "former city burn dump" taken from the Interim Phase II CSA/or NBHS and Walsh - Further research by the City has indicated that the historic disposal activities which occurred at the former Parker Street Dump cannot be accurately characterized as a "burn dump." Fires were sporadic, and much of the ash that is present was generated elsewhere in the City and deposited at the site."

Response: Language was revised in the Background/Introduction section to reflect this new information.

<u>Historical information and timeline regarding environmental sampling for PCBs</u>

Comments: "Page 3, Paragraph 3: The text states that the 23 indoor air samples collected included 1 co-located pair. The 23 indoor air samples actually include 2 co-located pairs, one at hallway locker 1579 and one at A-110-4. Please revise accordingly." "Table 5, August 2006, Revise to show 2 co-located pairs for indoor air."

Response: MDPH cited the summary sampling information directly from TRC (2006) which states, "*Twenty-three indoor air samples (including 1 co-located pair)....*" The MDPH notes that the sampling design included two co-located pairs, however, per TRC (2006) page 7-1, one of the pumps for a co-located pair at locker 1579 failed. Hence, TRC noted that effectively only one co-located pair could be used. No revision was made to the report.

Comment: "Paragraph 3: The text states that there were 5 outdoor/background samples collected. However, only three background samples were collected (one was collected using TO-lOA and two were collected using TO-4A with separate analyses of the PUF and particulate filter for comparison purposes at the request of EPA). Please revise accordingly." "Table 5, August 2006, Revise to show 3 background samples collected, as discussed above."

Response: According to TRC (2006) there were 2 background sample locations, one location (i.e., outside, playground) sampled with both methods TO-10A and TO-4A, and another location (i.e., outside, front of main office) sampled with method TO-4A only. Both TO-4A samples were analyzed separately for PUF and particulate filter to determine relative contributions of PCBs in vapor vs. particulate phase, resulting in 5 analyses total for the two locations. To clarify, the following language was added to the report: "To compare with sampling methods used by BETA (2006), one outdoor location was sampled using both EPA methods TO-10A and TO-4A, and another location sampled with TO-4A only. Both outdoor samples collected using TO-4A had polyurethane foam (PUF) and particulate filters analyzed separately for comparison at the request of USEPA (TRC, 2006)."

METHODS

Comment: "The comprehensibility of the report would be greatly improved by: …(iii) a section giving the basis for the various agency guidance values and action levels used in the report (e.g., whether the guidance values are health-based or technology-based; if the former, were they designed to be protective of children's health?) as well as references for each value…" (Note: Parts i, ii, and iv of this comment are addressed on page 220 of this Appendix.)

Response: As stated in the section entitled "Methods used to evaluate potential health risks associated with PCBs in NBHS," MDPH used comparison values derived by the federal public health agency (i.e., the Agency for Toxic Substances and Disease Registry [ATSDR]). ATSDR has derived a Cancer Risk Evaluation Guide for PCBs (CREG; 0.01 µg/m3) that MDPH used to screen indoor air for total PCB levels. This value is health-based and was derived based on daily exposure over a lifetime, assuming residential exposures for all populations, including children. It should be noted that ATSDR has not derived non-cancer comparison values for total PCBs in indoor air. The following language was added to the report to clarify: "The ATSDR CREG was derived based on daily exposure over a lifetime for all populations, including children. There are no available ATSDR Environmental Media Evaluation Guides (EMEGs) for PCBs in indoor air." It is our understanding that the US EPA guidance levels for indoor air used at NBHS were derived to be site-specific (originally for the Keith Middle School). Questions about derivation of those guidelines are best directed to US EPA. It is worthwhile to note, however, that the guidance used by MDPH (CREG) was more conservative than the US EPA values used for NBHS.

In the context of this evaluation, indoor air data are the only reliable data that can be used to evaluate the potential for health effects. Similar to evaluating asbestos in indoor school environments, wipe and bulk data are collected for remediation/regulatory purposes, not to assess health risk. For example, MDPH considers the California Department of Toxic Substances Control (CA DTSC) 2003 guideline, derived for clean up after spills in schools (i.e., 0.1 µg/100cm2 wipe), to suggest areas that may require additional cleaning. MDPH also considers the US EPA clean-up standard of 10 µg/100cm2 wipe, which is a regulatory (i.e., enforceable) clean-up standard applicable to low concentration PCB spills (i.e., less than 1 pound of PCBs by weight) (40 CFR 761.125).

Comment: "Page 7, line 14: the report states, "rather, if the concentration of PCBs in any medium (e.g. air) is greater than the CREG for that medium, the potential for exposure to

PCBs should be further evaluated for the specific situation to determine whether cancer health effects might be possible." It's unclear what this sentence means, and further explanation should be offered.”

Response: MDPH added the following language to address this comment: “Comparison values are specific concentrations of a chemical for air, soil, or water that are used by health assessors to identify environmental constituents that require further evaluation. These comparison values are developed based on health guidelines and assumed exposure situations that represent conservative estimates of human exposure. Chemical concentrations detected in environmental media that are less than a comparison value are not thought to pose a health threat. However, chemical concentrations detected in environmental media above comparison values do not necessarily mean health effects will occur. In order for a compound to affect one’s health, it must not only be present in the environmental media, but one must also come in contact with the compound. Therefore, if a concentration of a chemical is greater than the appropriate comparison value, the potential for exposure to the chemical should be further evaluated to determine whether or how much exposure is occurring for the specific situation and whether health effects might be possible as a result of that exposure.”

RESULTS: INDOOR AIR QUALITY

Comment: Page 11 - "Ventilation" - Please explain what steps, if any, MDPH took to communicate carbon dioxide levels to the City. If no steps were taken, please explain why, particularly since MDPH was reviewing the City's ongoing indoor air PCB sampling results and noted a potential correlation between carbon dioxide levels and the efficiency of the ventilation system.

Response: The following text was added as clarification: “Following each day of indoor air quality assessment, MDPH staff met with the School Principal at the time as well as the HVAC technician to discuss conditions observed at the school, including the conditions of the ventilation system and carbon dioxide levels that were measured.” In addition, in July 2011, MDPH staff met with then-Mayor Scott Lang and other City representatives to discuss possible recommendations to improve indoor air quality at NBHS. No revision to the repot was made as a result of this comment.

Comment: Page 14, paragraph titled Classroom Exhaust Ventilation: indicates that there are some classrooms in which exhaust vents are hindered in operation by their location near doors leading from the classroom to the hallway. Tables 1 and 2 are not clear in indentifying which rooms have this configuration. Does the phrase, “door vent exhaust” in the remarks column of Table 1 for room B-354 and room B-371 indicate that these classrooms have this configuration? If not, the report needs to identify in which classrooms exhaust vents are located near hallway doors.

Response: Many classrooms were observed to have exhaust vents located near/behind doors. This particular statement was designed to address the issue in a general manner, because it was not unique to a particular classroom or small number of classrooms With regards to classrooms B-354 and B-371 Chemical Storage, the comment “door vent exhaust” refers to the existence of a passive door vent to the adjacent storage area. The phrase “door vent exhaust” has been revised for clarification to “passive door vent.”

Comment: Pg 18: Chlorine odors from the pool can be a sign of improperly treated pool water.

Response: For the purpose of this report, we did not specifically inspect the pool at the high school. Language was added to the report: “Under Massachusetts state regulations, the pool at NBHS is considered a “semi-public” pool, which should be operated and maintained (e.g., water quality, testing, treatment) in accordance with 105 CMR 435.29, Minimum Standards for Swimming Pools (State Sanitary Code: Chapter V), which are enforced at the local level by local health officials.” In addition, a new recommendation was also added: “Operate and maintain pool in accordance with 105 CMR 435.29, Minimum Standards for Swimming Pools (State Sanitary Code: Chapter V).”

Comment: Page 22, section entitled Carbon Monoxide: This paragraph refers to a MDPH corrective action level concerning carbon monoxide and ice-skating rinks. It is not clear how this standard is relevant to conditions at NBHS, since there is no ice-skating ring at the High School. Further explanation is needed, or the reference to this MDPH corrective action level should be deleted.

Response: The reference for carbon monoxide (CO) was provided to give the reader information on CO levels that can present a health risk in the indoor environment. MDPH also included the EPA National Ambient Air Standard for carbon monoxide for reference. No detectable levels of carbon monoxide were measured in the building at the time of the assessment; therefore, no revision to the report was made.

Comment: Page 23, section entitled Particulate Matter (PM2.5): the explanation of the difference between the PM 10 standard and the PM 2.5 standard should include an explanation of the difference in size of particles being measured, and the significance of the difference in size, in order to be understood by a lay audience.

Response: Additional language concerning PM was included in the report text. Clarifying language reads as follows:

The size of particulate matter relates to the potential for causing health problems. Particles less than 10 micrometers in diameter exhibit a greater health risk because they can penetrate deeper into the lungs; larger particles behave differently and are more likely to serve as a source of eye, nose, and throat irritation (AirNow, 2003).

Comment: Page 15 - Paragraph 4 - The statement "To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy" is slightly different from the statement in the 5th paragraph that, per the Massachusetts Building Code, "The ventilation must be on at all times that the room is occupied." The third paragraph implies that the auto shop (D-116) was in active use during the assessment but that the exhaust ventilation was not turned on. Table I shows that there were no occupants for D-116 during MDPH's assessment.

Response: The MA building code references ventilation rates as part of the *minimum standards* that are required for building construction. Unless a specific pollutant exists, no exhaust ventilation rates are listed. The MA building code specifies the design criteria capacity relative to the fresh air supply of a heating, ventilating and air-conditioning system (HVAC), not the operation of that system when the building is occupied.

In order for an HVAC system to function properly, both supply and exhaust must operate when the building is occupied. The report indicates that the local exhaust systems in the auto shop used to vent vehicle exhaust from the auto shop was not operating at the time of this assessment, so no evaluation regarding function could be done. This comment was made in the report as a reference to specialty exhaust systems used for a specific purpose, to remove point sources of air pollutants generated by an activity in that location (e.g., chemical hoods in the science classrooms and the exhaust system for idling engines in the auto shop). The auto shop also has HVAC components that are part of the general system for maintaining temperature and comfort. The general ventilation system was operating during this assessment.

