



Wannalancit Mills
650 Suffolk Street
Lowell, MA 01854

978.970.5600 PHONE
978.453.1995 FAX

www.TRCSolutions.com

TRC Reference No. 115058

July 22, 2009

David J. Fredette, PE
Environmental Planner
Department of Environmental Stewardship
City of New Bedford
133 William Street
New Bedford, Massachusetts 02740

RE: Sampling Results for the Keith Middle School Foundation Vent Stack and Indoor Air for Polychlorinated Biphenyls and Volatile Organic Compounds April 2009 Monitoring Round. Report Dated July 2009

Dear Mr. Fredette:

Enclosed herein are two (2) copies of the above referenced report prepared by TRC. An electronic Portable Document Format (PDF) version is also included that is suitable for posting on the City of New Bedford's website.

We appreciate the opportunity to serve the City on this important project. If you have any questions or comments, please do not hesitate to contact me at 978-656-3565.

Sincerely,

A handwritten signature in blue ink that reads "David M. Sullivan". The signature is fluid and cursive.

David M. Sullivan, LSP, CHMM
Senior Project Manager

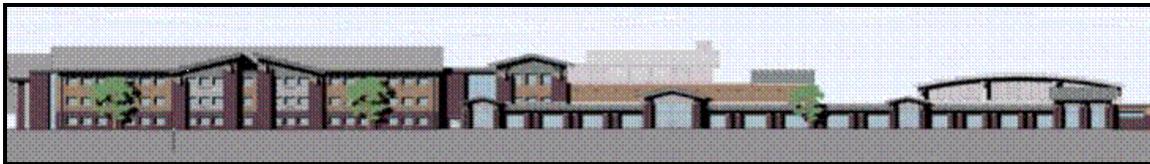
Enclosure

- cc. S. Alfonse – City of New Bedford, Dept. of Env. Stewardship (letter only)
L. Oliveira – City of New Bedford, School Department
K. Tisa – United States Environmental Protection Agency
M. Cote – Massachusetts Department of Environmental Protection



Sampling Results for the Keith Middle School Foundation Vent Stack and Indoor Air for Polychlorinated Biphenyls and Volatile Organic Compounds

April 2009 Monitoring Round



Prepared for:

Department of Environmental Stewardship
City of New Bedford
133 William Street
New Bedford, Massachusetts 02740

Prepared by:

TRC Environmental Corporation
Wannalancit Mills
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Lowell, Massachusetts 01854
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EXECUTIVE SUMMARY

TRC Environmental Corporation (TRC) of Lowell, Massachusetts was retained by the City of New Bedford (the City) to provide sampling support in conducting foundation vent stack and indoor air sampling for polychlorinated biphenyls (PCBs) and volatile organic compounds (VOCs) at the Keith Middle School (KMS) in New Bedford, Massachusetts. This report documents the indoor air and vent stack sampling performed by TRC during April 2009.

The sampling and analysis of vent stack and indoor air required for KMS is described in the approved *Long-Term Monitoring and Maintenance Plan* (LTMMIP), revision 4, dated October 20, 2006. The indoor air quality sampling program involved the collection of one indoor air quality sample from the ground floor of each of the three school building sections (Building A, Building B, and Building C). Concurrently with the indoor air quality sampling, air sampling of the sub-slab foundation ventilation system was performed during April 2009 from four selected rooftop vent stacks, including VS-1 and VS-4 which vent building Section A (classrooms), VS-11 which vents building Section C (near the Gymnasium), and VS-8 which vents building Section B. Duplicate sampling was performed at VS-8, however, the original sample was voided due to a flow controller that was clogged, preventing collection of air in the SUMMA canister. The passive sub-slab ventilation system was installed to allow any sub-slab soil gases to migrate from beneath the vapor barrier to the vent stacks, installed through the school building roof. Air samples were also collected immediately outside of the school during each round to provide comparative background results.

Following collection, the samples were analyzed for VOCs according to EPA Method TO-15 (VOCs in Air) by Alpha Woods Hole Labs of Westborough, Massachusetts and PCBs according to EPA Method 680 (PCB Homologues) by Northeast Analytical Labs of Schenectady, New York. Though this PCB method was not specified in the LTMMIP, the homologue analytical method is a reliable analytical method to quantify total PCBs. By quantifying PCB homologues, total PCB air data gathered at the KMS are directly comparable to total PCB air data gathered at the high school.