Comment: Page 6 - Ventilation - Since the MDPH study in April 2008, the City has significantly upgraded the school's HVAC system, including the installation of a digital Building Management System, which has integral carbon dioxide (C02) probes installed in all heating/ventilation units, all air conditioning units, and the 31 unit ventilators that were installed in B-Block in 2010. These probes are tied into the air supply system to automatically provide additional outside air and reduce C02 accumulation when CO2 levels exceed a set point between 800-1500 ppm (most units are currently set at 900 ppm, below the Occupational Safety and Health Administration's recommended maximum level of I 000 ppm).

Response: MDPH acknowledges that there have been a number of steps taken at NBHS since the 2008 IAQ assessment at the school (see new Appendix H that documents these steps as reported by the City). We note that although CO2 sensors can serve as an aid in understanding the ventilation needs of classroom, they are not a surrogate for equipment and maintenance of parts. HVAC systems still require periodic cleaning, filter changes, and balancing. Please note, CO2 sensors should be calibrated and/or replaced as per manufacturer's recommendation to ensure proper function.

As the comment notes, CO2 sensors were only installed in select equipment (i.e. air-handling units and univents in B-Block). This indicates that the majority of HVAC equipment in the A-Block, which consists of approximately 270 classrooms, are original to the building. As discussed in the September 2011 report, these univents are near the end of their useful life. Continued maintenance and servicing of these units may extend the life of the equipment; however, consideration should be given to replacing these original units with modern units.

Lastly, the MDPH recommends that carbon dioxide levels be maintained below 800 ppm. This level is health based and designed to reduce symptoms commonly associated with indoor air quality, including respiratory, eye, nose and throat irritation, lethargy and headaches. The provision of adequate ventilation not only serves to improve occupant comfort, but serves to dilute exposure opportunities from common indoor environmental pollutants (e.g. VOCs from equipment and products used).

Comment: Page 18, section entitled Pool Odors: the report indicates that the school odors were apparent in the B Block Tan Hallway. It is unclear from the floor plan in Figure 6 where B Block Tan Hallway is -- it is not identified on the floor plan. The arrow on the floor plan that indicates where odors were apparent seems to end between D-Block Auditorium and C-Block.

Response: Odors were observed primarily in D- and E-Blocks. However, when the fire doors between C- and D-Blocks were open, odors were apparent in C-Block. The fire door between C- and D-Block should remain closed. The text has been clarified in response to this comment, as follows: "Odor of pool treatment at the C-Block Hallway (a distance estimated to be 500 feet)."

RESULTS: QUANTITATIVE EVALUATION OF POTENTIAL HEALTH RISKS FROM OPPORTUNITIES FOR EXPOSURE TO PCBS

Comment: "In the beginning of the report, the reason for focusing only on inhalation exposure (and risk) and exclusion of oral and dermal routes of exposure should be given."

Response: As noted in the section entitled "Quantitative Evaluation of Potential Health Risks from Opportunities for Exposure to PCBs," indoor air data are the most appropriate data for evaluating potential health concerns; hence, the inhalation route of exposure was the focus. This section noted that results from wipe and bulk samples are typically used to determine remedial action, not for purposes of assessing health risk. Exposure opportunities to PCBs and health risks are best addressed by indoor air data. Hence, no revisions to the report were made in response to this comment.

Comment: "Page 28, Top of page: The report states that rooms B-113 and B-114 were not measured for CO2 since they are not occupied classrooms. However, many other rooms were measured for CO2 that were not occupied. Please clarify the rationale for the difference in the data collection methodology."

Response: To clarify, the following language was added to the report: "Rooms B-113 and B-114 were not measured for CO2 because they are the shipping room and mechanical room, respectively, and therefore, are not 'occupied' similar to classrooms or other occupied areas."

Comment: "Page 28, paragraph 3: MDPH comments that 11 additional indoor air samples analyzed for dioxin-like PCB congeners were about at or less than the EPA Regional Screening Levels (RSLs). The report should state whether residential or industrial RSLs were used for this comparison and confirm whether the most recent WHO toxic equivalency factors were used to convert dioxin-like PCB congener concentrations to a single dioxin toxic equivalent (TEQ) concentration. Comparison to industrial RSLs based on exposures of 8 hours per day, 250 days per year for 25 years is more applicable to exposures occurring at NBHS than residential RSLs. The City performed its own comparison of TEQ from dioxin-like PCB congeners to the RSLs and concurs with the MDPH finding that they are about at or less than EPA's industrial RSLs, therefore indicating that dioxin-like PCB congeners are not contributing to cumulative cancer risk above MassDEP's benchmark." "Page 28, 2nd full paragraph: An explanation of the basis for EPA Regional Screening Levels should be given. Why aren't the sampling data provided?"

Response: MDPH reported the results of the City's (TRC) evaluation of these 11 samples. Based on a review of TRC's summary fact sheet and data tables (2011e, 2011f), TRC compared dioxin-like congener concentrations to EPA RSLs for industrial setting. The EPA industrial RSL assumes default adult occupational exposure assumptions, i.e., 8 hr/day, 250 days/year, and 25 years of exposure, more typical for NBHS than residential

RSLs, which assume daily exposure, 24 hr/day, and a 70 year lifetime (US EPA 1991). The 2005 World Health Organization toxic equivalency factors were used to convert dioxin-like PCB congener concentrations to a dioxin toxic equivalent concentration. Indoor air testing results from the February 2011 sampling round are available on the City of New Bedford website at http://www.newbedford-ma.gov/McCoy/2011/Final%20NBHS%20Indoor%20Air%20Results%20Tables.pdf. A reference citing the data tables (TRC 2011f) was added and edits were made to the text to clarify.

Comment: "Page 31, A-House 1 (Green): "The use of the supply/exhaust vents and the CO2 for explaining malfunctioning ventilation in these rooms may not be appropriate. These results are not evidence of significant PCB buildup in the indoor air."

Response: The MDPH CO2 measurements are used as an indicator of the adequacy of fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilation system is malfunctioning or the design occupancy of the room is being exceeded. At the time of inspection, MDPH IAQ program staff noted many univents either deactivated and/or with obstructions blocking airflow at diffusers and return vents. Also, CO2 measurements under no or low occupancy conditions were observed above 800 ppm in some of the same rooms, indicating inadequate ventilation. Inadequate air exchange is one of several factors that may affect observed levels of PCBs in indoor air; enhancing fresh air exchange would result in a reduction of PCB levels. The following text was added to the report to clarify: "The CO2 data are an indicator of the adequacy of fresh air ventilation, and inadequate air exchange is one of several factors that may affect PCB levels in indoor air."

Comments: There were a number of comments recommending that concentrations of PCBs detected in indoor air be compared to the US EPA site-specific action level of 0.05 µg/m3 and the US EPA defined risk-based cleanup goal, the Acceptable Long-Term Average Exposure Concentration (ALTAEC) of 0.3µg/m3 instead of the ATSDR Cancer Risk Evaluation Guide (CREG) (0.01 µg/m3). One commenter also requested that the basis for the US EPA action level be given.

Response: As a public health agency, the MDPH uses scientifically peer-reviewed health-based screening values and health guidelines derived by the federal public health agency, ATSDR, to evaluate data for potential health implications. The ATSDR comparison value for total PCBs (i.e., the Cancer Risk Evaluation Guide, or CREG, 0.01 μg/m3) is more conservative (i.e., health protective) than US EPA's action level (AL) of 0.05 μg/m3. Based on the MDPH analysis of PCB results in indoor air, the MDPH concludes that no unusual cancer risk exists. Therefore, the MDPH evaluation used a more health protective screening value resulting in concurrence with the City's conclusion based on use of US EPA values. MDPH believes that it has clearly explained its evaluation and no revisions to the report were made based on these comments. Specific questions regarding how US EPA levels were derived may be addressed to TRC, or the US EPA.

Comments: "Pg 3, 2nd paragraph: Indoor air concentrations for PCBs are given, but no information is provided on which PCBs were included in the overall concentration. This should be clearly stated (this comment pertains to other parts of the report, for example the last paragraph on pg 3)."

Response: The majority of indoor air samples collected to date were collected by TRC, the current City of New Bedford contractor. TRC analyzed air samples for PCB homologues and not for individual congeners, and reported as total PCBs. Analysis of air samples by PCB homologues is an acceptable way of measuring total PCBs, but the method does not allow for identification of specific PCB congeners in the sample. We have added clarifying language to the report to address this comment by noting that homologue methods don't allow for congener identification.

Comment: "Page 35, A-House 4 (Blue): The final sentence of this section states that it is plausible that disturbing materials for bulk sampling in 2006 may have impacted PCB levels measured in air in room A-4-212. Since PCBs were not measured in this room in 2006 and there is therefore no pre-bulk sampling baseline, this statement should not be made for this room. The City further disagrees with MDPH's statement that it is plausible that any measurable impact from bulk sampling activities would be evident in facility spaces of this size."

Response: Although there is no pre-bulk indoor air sampling baseline for this room, the pattern of PCB results in A-House 4 (Blue) suggests a peak in indoor air results during the 8/14/07 sampling, which was conducted in the midst of remedial activity, supplemental bulk sampling, and clearance testing, thereby generating dust that could also potentially be transported with associated foot traffic. Following the 8/14/07 indoor air sample round, and after remedial and bulk sampling activities ceased, select rooms were HEPA filtered to remove dust and then indoor air was retested on 8/29/07. In fact, rooms sampled both before and after HEPA filtration (i.e., A-4-110 and A-4-212), showed a small decline in PCB levels after HEPA filtration compared to levels measured before HEPA filtration.

For room A-4-110 with available indoor air data in 2006 (0.059 µg/m3), PCB levels peaked in early August 2007 (i.e., to 0.69 (J) µg/m3) then declined slightly to 0.61 (J) µg/m3 immediately following HEPA filtration. In room A-4-212, the PCB level was 0.62 (J) µg/m3 in August 2007, before HEPA filtration, and 0.59 (J) µg/m3 immediately following HEPA filtration. Despite the HEPA filtration, there was only a slight decline between pre- and post-remedial activities in August 2007 and may reflect that bulk sampling and remedial activity in the school had just recently ceased (in the case of bulk sampling, only 4 days prior to re-sampling).

Following a subsequent 6 month period of no bulk sampling at the school, PCB levels in both these rooms declined markedly as observed in February 2008 (i.e., from 0.61 (J) µg/m3 to 0.0056 (J) µg/m3 in room A-4-110; from 0.59 (J) µg/m3 to 0.13 (J) µg/m3 in room A-4-212). Hence, MDPH believes it plausible that bulk sampling and all the previous remedial activity may have impacted observed PCB levels in 2007.

Comment: "The City disagrees with MDPH's conclusion that bulk sampling 'is likely' to have affected PCB levels in indoor air, given that a very small quantity of material is collected during bulk sampling. Based on mass transfer theories, the rate of pollutant emission from a solid material is strongly influenced by a chemical's partitioning behavior, a function of vapor pressure, and ability to diffuse out of the bulk solid, related to the size of the molecule and surrounding matrix. PCBs are low volatility materials, and the bulk sampling conducted in the school affects small amounts of material (less than 10 grams).

To suggest that a 'release' of PCBs to the air from a less than 10 gram sample with small affected surface area can have a significant impact on air monitoring results, given the air volume in an over 500,000 square foot building, is implausible."

Response: As described in the report, the MDPH reported that the initial April 2006 indoor air sampling round conducted by BETA, albeit small in scope, had the lowest range of detectable PCBs in the school (0.0043 μg/m3 – 0.0519 μg/m3; n=5) of all data reported subsequent to 2006. No bulk samples were collected in the school at that time. During the subsequent August 2006 indoor air sampling round by TRC, bulk samples were also collected throughout the school. The PCB levels detected in indoor air at this time ranged from 0.0024 μg/m3 – 0.31 μg/m3. Indoor air samples in August 2007 showed detectable PCBs ranging from 0.0025 μg/m3 – 0.69 μg/m3, and were collected during a time of remedial activity and supplemental bulk sampling in the school. [Please see response to previous comment for additional detail.] The MDPH believes that several factors may account for the observed higher PCB levels, including disturbing building materials (e.g., via bulk sampling and remedial activities) and ventilation system malfunctions (e.g., 20 of 120 rooftop exhaust vents non-functioning, malfunction of 40% of perimeter univents) that do not allow optimal fresh air exchange that could dilute/reduce indoor PCB concentrations (TRC 2008a). Results for the February 2008 round of indoor air testing, following a 6 month period of no remedial activities or bulk sampling in the building and repair of the HVAC system, resulted in a lower range of PCB concentrations (0.0014 μg/m3 – 0.13 μg/m3). Hence, the pattern suggests that disruption of materials for testing or removal and inadequate ventilation may indeed affect indoor levels of PCBs.

Comments : "Page 3, bottom: The term "bulk sample" is introduced here and should be defined. What are bulk samples used for in the report? How are they assessed?" "Page 3, top: Please give a reference and the basis for the TSCA PCB waste limit. I found a reference that provided situation-dependent waste limits. Is the value in the report protective of children?"

Response: According to TRC (2006), bulk samples (e.g., of caulk, paint, laminate adhesives and mastics) were collected to identify potential PCB containing materials inside of NBHS.

The Toxic Substances Control Act (TSCA) PCB bulk product waste definition may be found in 40 CFR § 761.3 and refers to non-liquid compounds that were originally manufactured to contain PCBs and are regulated for disposal at concentrations equal to or greater than 50 ppm. The 50 ppm regulatory limit drives disposal, not health protection. MDPH simply reported that bulk samples were taken at various times. The best data available to evaluate potential health impacts from exposure to PCBs at NBHS are indoor air data, and the MDPH evaluation of potential health effects was indeed based on indoor air data.

Comment : To better communicate the large amount of indoor air data evaluated in the report, a number of comments requested the addition of graphics or charts illustrating the data.

Response: To enhance presentation of data, Figures 7a and 7b were added to the final report to demonstrate maximum detected levels of PCBs in indoor air for each sample round in relation to the timing of remedial activity and sampling for other media (i.e., wipes, bulk). Figure 7c was added and shows disturbance of walls and baseboard areas typical of bulk sampling. For additional detail, readers are encouraged to refer back to Table 4, which lists maximum indoor air results by date and sample location, and Table 5, which lists summary results for indoor air, wipe, and bulk samples for each major sampling round.

Comment: There were a number of comments pertaining to MDPH's evaluation of the wipe samples collected by the City's contractor, TRC. Commenters wanted to know why MDPH compared wipe samples to both EPA's regulatory cleanup standard of 10 µg/100 cm^2 and the California Department of Toxic Substances Control guideline for clean up after spills in schools of 0.1 µg/100cm2. They also wanted to know if these comparison values are health- or technology-based. There was also one question that asked if there had been any effort to obtain a lower detection limit for the analysis of the wipe samples.

Response: The comments above pertain to wipe samples collected by the City's contractor, TRC. To clarify, there are no ATSDR health based comparison values for wipe data in relation to potential health effects. Wipe samples are collected for the purposes of determining areas that need to be better cleaned not for evaluating potential health effects. For completeness, MDPH provides both the California Department of Toxic Substances Control (CA DTSC) guideline for clean up after spills in schools (i.e., 0.1 µg/100cm2) as well as US EPA's regulatory clean-up standard of 10 µg/100cm2. The CA DTSC (2003) reports that their wipe guideline was derived to be protective of short and long term health impact to teachers and students. The EPA Toxic Substances Control Act (TSCA) regulatory cleanup standard (i.e., 10 µg/100 cm2) is an enforceable cleanup level applicable to low concentration PCB spills (< 1 pound PCBs by weight), and is used to determine whether more clean-up is needed, not to assess health risk (40 CFR §761.125). TRC collected the wipe samples that the MDPH reviewed; questions regarding laboratory analytical detection limits are best addressed by either TRC or the City.

Comment: "Pg 11 and forward: While soil testing was conducted, it is not possible to evaluate the soil results from the information given in this report. A map with sampling locations was not provided nor was the depth of sample collection given. Without this information, it is not possible to determine whether the decision to exclude assessment of soil PCBs entering the school via open windows or by the ventilation system was supported." "Pg 39, top. Where/how were the soil samples collected? Soil data and a sampling map should be provided."

Response: If soil contamination contributes to indoor PCB levels, the most relevant data to evaluate potential health effects from the indoor environment are indoor air data for the school, regardless of what specifically may have contributed to PCBs being detected in indoor air.

Comment: "Page 29, Paragraph 2: MDPH used 2008 CO2 data to compare to 2011 PCB indoor air data. Given the improvements previously noted with the installation of the Building Management System, more recent CO2 readings should have been collected for this comparison. Also, the 2011 PCB data were collected under unoccupied conditions."

Response: The 2nd full paragraph on page 29, describes indicators of suboptimal ventilation (i.e., supply and/or exhaust off; CO2 levels well above 800 ppm under low occupancy) noted by MDPH IAQ staff in 2008 in classrooms A-1-110 and A-1-315. The indoor air in these two classrooms was first tested for PCBs 2011. MDPH asserts that suboptimal ventilation may be affecting observed PCB levels in indoor air. If ventilation improves, PCB levels would be expected to decline. It is the understanding of MDPH that the City and School Department are working to optimize ventilation and restore use of these closed classrooms (TRC 2012c).

Comment: "The use of the carbon dioxide concentrations measured in 2008 to explain indoor air concentrations of PCBs in 2006, 2007 and 2011 is inappropriate as significant changes occurred before and after the 2008 sampling period. The City requests that MDPH revise the report accordingly. Also, the comparison of the CO2 levels to the CREG is not necessarily straightforward and does not always show a similar pattern. For instance, several rooms sampled in 2008 had PCB concentrations above the CREG with CO2 levels above 800 ppm, but there were also two rooms (A-307-3 and B-242) with concentrations of PCBs above the CREG despite having CO2 concentrations less than 800 ppm with recorded occupancy. In addition, there were also several rooms (A-205-1, A-I 10-4, and Cafeteria) where the concentrations of PCBs were below the CREG despite the fact that CO2 concentrations were above 800 ppm. The report also indicates inadequate ventilation when the CO2 levels are below 800 ppm with low or no occupancy. This was used to explain PCB concentrations above the CREG in rooms A-212/213, B-240, and B-288. But, PCB concentrations were below the CREG in rooms A-303-1, A-105-2, and D-116, and CO2 levels were below 800 ppm with low occupancy. Hence, the use of CO2 measurements to explain increases or decreases in PCB concentrations may not be appropriate based on these inconsistencies."

Response: The MDPH CO2 data provide an indication of the adequacy of air exchange in the rooms tested. The CO2 levels were not compared to any screening values (e.g., CREG). The CO2 data were simply used as a guide to indicate areas of suboptimal ventilation. Suboptimal ventilation, as stated by the MDPH in the report, may affect indoor environmental conditions including air levels of PCBs. PCB levels in indoor air would be expected to decrease with enhanced ventilation. MDPH has added an appendix (Appendix H) to report on steps that have been taken to improve the school's HVAC system as of August 17, 2012.

Comments: There were a number of comments regarding J values. Comments requested more information on what J values are and how they were used in the report. Some comments disagreed with how MDPH defined J values on page 4 at the top of the page.

Response: According to EPA's Risk Assessment Guidance for Superfund (1989), J qualifiers typically indicate a chemical is present, but its concentration is estimated. As MDPH stated in the report, J values are estimated, meaning PCBs were present, but could not be quantified.

Depending on the reason for the J qualifier, J results may be evaluated along with other detected results. MDPH evaluated J-qualified results as detected results because the City's contractor indicated these results were valid. Please note that questions pertaining to the reasons for data qualifications should be addressed to the City's contractor, TRC, which collected and submitted indoor environmental samples for laboratory analysis.