During the April 2009 sampling round, VOCs were detected in indoor air and vent stack air samples, and PCBs were detected in the three indoor air samples. However, PCBs were not detected in any of the vent stack air samples. It should be noted that PCB vent stack air detection limits were well below applicable criteria. The presence of VOCs in vent stack air samples is an expected finding for a sub-slab ventilation system and indicates that the passive ventilation system is performing as designed. The presence of VOCs in vent stack air may also be indicative of off-gassing from the venting system components in addition to subsurface VOC release.

VOCs are present in indoor air due to off-gassing from building materials and the storage and use of cleaners, adhesives, paints, and other VOC-containing products indoors at the school. Detected concentrations for PCBs in indoor air samples were generally consistent with urban indoor background levels. However, TRC will continue to monitor the PCB concentrations in indoor air to determine whether the higher concentrations detected in April 2009 relative to previous sampling rounds are an anomaly or part of a trend. Levels of PCBs and VOCs detected

in indoor air demonstrate fluctuations in measured concentrations over time due to: 1) the degree of building air exchange that occurs during normal school operation (i.e., open conditions) versus vacation periods when the school is not in session (i.e., closed conditions); 2) changes in ambient temperatures that may increase or decrease the off-gassing of contaminants from indoor building materials, as well as fugitive releases from VOC-containing products in storage; 3) the degree to which activities within the school building (e.g., cleaning and repairs) are contributing to indoor air concentrations of contaminants; and 4) reductions in building material related VOC emission sources over time.

PCB indoor air concentrations and vent stack air detection limits were compared to site-specific outdoor air concentrations and risk-based air concentrations (RBACs). Two PCB RBACs have been developed for the KMS, assuming occupational exposures within the school (8 hours/day, 250 days/year, for 25 years). The first RBAC is the Action Level (AL; 0.05 ug/m^3), which is used as an initial indicator that PCB air concentrations above background levels have been detected. The second RBAC is the Acceptable Long-Term Average Exposure Concentration (ALTAEC; 0.3 ug/m^3), indicative of the maximum acceptable air concentration that should not be exceeded for an extended time period. Indoor air PCB concentrations and vent stack air PCB detection limits were lower than RBACs.

VOC data were compared to MassDEP Threshold Effects Exposure Limits (TELs) and Allowable Ambient Limits (AALs), published in December 1995, consistent with the LTMMIP. TELs are developed to be applicable to short-term exposure concentrations (average 24-hour levels) while AALs are developed to be protective of long-term exposure concentrations (average annual levels over 30 years). Because TELs and AALs have not been updated since 1995, VOC concentrations in excess of AALs and TELs were discussed relative to EPA screening levels (EPA SLs) developed by Oak Ridge National Laboratory (2009) to be protective of continuous long-term residential exposures and shorter-term commercial exposures, using the most current toxicity information available. Because AALs, TELs, and EPA SLs are set at risk levels that are only a portion of the MassDEP risk management criteria, concentrations that slightly exceed (i.e., less than 5-fold) one or more comparison criteria are unlikely to be a cause for concern. VOC concentrations in excess of comparison criteria were also compared to MassDEP indoor air background values, used by MassDEP in the development of the Massachusetts Contingency Plan (MCP) numeric standards and Indoor Air Threshold Values (IATVs), developed by MassDEP considering typical indoor air background concentrations and MassDEP risk management criteria. Indoor air concentrations below the IATVs indicate that the vapor intrusion pathway is incomplete and does not require further evaluation.

Among all indoor air samples, eight VOCs (1,2,4-trimethylbenzene, benzene, chloroform, ethylbenzene, isopropanol, p/m-xylene, o-xylene and tetrachloroethene) exceeded one or more comparison criteria. Of these compounds, benzene, chloroform and tetrachloroethene were detected at concentrations below their corresponding MassDEP indoor air background value and IATVs. The LTMMIP specifies that the LSP-of-Record should submit the indoor air data to a toxicologist/risk assessor for further assessment if indoor air VOC concentrations exceed TELs, AALs, or 150% of outdoor air background concentrations. Further quantitative assessment of the

indoor air data indicated that VOC concentrations were associated with a condition of no significant risk to potentially exposed individuals.

In vent stack air, ten VOCs (1,2-dichloroethane, 1,3-dichlorobenzene, 2-butanone, benzene, carbon disulfide, chloroform, ethylbenzene, methyl tert butyl ether, tetrachloroethene, and trichloroethene) exceeded risk-based comparison criteria. Even though the LTMMIP specifies that both indoor air and vent stack air VOC concentrations are to be compared to comparison criteria, this comparison is not appropriate for vent stack air results. The vent system is designed to capture VOCs being released from the subsurface beneath the KMS and transport the gases through PVC piping to outdoor air, limiting migration through the building slab and into indoor air. Little if any human exposure to air within the vent stack system itself takes place. Air from the vent stack is released to outdoor air where the VOCs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to comparison criteria developed assuming short-term (24-hour) and long-term exposure is highly conservative, if not conceptually irrelevant.