Comments: "Page 27, Paragraph 2: The text states that TO-4A is generally a more sensitive method than TO-10A. In order to avoid being misleading to the reader, it would be helpful to also note that although TO-4A is more sensitive, TO-10A is sensitive enough to achieve the project screening criteria and was utilized with the concurrence of EPA." "Why use the TO-10A method which appears to be less sensitive than the USEPA method?"

Response: MDPH added clarifying language to the report to acknowledge that the City's contractor, TRC, indicated, through direct comparison of co-located background samples (TRC 2006) that the TO-10A method was able to achieve the concentration range expected based on 2006 sampling conducted using TO-4A by the City's previous contractor, BETA Inc. The following language was added to the report for clarification: "The pilot testing of method TO-10A through comparison of co-located background sample results indicated the TO-10A method was sensitive enough to achieve project criteria and approved for use by USEPA." For questions regarding method selection and the rationale for using TO-10A for collection of indoor air samples, the MDPH suggests comments be referred to TRC, which collected the data in collaboration with EPA approval.

Comment: "In this health consultation, the PCBs language is further complicated by the use of both congener-specific and Aroclor language. These terms should be clearly defined and the justification for considering one versus the other given."

Response: The MDPH reviewed the available indoor environmental sampling data from the City's contractors, for which different media were analyzed by different methods (i.e., bulk and wipe samples were analyzed for Aroclors; indoor air mainly for homologues). The terms "congeners," "homologues," and "Aroclors" were introduced and defined in the second two paragraphs under the section entitled, "Quantitative Evaluation of Potential Health Risks from Opportunities for Exposure to PCBs." For further clarification, the terms "Aroclor", "PCB congener", and "PCB homologue" have been added to the glossary in the appendix of this report. To determine why one method was used over another, questions are best directed to the City or TRC.

Comment: "Page 28, Paragraph 1: The text refers to 11 rooms with CO2 levels below 800 ppm. However, the text incorrectly states that 8 of the 11 rooms had no or low occupancy. This should be 7 of the 11 rooms instead, as rooms A-3-205, A-3-307, B-309, and B-242 had occupants."

Response: It is accurate that 8 of the 11 rooms had no or <u>low</u> (i.e., 7 or less, B-242) occupancy. Typically the MDPH would consider occupancy less than 50% to be low occupancy. The following language was added to the report to clarify: "The MDPH typically considers occupancy less than 50% of the typical occupancy of a given area to be low occupancy."

Comment: "Pg. 7: References for values such as EMEGs and CREGs should be provided. Why were these values used? Why weren't the US EPA's risk-based concentrations (RBCs) for residential or industrial air (~1 x 10-2 – 2 x 10-3 µg/m3) for individual congeners used for screening? It appears that many of the air measurements at the school would be in exceedance of these values."

Response: As a public health agency, the MDPH uses scientifically peer-reviewed screening values derived by the federal public health agency, ATSDR, including Cancer Risk Evaluation Guides (CREG) and Environmental Media Evaluation Guides (EMEGs). As stated in the report, ATSDR has derived a CREG of 0.01 µg/m3 for total PCBs in indoor air. ATSDR does not have an EMEG for PCBs in air. Further, as noted in the report, the majority of the indoor air measurements at the school were in exceedance of the CREG, triggering further evaluation. The MDPH reviewed available indoor air data provided by the City's consultants, which were primarily reported as total PCBs, not PCB congeners; hence, the ATSDR screening value for total PCBs, i.e., the CREG, was used for the MDPH evaluation. As stated in response to a previous comment, the ATSDR CREG (0.01 µg/m3) for total PCBs in indoor air is more conservative (i.e., health protective) than the US EPA's action level (0.05 µg/m3).

Comment: "Page 58, The City notes that the BETA sampling results, noted as 'the lowest' were also the smallest data set (6 samples). Later sampling efforts conducted by the City were larger and representative of more of the interior space than the initial work undertaken by BETA."

Response: The MDPH agrees that the BETA 2006 indoor air sampling event was smaller in scope compared to other sampling events, however, this round of sampling did have the lowest maximum detection of all sampling rounds, as stated.

Comment: "Page 29, Paragraph 1: The text refers to room A-3-307 having a higher concentration of PCBs in February 2011 (0.139 µg/m3) than February 2008 (0.085 µg/m3). These two concentrations are not significantly different under the accuracy and precision limits of the analytical method. It is inappropriate and misleading to highlight this as a significant increase or try to explain the reasoning for this very slight increase."

Response: The MDPH noted the difference in indoor air levels in room A-3-307 from February 2008 (0.085 J µg/m3) to February 2011 (0.139 J µg/m3) as an "increase," which simply describes the data provided by the City's contractor. Both results are above the ATSDR CREG (0.01 µg/m3). Also noted by MDPH is the fact that an impacted light fixture tray was removed from this room in April 2011. MDPH further notes that April 2011 indoor air sampling data for this room (not available at the time the draft for public comment was released) indicates another increase in PCB level (0.167 µg/m3; non-J value; sampled 4/21/11). Of note, all impacted light fixture trays were removed by 4/19/11, just a couple of days before sampling. PCB levels in this room decreased to 0.0683 µg/m3 in August 2011, several months after the impacted light fixture tray was removed, supporting the overall MDPH conclusion that disturbance of PCB impacted materials for testing/removal in close proximity to the timing of indoor air sampling may have affected the levels observed in indoor air. The following language was added to the report to clarify: "Follow up indoor air testing two days after the light fixture tray was removed in A-3-307 indicated another increase, indicating the timing of the sampling so close to disturbance of the PCB containing materials may have impacted results. PCB levels in this room then decreased in August 2011, several months after the impacted light fixture tray was removed."

In addition, the following summary of April and August 2011 indoor air data was added to the report (data was not available at time of public comment report release): "The results of the April 2011 round of indoor air sampling (9 samples, including duplicate) ranged from ND (<0.00347 µg/m3) in room A-4-212 to 1.25 µg/m3 in room A-1-315. Although the overall maximum PCB level in indoor air was down in April 2011, the highest detections of PCBs in this round were found in the 4 rooms with PCB containing light fixture trays that were removed right before testing (i.e., A-1-110, 0.851 µg/m3; A-1-315, 1.25 µg/m3; A-2-203, 0.343 µg/m3; and A-3-307, 0.167 µg/m3) and in another room (i.e., A-2-311, 0.225 µg/m3). Eight rooms sampled in April 2011 (including the 5 rooms above), another 3 rooms that were sampled in February 2011 but not April 2011, and locker 1579 were all re-sampled in August 2011 after remedial work (e.g., bulk removal of remaining PCB impacted light fixtures, paint, auditorium seating). All sample results from the August 2011 round had detectable PCBs, ranging from 0.00536 µg/m3 to 0.577 µg/m3 (TRC, 2011h). Of the 4 rooms with impacted light fixtures that were removed immediately before the April 2011 round, August 2011 PCB levels decreased in 3 of these rooms (i.e., A-1-110, 0.411 µg/m3; A-1-315, 0.577 µg/m3; and A-3-307, 0.0683 µg/m3) and increased slightly in room A-2-203 (i.e., 0.564 µg/m3) (TRC, 2011h). Rooms A-1-110, A-1-315, and A-2-203 remain closed. In 2012, adjustments were made to the ventilation system to increase air exchange in room A-2-203, and re-sampling was conducted in April 2012 with results of 0.343 µg/m3 and 0.383 µg/m3 (duplicate) (TRC, 2012a). Univent air filters were changed, ceiling tiles were removed/replaced, and all moveable furniture was removed in this room before an additional sample event in July 2012, with results of 0.559 µg/m3 and 0.526 µg/m3 (duplicate) (TRC, 2012a). It is unclear why levels continue to fluctuate in room A-2-203, but, as noted above, remedial activity has been ongoing. It is the understanding of MDPH that the status of rooms A-1-110 and A-1-315 are pending further ventilation system assessment and adjustment (TRC, 2012b)."

Comment: "In several places throughout the report, the text states that the indoor air results for total PCBs from the BETA April 2006 sampling round ranged from 0.0043 – 0.0519 µg/m3. The lowest concentration detected during the BETA April 2006 sampling round was 0.000013 µg/m3 at location IAQ-4 (House 2 Hallway). Please revise accordingly." "Table 5, April 2006, Revise the range of PCBs detected to 0.000013 – 0.0519 µg/m3. The lowest concentration detected during the BETA April 2006 sampling round was 0.000013 µg/m3 at location IAQ-4 (House 2 Hallway)."

Response: MDPH carefully reviewed data available from the City's contractors, including the above referenced data set from BETA (2006). According to Table 1 of the BETA indoor air results (BETA 2006), the laboratory reported that a field blank used for QA/QC purposes had detected target compounds while sample IAQ-4 did not, suggesting potential contamination. A laboratory traceback was conducted and no laboratory inconsistencies were identified. As stated in the BETA (2006) report by Wilcox & Barton, Inc., retained by BETA to review indoor air data: "*As noted in the laboratory report and conveyed to me by Dave Billo, LSP, of BETA, it is probable that the labels for samples FB-1 and IAQ-4 were switched prior to analysis, so results for FB-1 are taken to represent indoor air concentrations at IAQ-4 and results for IAQ-4 are taken to represent the field blank.*" In addition, the City's second contractor, TRC reported in their summary of BETA's indoor air data: "*The concentrations of total PCBs found in NBHS indoor locations by BETA ranged from 0.0043 micrograms per cubic meter (µg/m3) to*

0.0519 µg/m3." (TRC 2006). Hence, MDPH reported the concentration range from lowest to highest as 0.0043 µg/m3 to 0.0519 µg/m3.

RESULTS: PCB EXPOSURE ASSESSMENT

Comment: There were a number of comments regarding a discrepancy between the text of the report and MDPH's theoretical cancer risk calculations in Appendix D. The text of the report stated that MDPH assumed a worst case scenario, and that the maximum detected PCB concentration of 1.45 µg/m3 was used to conduct exposure dose and theoretical cancer risk calculations; however, the calculations shown in Appendix D indicated that a concentration of 0.31 µg/m3 was used.

Response: The MDPH used the maximum value of 1.45 (J) µg/m3 for estimating a worst case scenario, as stated in the narrative of the public comment report. When the draft report was released for public comment, a revised Appendix D was inadvertently left out. The inadvertent inclusion of Appendix D that had not been revised did not affect the results of the cancer risk assessment that were reported in the report narrative as the report contained the correct results of cancer risk estimates. The correct version of Appendix D appears in this final report.

Comment: There were a number of comments that asked why risk calculations were not completed for the children at the daycare located in room A-4-227. Also, commenters asked why risks from incidental ingestion and noncancer risks for Aroclor 1254 and 1016 were not evaluated.

Response: As stated in the Methods section of the report, to evaluate potential health concerns that may be associated with exposure opportunities to PCBs at NBHS, health-based screening values, called comparison values, were used for initial comparison. If a concentration of a chemical is greater than the appropriate comparison value, the potential for exposure to the chemical is further evaluated to determine whether exposure is occurring and whether health effects might be possible as a result of that exposure; however, the indoor air results for the daycare room (A-4-227; 0.00763 J µg/m3, 0.0054 J µg/m3, and 0.0035 U) were well below the ATSDR CREG (0.01 µg/m3) or non-detect and hence were unlikely to present health effects.

MDPH could not assess cancer or non-cancer risks from Aroclor 1254 and 1016 because indoor air samples were not analyzed for Aroclors. Only wipe and bulk samples (e.g., paints, mastics, etc.) were analyzed for Aroclors, and these samples were collected for regulatory and remediation purposes, not for the purpose of assessing potential health risk. MDPH did not evaluate incidental ingestion because results from wipe and bulk samples are used to determine cleaning efficacy, not for purposes of assessing health risk. Exposure opportunities to PCBs and health risks are best addressed by indoor air data.

Comment: "Why wasn't the EPA IRIS slope factor for inhalation (0.4 per mg/kg-dy) used?

Response: The ATSDR CREG (0.01 µg/m3) that was used for screening of the indoor air results is derived by dividing the target risk (i.e., 1 x 10-6) by the EPA inhalation unit risk (i.e., 0.0001 µg/m3), thus, already taking into account EPA values. The slope factor cited in this comment (i.e., 0.4 per mg/kg-dy) is considered the middle reference point by EPA in estimating cancer risk according to the documentation in support of EPA IRIS values (EPA 1996). The MDPH used the more conservative (i.e., health protective) cancer slope factor of 2 per mg/kg-dy as recommended by EPA as the upper reference point (EPA 1996). Note that the choice of the more conservative ATSDR value is based on the MDPH's experience conducting evaluations of similar scenarios in schools and other buildings in Massachusetts.

RESULTS: PCB BLOOD/SERUM TESTING

Comment: A number of comments suggest that, to be consistent with the Patterson paper that reports CDC's summary of the results of the NHANES serum PCB analyses, MDPH should sum dioxin-like congeners detected in serum samples separately (Patterson 2009).

Response: MDPH's evaluation of New Bedford participants' serum PCB levels was conducted in a manner that was consistent with the goal of the serum PCB testing offer; to determine if school staff and students at New Bedford High School and Keith Middle

School had elevated serum PCB levels compared to the U.S. population based on comparison with CDC's reference ranges for the general U.S. population.

New Bedford results were compared with the sum of the 15 most commonly detected congeners from NHANES 2003-2004 as provided to MDPH by CDC for this purpose. A total PCB concentration was calculated for each of the New Bedford participants by summing the concentrations of the 15 most commonly detected congeners following NHANES methodology. These congeners also include a sub-set of the dioxin-like congeners (105, 118, and 156). Thus, the approach used by MDPH to calculate total PCB concentrations is consistent with CDC's approach; hence no revision was made to the report.

Comment: "…the comprehensibility of the report would be greatly improved by: (i) the addition of a clearly written executive summary, (ii) a glossary defining key scientific and technical terms (e.g., 95% confidence interval, congeners, SIRs), … and (iv) clear graphics summarizing the biomonitoring data and providing comparative values such as the NHANES median values." (Note: Part iii of this comment is addressed separately on pages 5 and 6 of this Appendix.)

Response: An executive summary, a glossary, and graphs (Figures 8 through 15) have been added to the report.

Comment: "Page 8, first paragraph: the report describes an exposure assessment questionnaire. It would be helpful to see a copy of the questionnaire used and referred to in this paragraph. Could a copy of the questionnaire be included in an additional appendix?"

Response: The exposure assessment questionnaire has been used many times over the years to test industrial contributions to PCB exposures. To reduce the potential for introducing bias and other concerns, MDPH/BEH has a policy against distribution of such questionnaires. It should be noted that the report does provide information on the general categories of information gathered using the questionnaires (see page 11 of the report). No revision to the report was warranted based upon this comment.

Comment: "Page 41, section entitled PCB Blood/Serum Testing: as mentioned in prior comments, it would be helpful if the report clearly indicated the timeline for when blood was drawn for the testing, when the analysis was done, and explained the impact, if any, of the passage of time on the blood test results."

Response: The following language has been added to the Methods section of the report: MDPH began offering blood draw appointments in February 2009 and SLI completed testing of blood samples in February 2010. Consistent with good laboratory practice, samples were stored frozen until ready for analysis. According to the National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM), Method 8004, PCBs in serum are stable indefinitely if frozen. Additionally, according to a personal correspondence with CDC's Dioxin and Persistent Organic Pollutants Laboratory, it has been their experience that PCBs in Quality Control samples (serum spiked with known quantities of PCBs) are stable for 2 – 5 years, the amount of time they use these QC samples. Thus, we would not expect any effect related to the time between collection and analysis on serum PCB levels for NBHS participants.

Comment: "Pg 43 and forward: The serum data for the New Bedford residents does not appear to have been included in the report for the sections where the 95th percentile NHANES are given."

Response: The range of serum concentrations detected for the participants was provided instead of providing the 95th percentile value. It was felt that providing the maximum concentration detected was more useful than providing the 95th percentile. As noted in the report, all serum PCB concentrations were below the 95th percentile concentration for the US population for the relevant age groups. No revision was made to the report.

Comment: "Pg 45: The approach used to evaluate serum PCB levels and years worked at NBHS is not justified and does not seem to be the most useful approach. What is the basis for splitting "years worked" this way? Why not do a regression analysis? Why jump from medians to means to geometric means?"

Response: Serum PCB sampling was offered as a public service to address community concerns about opportunities for exposure to PCBs at NBHS. Thus, the testing offer was not designed as a study, where participation, for example, might have been restricted to randomly selected school staff and students. MDPH believed that it was important to evaluate any potential relationship between length of employment and serum PCB levels. MDPH took the midpoint (or median) of the range of length of employment at NBHS to compare serum PCB levels in two groups (less than or equal to the median years worked versus more than the median years worked). As noted in the report, these data did not show a consistent pattern of higher serum PCB concentrations with more years worked at NBHS, and they suggest that employment at NBHS was not a primary indicator of serum PCB levels. No revision to the report was warranted.

Comment: "Pg 9: The analytical method and QA/QC procedures used by SLI should be described. Given that the results from this lab are being compared to CDC's results, there should be evidence to support comparability of the two labs' methods and results."

Response: The following language was added to the Methods section of the report: The method for determination of PCB congeners was developed at CDC and transferred to the SLI. The standard operating procedure (SOP AC.012) for determination of PCB congeners in human serum details a solvent extraction, silica gel clean-up and dual capillary column gas chromatographic analysis with electron capture detection.

Quality assurance measures for the method include the analysis of reagent blanks that are monitored for contamination and subtracted from the samples in each run; the analysis of fortified serum samples, the results of which are plotted on lot & instrument specific quality control charts for review to determine compliance with acceptance criteria for the batch; and individual sample fortification with surrogate analytes that are evaluated for compliance with acceptable recovery criteria. Other batch specific controls include criteria for the calibration curve and internal standard recovery.

Comment: "Pg 10: The CDC National Exposure Report does not sum the most common 15 congeners but rather presents data for each individual congener. Patterson et al. sum 35 congeners. If this report is summing fewer congeners, then it is not unreasonable to expect that the overall values would be lower than those reported by Patterson et al." "Pg 43, top: Where did the value of 30.8 ppb come from? I search Patterson et al. and did not find this value. If it is derived from summing the data in CDC's National Exposure Report, then this should be clearly stated…

Response: In previous MDPH serum PCB blood sampling efforts, CDC had advised that the most appropriate way to compare the data is to take the most common 15 congeners identified in NHANES that were also identified in participants and compare those congeners.

New Bedford results were compared with the sum of the 15 most commonly detected congeners from NHANES 2003-2004. These NHANES summary statistics (e.g., 30.8 ppb) were provided to MDPH by CDC to aid in the interpretation of serum PCB results. No revision was made to the report.

Comment: There were several comments requesting more information about the treatment of non-detects in the calculation of participants' total serum PCB concentrations.

Response: The following language was added to the Methods section of the report: To calculate total PCB concentrations, as well as summary statistics such as geometric means and percentiles, CDC assigns sample results that were not detected above the method's limit of detection (LOD) a value equal to the LOD divided by square root of 2. New Bedford participants' individual serum PCB results, as well as summary statistics (e.g., geometric means and percentiles) were calculated using this method to be comparable to CDC summary data.

Comment: "Pg 43 and forward: Why use the language "median/50th percentile"? Pg 45: Why jump from medians to means to geometric means?"

Response: The term 50th percentile was used because the report also discusses the 95th percentile, based upon NHANES terminology; however, the term median, which is the same as 50th percentile, is more familiar to most people, and hence MDPH used both terms for clarity.

The median serum PCB levels for each age group were calculated for comparison to NHANES median levels used to characterize a population. Geometric means (another statistic used by NHANES for comparison purposes) were calculated by MDPH to compare different groups (e.g., comparisons of serum PCBs levels based on years worked at NBHS). According to CDC, a geometric mean provides a better estimate of central tendency than the arithmetic mean for data that are distributed with a long tail at the upper end of the distribution. This type of distribution is common in the measurement of environmental chemicals in blood or urine. No other averaging statistic (e.g., arithmetic mean) was used in the evaluation of serum PCB results. No revision was made to the report.

Comment: There were several comments requesting additional information on how MDPH conducted its qualitative comparison of congener patterns between New Bedford participants and NHANES data.

Response: MDPH added information in the report regarding the qualitative evaluation of congener patterns to the Methods and Results sections of the report and has added example congener pattern graphs to the Figures section of the report (Figures 12 and 13).

The additional language added to the Methods section is as follows: For the qualitative congener pattern evaluation, MDPH visually compared the distribution of percent contribution of the 35 congeners most commonly seen in serum and analyzed by SLI for all New Bedford participants, individually and as a group, to the percent contribution of these congeners for all ages from the NHANES data. In addition, a subset of sample results was submitted to CDC for review to confirm that individual differences noted were within the range typically seen.

The additional language in the Results section is as follows: In this report, data have been provided on total PCBs based on summing the most frequently detected 15 congeners. Figure 12 shows the distribution of percent contribution of the 35 congeners most commonly seen in serum and analyzed by SLI for all New Bedford participants. Percent contributions are also provided in Figure 13 for all ages from the NHANES data. The congener patterns observed in New Bedford and NHANES are similar, suggesting similarities with what is found in the U.S. population. In addition, individual congener patterns were reviewed and a subset of sample results was submitted to CDC for review to confirm that individual differences noted were within the range typically seen. CDC noted that the congener patterns of NBHS staff and students appeared to be typical;

suggesting that exposure in the NBHS participants appeared similar to those of the general U.S. population.

Comment: "Page 29, reference to table 4: table 4 indicates that in some cases, maximum levels of PCBs were detected as late as 2011. Individuals who participated in the serum PCB blood tests had their blood drawn in the spring of 2009. Building occupants may wonder whether the analysis of PCB serum levels that predated the maximum detected PCB levels in the building provide an overly optimistic (i.e., lower) result. In addition, building occupants may wonder whether, because their blood was drawn more than two years before the MDPH report was completed, their exposures to PCBs was actually greater than is reflected in the blood serum level results presented in this report. Without retesting all building occupants, it is impossible to know whether PCB exposures between 2008 in 2011 would have contributed to higher PCB serum levels. However, it would be helpful if MDPH could offer an explanation of the impact or lack thereof on the significant passage of time between drawing blood and the analysis of the blood test results."

Response: Serum levels of PCBs reflect accumulated exposure over many years and studies have shown that concentrations of PCBs in serum generally increase with age, largely through dietary exposure to PCBs. It is important to stress that there was no consistent pattern of increasing serum PCB levels with increasing years of employment at NBHS; therefore, we would not expect any appreciable rise in serum PCB levels based upon occupancy.

Air samples collected in February 2011 showed that 23 of 48 samples from throughout the school were non-detect for PCBs. In addition, samples were taken from 20 of 26 locations sampled in 2008. Of these 20 locations, 15 locations had similar or lower levels of PCBs in indoor air in 2011, compared to 2008. These data indicate that we would not expect serum PCB results to be markedly different had serum samples been taken in 2011. No revision was made to the report.

Comment: "It should also be made clear that NHANES data give reference ranges for exposure, but do not provide information on risk."

Response: MDPH agrees with this comment and the following language was added to the Methods section of the document: "The goal of the blood sampling offer was to determine if school staff and students at New Bedford High School and Keith Middle School had elevated serum PCB levels compared to the U.S. population based on comparison with CDC's reference ranges for the general U.S. population. According to CDC, biomonitoring studies of serum PCBs can provide physicians and public health officials with data to evaluate whether individuals have been exposed to higher levels of PCBs than the general population. The measurement of an environmental chemical, including PCBs, in a person's blood or urine does not by itself mean that the chemical causes disease or say anything about potential risk."

Comment: Three comments were submitted regarding the comparison of serum PCB testing results of NBHS staff and students to the U.S. CDC's NHANES data. Comments requested information about why NHANES was an appropriate data set for this comparison and if PCB congeners included in NHANES are the same as the PCB congeners detected in indoor environmental samples from NBHS.

Response: Due to NHANES stratified random sampling design and large sample numbers, this survey provides the most representative biomonitoring data for the general U.S. population available. Thus, NHANES is the most appropriate reference range to compare with results from a specific population (such as the NBHS community). NHANES data are used by public health and medical professionals across the country for these types of comparisons.

Because the vast majority of indoor environmental samples collected from NBHS, by the City's contractors Beta and TRC, were not analyzed for individual congeners, there is insufficient information to determine what specific congeners are most prevalent in the indoor environment at NBHS or to compare the most prevalent congeners with the NHANES congener list.

As emphasized in this report, diet is the main source of exposure for the general population. This observation was true of the general New Bedford population, based upon previous MDPH studies. BEH qualitatively compared the specific congener pattern for New Bedford participant results to what is typically seen in the U.S. population based on the latest NHANES data (2003-2004). The congener patterns observed in New Bedford and NHANES are similar, suggesting that the exposure patterns are similar to those of the general U.S. population.

Language from the first paragraph of this response was added to the Methods section of the report.

Comment: "Pg 47, KMS: Please clarify which health-based comparison values were used."

Response: As stated in the report, air sample results were compared with the ATSDR CREG of 0.01 $\mu g/m^3$. No revision was made to the report.

Comment: "Pg 46, building location: This section is problematic. There are so few measurements that it is unlikely that any useful results could be obtained from this type of assessment. For example, there are no data to shed light on temporal variability. At the very least, the limitations of this assessment should be spelled out." "Pg 48, top: This assessment is complicated by the fact that there may be individuals with both KMS and NBHS exposures plus age as a confounder (i.e., an individual could be younger but have worked at KMS longer). Limitations with this analysis should be described."

Response: These comments refer to MDPH's evaluation of serum PCB data versus years worked at NBHS. While we agree that the numbers are small, they were the only data available to answer the questions regarding employment in the building and risk of exposure to PCBs. The following statement of limitations was included in the original public comment version of the report at the end of the sections *Serum PCB Levels Compared with Years Worked at NBHS* and *Serum PCB Levels Compared with Years Worked at KMS*. "It should be noted that the ability to discern differences between the groups is difficult because of the small number of participants and the likely contributions to serum PCB levels by other factors (e.g., fish consumption)." However we believe our evaluation provided useful information that did not suggest that PCB levels were markedly different among those who worked longer at the school versus those who did not. Additionally, no confounding by age is expected because comparisons were made by age group. No revision was made to the report.

Comment: "Pg 46: Other factors most certainly contribute to serum PCBs, but data on some of these factors were collected as part of the questionnaire portion of the study. Why not utilize the questionnaire data?"

Response: An exposure assessment questionnaire was administered to all participants of the blood serum PCB testing offer. The exposure assessment questionnaire was designed to obtain information on risk factors that are known to or may affect serum PCB levels (e.g., age, fish consumption, occupational exposures), as well as information on school-specific factors, such as years of employment at NBHS.

Information collected by this questionnaire was used to evaluate serum PCB results. In particular, information regarding age, place of residence, and location and length of employment of school staff were evaluated in the report. Information, including diet, other occupational exposures, and specific routes of exposure related to the PSWS were also evaluated on an individual level on a case-by-case basis. The Methods section of the report was updated to include information on how the questionnaire data was used.

Comment: Three comments were received requesting an explanation for the selection of the 95th percentile of the NHANES data as the comparison value for the blood serum PCB results. One comment asked why the 50th percentile was not selected as the comparison value.

Response: As mentioned previously, the NHANES survey is designed to provide biomonitoring data that is representative of the general U.S. population.

The following language was added to the Methods section of the report: Due to differences among individuals, you would expect to see a range of serum PCB levels in the general population. The range of concentrations reported by NHANES provides health professionals with information on the degree of variation that can be expected in the general population. According to the U.S. CDC, the 95th percentile is useful for determining whether serum PCB levels are unusual. Based on this guidance from CDC, an individual with serum concentrations above the 50th percentile but below the 95th percentile is within the typical level of variation seen in the general U.S. population.

Thus, MDPH used the 95th percentile value for comparison with the participants' serum PCB results.

RECOMMENDATIONS

Comment: The city of New Bedford submitted a number of comments providing information on actions already taken to address recommendations made by MDPH in its Public Comment Release draft of this report (dated September 27, 2011). In response to these comments, Appendix H was added to the final report to summarize information provided by the city on these actions. Additionally, the following recommendation was added to the final report: "As requested, the MDPH/BEH Indoor Air Quality Program will conduct a follow-up inspection of the NBHS."

TABLES

Comment: Three comments were received commenting that the wipe sample units in Table 5 should be revised to µg/100 cm2.

Response: Wipe sample collection methods to satisfy regulatory clean up requirements typically use a 10 cm by 10 cm template for surface area. Per TRC's account (2006) some wipe surface areas (e.g., pipes, non-flat surfaces) were not uniform, thus more qualitative. TRC stated (2006*):* "*Wipe samples collected for compliance monitoring purposes are typically collected using a 100 cm2 acetate template. However, in this application, many of the locations targeted for wipes had unusual configurations (e.g., interiors of floor drains, difficult to access void spaces beneath lockers, heater coils, etc.); therefore, with concurrence from the EPA representative on-site the wipe samples were collected for non-quantitative diagnostic purposes to help evaluate the presence or absence of PCBs in an area or on a surface.*" Therefore, the MDPH used wipe units of "µg/wipe" in Table 5. Although "per wipe" generally refers to a standard 100 cm2 wipe surface area, these wipes were used for qualitative purposes since a uniform surface area could not be established in some areas, hence, 100cm2 was not used as the denominator for wipe units by the MDPH.

Comment: Two comments were received from the city of New Bedford requesting that information be added to Table 5 to make it clear that EPA Method TO-4A was used to analyze background samples only; while EPA Method TO-10A was used to analyze all field samples.

Response: The MDPH will add this additional information to clarify per the City's request, however, this added detail does not change any of the conclusions or other information presented in this report.

Comment: "February 2008: Revise to show 26/28 detects in indoor air."

Response: Based on a review of TRC's letter report *Results of February 2008 Polychlorinated Biphenyl Air Monitoring New Bedford High School* (2008b), MDPH notes there were actually 23/28 detects in indoor air. Table 5 has been updated to reflect this information.

APPENDIX H

Status/Responses to MDPH Recommendations

In response to the September 2011 release of the public comment draft of this report, the City of New Bedford reported on a number of steps that had been taken to address MDPH/BEH recommendations. In addition, State Senator Mark C. Montigny and Representative Antonio Cabral, asked the MDPH/BEH to return to NBHS on August 17, 2012 to conduct a visual inspection of actions undertaken by the City of New Bedford at the school since the time of the City's response to the September 2011 report. This Appendix contains specifics on what the City reported in its comments on this report, as well as MDPH/BEH staff observations from August 2012. The original MDPH/BEH recommendation contained within this report [referenced as "MDPH/BEH Recommendations (September 27, 2011)"], is listed below along with responses from the City of New Bedford on the original 2011 recommendations [labeled "City of New Bedford Update (November 8, 2011)"], and MDPH/BEH's recent observations [identified as "MDPH/BEH Follow-Up (August 17, 2012)"].

The recommendations provided (MDPH/BEH Report Recommendation (September 27, 2011) correspond to recommendations as numbered in the original report. The City of New Bedford did not provide responses to all of the recommendations. Only those warranted responses were included in the Appendix.

Recommendations Specific to PCB Exposures

2. **MDPH/BEH Report Recommendation (September 27, 2011):** Burnt out bulbs in light fixtures that may still contain PCB residues should be replaced as soon as they go out. MDPH has worked with other schools in the Commonwealth to develop ongoing operations and maintenance plans (O&M) to address cleaning and replacing bulbs (see Appendix F for MDPH 2009 guidance). It is also our understanding that plans were underway to replace all PCB-containing ballasts during the summer of 2011. Additional bulk sampling in the school is not recommended.

   City of New Bedford Update (November 8, 2011): All PCB-impacted fixtures (including any remaining PCB-containing ballasts) were reportedly removed from the building as part of remedial work conducted during summer 2011.

   MDPH/BEH Follow-Up (August 17, 2012): based on reports filed with the Department of Environmental Protection, PCB-containing ballasts were identified and removed.

Recommendations Specific to Lead, Mercury, and Other Chemicals

4 **MDPH/BEH Report Recommendation (September 27, 2011):** Until further sampling is conducted to characterize lead contamination in the firing range (D-143), access to that room should be restricted to remediation personnel only.

City of New Bedford Update (November 8, 2011): Access to the firing range (D-143) has been limited to accessing the storage locker since mid-October 2011 until sampling indicates whether remediation is necessary.

MDPH/BEH Follow-Up (August 17, 2012): MDPH received and reviewed a "Lead Dust Sampling" report conducted by Triumvirate Environmental, Inc (Triumvirate) for the New Bedford Public Schools. Sampling was conducted on January 27, 2012. As reported by Triumvirate, "elevated lead in dust is present in the firing range on horizontal surfaces, in the dust work associated with exhausting air to the firing line, adjacent office areas and classroom D-136 and in the corridor outside of the Jr. ROTC department and stairwell." Based on these reports, the MDPH recommends that access to the firing range continue to be restricted as well as access to the surrounding areas until remediated appropriately.

5. **MDPH/BEH Report Recommendation (September 27, 2011):** Conduct further sampling in Room D-143 to determine lead levels in units of milligrams (mg) of lead dust per square foot of surface area. Remediate lead in conformance with U.S. EPA standards, or if planned for use for food preparation or eating, in conformance with Department of Labor Standard (DLS) guidelines.

City of New Bedford Update (November 8, 2011): Ductwork in the firing range was remediated in 2007 during the vent cleaning project and the lead impacted material was removed from the exhaust vent system.

MDPH/BEH Follow-Up (August 17, 2012): See MDPH Follow-up response to recommendation 4.

7. **MDPH/BEH Report Recommendation (September 27, 2011):** Replace mercury-containing thermometers with less toxic alternative (e.g., mineral sprits, alcohol). Conduct a thorough inventory for any other mercury-containing devices and dispose of them in accordance with all local, state and federal regulations.

City of New Bedford Update (November 8, 2011): NBHS's headmaster reported that a school-wide removal of mercury-containing products has occurred since MDPH's original 2008 visits.

MDPH/BEH Follow-Up (August 17, 2012): No mercury-containing products were observed in room B-311, the location where a mercury-containing thermometer was originally observed by MDPH inspectors.

8. **MDPH/BEH Report Recommendation (September 27, 2011):** Use VOC-containing products in a properly vented area. Store all flammable materials in a flameproof cabinet.

   City of New Bedford Update (November 8, 2011): This recommendation is reportedly being addressed on an ongoing basis by the School Department.

10. **MDPH/BEH Report Recommendation (September 27, 2011):** Discontinue the use of air fresheners in classrooms and restrooms in order to avoid respiratory irritation from chemicals contained in the products.

    City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

Recommendations Specific to the Pool Area

12. **MDPH/BEH Report Recommendation (September 27, 2011):** Consult with a ventilation engineer concerning the repair and operation of the pool exhaust system. The pool exhaust system should be operating 24 hours a day to remove water vapor and chlorine odors from the building. If not operable, this system should be repaired to ensure pool moisture and odors are vented out of the building.

    City of New Bedford Update (November 8, 2011): This recommendation is under review by the School Department and the Department of Environmental Stewardship.

    MDPH/BEH Follow-Up (August 17, 2012): MDPH/BEH/IAQ staff could not detect any associated pool odors in any location of the school other than inside the pool and its locker rooms. NBHS facilities staff reported that repairs to the pool's ventilation system have been made, and the system now functions appropriately.

13. **MDPH/BEH Report Recommendation (September 27, 2011):** Seal all breaches to the exterior wall of the pool area with an appropriate material to prevent stairwell air

penetration. Consider consulting a building engineer for advice on the best methods for sealing this wall.

City of New Bedford Update (November 8, 2011): This recommendation is under review by the School Department and the Department of Environmental Stewardship.

MDPH/BEH Follow-Up (August 17, 2012): Breaches in the pool wall were sealed with expandable foam, preventing moisture and associated pool treatment odors from entering the stairwell and hallway beyond the pool area.

14. **MDPH/BEH Report Recommendation (September 27, 2011):** Clean visible surface mold from door frames in pool area (Picture 22) with an appropriate antimicrobial.

    City of New Bedford Update (November 8, 2011): The mold shown in Picture 22 was reportedly removed. Other mold in the building is being addressed as soon as it is identified.

    MDPH/BEH Follow-Up (August 17, 2012): No mold was observed on doorframes to doors in the pool area nor other areas inspected by MDPH staff.

Recommendations Specific to the HVAC System

15. **MDPH/BEH Report Recommendation (September 27, 2011):** Operate all ventilation equipment when the building is occupied. Use openable windows to supplement fresh air in classrooms.

    City of New Bedford Update (November 8, 2011): All unit ventilators, HVAC, and AC units operate during the school day; NBHS staff adjust programming for ventilation during after-school activities daily to ensure adequate airflow.

    MDPH/BEH Follow-Up (August 17, 2012): Univents were operating in all classrooms inspected, except those that were manually turned off likely due to school not being in session. Univents that were turned off were reactivated by NBHS facilities staff during our visit; these units were functional. On August 17, 2012, MDPH did not observe blockages; however, it would be important to reaffirm the need to keep Univents exhaust vents clear during the school year.

16. **MDPH/BEH Report Recommendation (September 27, 2011):** Remove all blockages from univents and exhaust vents to ensure adequate airflow.

City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

17. **MDPH/BEH Report Recommendation (September 27, 2011):** Clear plant debris from subterranean univent air intakes; inspect periodically.

    City of New Bedford Update (November 8, 2011): This recommendation is under review by the School Department and the Department of Environmental Stewardship.

    MDPH/BEH Follow-Up (August 17, 2012): As reported by NBHS facilities staff, the grates covering the fresh air intake pits had been welded shut many years ago. In response to the MDPH/BEH recommendation, the welded grates were unsealed. All debris was removed down to the stone lining the bottom of the pits.

20. **MDPH/BEH Report Recommendation (September 27, 2011):** Install pleated disposable filters in univents and AHUs. Clean/change filters in HVAC equipment as per the manufacturer's instructions or more frequently if needed.

    City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

    MDPH/BEH Follow-Up (August 17, 2012): The original cut-to-fit filters were replaced with disposable pleated filters

21. **MDPH/BEH Report Recommendation (September 27, 2011):** Ensure ACs have filters. Clean/change filters in ACs as per the manufacturer's instructions or more frequently if needed.

    City of New Bedford Update (November 8, 2011): All AC units have filters; these filters are changed at least twice per year.

23. **MDPH/BEH Report Recommendation (September 27, 2011):** Use openable windows in conjunction with classroom univents and unit 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.

    City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

24. **MDPH/BEH Report Recommendation (September 27, 2011):** Inspect classroom/restroom exhaust motors and belts for proper function. Repair and replace as necessary.

City of New Bedford Update (November 8, 2011): NBHS' engineers reportedly check the 111 exhaust fans on the roof twice a year and when problems are noted.

MDPH/BEH Follow-Up (August 17, 2012): As stated in the MDPH response to recommendation 15, univents appeared to be operating/functional at the time of the August 2012 visit.

25. **MDPH/BEH Report Recommendation (September 27, 2011):** Close classroom doors to maximize exhaust capabilities and increase air exchange.

City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

26. **MDPH/BEH Report Recommendation (September 27, 2011):** Repair and use exhaust ventilation system for all laboratories and shop activities as needed.

City of New Bedford Update (November 8, 2011): All exhaust ventilation units in the labs and shops are working and are programmed to run continuously. Each unit can be manually shut off as needed.

MDPH/BEH Follow-Up (August 17, 2012): Given that school was not in session during the August 2012 visit, it was not possible to evaluate the operational function.

27. **MDPH/BEH Report Recommendation (September 27, 2011):** Clean expanding mastic between tiles in below grade areas. Monitor for humidity, condensation and further expansion of tile mastic.

City of New Bedford Update (November 8, 2011): Any expanding tile mastic was cleaned when floors are stripped and re-waxed (note that typically, mastic is covered by two coats of floor sealer and two coats of wax and is therefore inaccessible to building personnel).

MDPH/BEH Follow-Up (August 17, 2012): At the time of the August 2012 visit, the tiles appeared free of expanded mastic.

28. **MDPH/BEH Report Recommendation (September 27, 2011):** Remove birds' nests from univent fresh air intake vents and clean with an appropriate antimicrobial. If bird nesting/waste contamination is determined to be extensive, consider contacting a professional cleaning company. Consider installing wire mesh bird screens over air intakes to prevent further roosting.

    City of New Bedford Update (November 8, 2011): This recommendation is under review by the School Department and the Department of Environmental Stewardship.

    MDPH/BEH Follow-Up (August 17, 2012): Birds' nests were not observed in fresh air intakes.

30. **MDPH/BEH Report Recommendation (September 27, 2011):** Ensure water is poured into floor drains several times per week, or as needed, to maintain traps and prevent infiltration of sewer gas odors.

    City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

    MDPH/BEH Follow-Up (August 17, 2012) (November 8, 2011): No odors were apparent during the MDPH visit.

31. **MDPH/BEH Report Recommendation (September 27, 2011):** Clean chalk dust trays and pencil sharpeners periodically to prevent dust aerosolization.

    City of New Bedford Update (November 8, 2011): Chalk dust trays and pencil sharpeners are cleaned periodically by building staff.

    MDPH/BEH Follow-Up (August 17, 2012): No excessive amounts of chalk dust were observed on 8/17; however, the importance of this activity should be reaffirmed once school is in session.

34. **MDPH/BEH Report Recommendation (September 27, 2011):** Examine school/district policy on space heaters; ensure no flammable materials are in close proximity to constitute a fire hazard. Consider removal if not necessary.

    City of New Bedford Update: This recommendation is being addressed on an ongoing basis by the School Department.

35. **MDPH/BEH Report Recommendation (September 27, 2011):** Examine methods to prevent/enforce smoking regulations by students in restrooms.

City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

36. **MDPH/BEH Report Recommendation (September 27, 2011):** Examine damaged gym mats and determine if they are still functional, discard if moldy or are no longer in useable condition.

City of New Bedford Update (November 8, 2011): Gym mats that were damaged or no longer in usable condition were reportedly replaced as part of remediation work during the summer of 2009.

MDPH/BEH Follow-Up (August 17, 2012): No gym mats were visible at the time of the August 17th visit, likely because school was not in session. The importance of this activity should be reaffirmed once school is in session.

37. **MDPH/BEH Report Recommendation (September 27, 2011):** Clean accumulated dust and debris periodically from the surface of air diffusers, exhaust vents and blades of personal and ceiling fans.

City of New Bedford Update (November 8, 2011): Air diffusers, exhaust vents, and ceiling fan blades are cleaned periodically by building staff.

MDPH/BEH Follow-Up (August 17, 2012): While cleaning actions were in progress, it appeared that efforts to clean such debris had been undertaken.

Recommendations Specific to Moisture and Mold Issues

40. **MDPH/BEH Report Recommendation (September 27, 2011):** Ensure roof/window leaks are repaired and replace water-damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.

City of New Bedford Update: NBHS' engineers have worked on replacing roof flashing in 2010 and 2011, which has addressed the majority of leaks. Other leaks are repaired as they are identified.

MDPH/BEH Follow-Up (August 17, 2012) (November 8, 2011): NBHS facilities staff have conducted cement repointing and roof repair to address water leakage. Water-damaged ceiling tiles of non-standard shape remain in place. At the time of the August

2012 visit, MDPH/BEH/IAQ staff found some water damaged tiles and recommended that these be replaced along with others as needed.

41. **MDPH/BEH Report Recommendation (September 27, 2011):** Refrain from storing porous items (boxes, papers, books, etc.) in areas of suspected water leaks.

City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

MDPH/BEH Follow-Up (August 17, 2012): No storage was observed in any of the classrooms MDPH had previously noted as having potential water leaks.

42. **MDPH/BEH Report Recommendation (September 27, 2011):** Contact a building-engineering firm to examine ways to mitigate/prevent water pooling in the mechanical/boiler room.

City of New Bedford Update (November 8, 2011): A vendor was hired by the City in 2010 to seal all accessible cracks in cement where groundwater was infiltrating the Mechanical Room. The School Department reported that this work has significantly decreased the amount of water present in this area. Additional work was reportedly conducted in 2011.

MDPH/BEH Follow-Up (August 17, 2012): No standing water was observed at this time.

43. **MDPH/BEH Report Recommendation (September 27, 2011):** Ensure all plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Remove plants from univents.

City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

MDPH/BEH Follow-Up (August 17, 2012): Given that most plants are reportedly brought into the school by personnel, it was not possible to evaluate progress in this area at the time of the MDPH visit.

44. **MDPH/BEH Report Recommendation (September 27, 2011):** Examine sink countertop and backsplash areas for water damage and/or mold growth. Disinfect and replace as necessary. Seal breaches to prevent damage.

City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing or case-by-case basis by the School Department.

MDPH/BEH Follow-Up (August 17, 2012): Backsplashes had been repaired at the time of the MDPH visit.

45. **MDPH/BEH Report Recommendation (September 27, 2011):** Clean and maintain aquariums and terrariums to prevent bacterial/mold growth.

    City of New Bedford Update (November 8, 2011): The aquarium shown in Picture 34 is no longer present in that classroom.

    MDPH/BEH Follow-Up (August 17, 2012): While no aquarium/terrariums were observed to have bacterial growth at the time of the visit, it is important to reaffirm this potential IAQ issue when school is in session.

46. **MDPH/BEH Report Recommendation (September 27, 2011):** Continue to use dehumidifier in below grade areas as needed during the summer months and monitor for floor condensation. Ensure dehumidifiers are cleaned and maintained as per the manufacturer's instructions to prevent microbial growth.

    City of New Bedford Update (November 8, 2011): This recommendation is being addressed on an ongoing basis by the School Department.

    MDPH/BEH Follow-Up (August 17, 2012): The floors of the lower level classrooms and the kitchen showed no visible signs of condensation at the time of the visit, which may be attributed to cleaning of the fresh-air intake pits for the ground-level univents. Regular cleaning allows these pits to readily drain and dry.

47. **MDPH/BEH Report Recommendation (September 27, 2011):** Inspect and make repairs to kitchen refrigerators/freezers to prevent air leakage and condensation issues.

    City of New Bedford Update (November 8, 2011): This recommendation is under review by the School Department and the Department of Environmental Stewardship.

    MDPH/BEH Follow-Up (August 17, 2012): The refrigerator/freezer door was repaired in the area where condensation had previously been noted.

48. **MDPH/BEH Report Recommendation (September 27, 2011):** Remove plant growth against exterior walls to prevent water impingement.

City of New Bedford Update (November 8, 2011): This recommendation is under review by the School Department and the Department of Environmental Stewardship.
MDPH/BEH Follow-Up (August 17, 2012): Plants and trees had been cut back from exterior walls at the time of the MDPH visit.

49. **MDPH/BEH Report Recommendation (September 27, 2011):** Make repairs to damaged exterior brickwork and seal cracks/breaches to prevent moisture intrusion and pest entry.
City of New Bedford Update(November 8, 2011): This recommendation is being addressed on an ongoing or case-by-case basis by the School Department.
MDPH/BEH Follow-Up (August 17, 2012): Cracks were repaired at the time of the MDPH visit reportedly by NBHS facilities staff.

APPENDIX I

Glossary of Environmental Health Terms[5]

[5] Terms and definitions included in this glossary are primarily from the U.S. Agency for Toxic Substance and Disease Registry's 2005 Public Health Assessment Manual with some additional terms and definitions added by MDPH.

Glossary of Terms

This glossary defines words used in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call MDPH/BEH at 617-624-5757.

General Terms

50th percentile
The 50th percentile is also known as the median. The midpoint of a group of observations when they are arranged in order from lowest to highest.

95th percentile
The serum PCB level below which 95% of the levels measured in NHANES participants are found.

95% confidence interval
The 95% confidence interval is a range of estimated values that have a 95% probability of including the true value for the population.

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Aroclor
PCBs were commercially produced and sold in the U.S. as mixtures called Aroclors.

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assessment Program.]

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assessment Program (CAP)
A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing follow-up of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life (t½)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Median
The median is also known as the 50th percentile value. The midpoint of the a group of observations when they are arranged in order from lowest to highest

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm2
Milligram per square centimeter (of a surface).

mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen
A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

PCBs
Polychlorinated biphenyls (PCBs) refer to a class of chemical compounds with 209 possible congeners in which chlorine atoms have replaced some or all of the hydrogen atoms in the biphenyl molecule. PCBs are generally odorless and colorless, very heat stable and fire resistant, non-conductive and virtually insoluble in water. PCBs were historically used in electrical components (e.g. capacitors) and in building materials (e.g. caulking), among other uses.

PCB congener
PCB molecules vary in how much chlorine they contain. Individual unique chlorinated biphenyl compounds are known as congeners and there are 209 possible congeners depending on number and location of chlorine atoms on the molecule. Note, the chlorine in PCBs is unrelated to the type of chlorine used in pools.

PCB homologue
Congeners that are organized into groups according to similar numbers of chlorine atoms (e.g., dichlorobiphenyls, trichlorobiphenyls, etc.) are called homologues.

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RCRA [see Resource Conservation and Recovery Act (1976, 1984)]

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

SIR
The ratio of the observed number of cancer diagnoses in an area to the expected number of diagnoses multiplied by 100.

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological

profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:

Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Center for Environmental Health (CDC)
(http://www.cdc.gov/nceh/dls/report/glossary.htm)

National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)