Temporal trends show that VOC concentrations have been decreasing in indoor air, suggesting that off-gassing from the newly constructed school building is diminishing over time. The sporadic detection of slightly higher VOC concentrations compared to those typically detected when the school is normally occupied is noted during the spring and summer school vacation periods. During the vacation periods the building is experiencing lower than normal air exchange and the indoor use of VOC-containing cleaning products and repair materials increases. Low-level fluctuations in PCB concentrations in indoor air are representative of background conditions. Measured concentrations of PCBs and VOCs in vent stack air are expected, and indicate that the passive ventilation system is performing as designed. Fluctuations in PCB vent stack air concentrations and decreasing vent stack air VOC concentrations suggest that the range of measured concentrations is representative of typical conditions within the subsurface ventilation system and that off-gassing from the system is diminishing over time. In addition, the human health risk calculations indicate that there is no significant risk associated with the occupancy of KMS.

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1.0 INTRODUCTION

1.1 Overview

TRC Environmental Corporation (TRC) of Lowell, Massachusetts was retained by the City of New Bedford (the City) to provide sampling support in conducting foundation vent stack and indoor air sampling for polychlorinated biphenyls (PCBs) and volatile organic compounds (VOCs) at the Keith Middle School (KMS) in New Bedford, Massachusetts. This report documents the indoor air and vent stack sampling performed by TRC during April 2009.

Soil gas sampling was performed under the location of the KMS building in December 2001. In addition to PCBs present in soil at this location, the primary VOCs detected in the soil gas samples included acetone, 2-butanone, cyclohexane, ethanol, heptane, n-hexane, and toluene. Lesser concentrations of benzene, carbon disulfide, ethylbenzene, methyl tert butyl ether, tetrachloroethene, 1,2,4-trimethylbenzene, and xylenes were also detected in soil gas samples. The results of the December 2001 soil gas sampling event were evaluated for potential adverse impacts on indoor air quality, assuming no vapor barrier was installed. Despite the conclusion that no significant risk to human health is posed by the measured soil gas concentrations, the City and School Department decided to install a vapor barrier on top of the soil beneath the school building concrete floor as an added layer of protection against intrusion of any gases that may accumulate under the building. Passive ventilation has been installed to allow any sub-slab soil gases to migrate from beneath the vapor barrier to the vent stacks, installed through the school building roof. Sampling of indoor air quality and vent stack air is conducted to confirm the proper functioning of the passive ventilation system.

PCBs and VOCs have historically been detected in both indoor air and vent stack air samples. However, concentrations of PCBs and VOCs in indoor air samples are consistently lower than those observed in vent stack air samples. VOCs are present in indoor air due to off-gassing from building materials and the storage and use of cleaners, adhesives, paints, and other VOC-containing products indoors at the school. An inventory of cleaning supplies used at KMS and their ingredients is provided in Appendix A. Concentrations of PCBs detected in indoor air samples are consistent with background levels measured in outdoor air samples collected simultaneously. Levels of PCBs and VOCs detected in indoor air fluctuate and demonstrate noticeable trends in measured concentrations over time due to: 1) the degree of building air exchange that occurs during normal school operation (i.e., open conditions) versus vacation periods when the school is not in session (i.e., closed conditions); 2) changes in ambient temperatures that may increase or decrease the off-gassing of contaminants from indoor building materials, as well as fugitive releases from VOC-containing products in storage; 3) the degree to which activities within the school building (e.g., cleaning and repairs) are contributing to indoor air concentrations of contaminants; and 4) reductions in building material related VOC emission sources over time. The presence of higher levels of VOCs and PCBs in vent stack air samples is an expected finding for a sub-slab ventilation system and indicates that the passive ventilation system is performing as designed. The presence of VOCs in vent stack air may also be indicative of off-gassing from the venting system components in addition to subsurface VOC release.

Although PCBs and VOCs have been measured historically in indoor air and vent stack air samples, the concentrations detected do not pose a significant risk to human health, based on the comparison of concentrations to both background concentrations and applicable risk-based criteria (TRC, 2008a, 2008b, 2008c, 2008d, and 2009).

This report presents monitoring data collected during April 2009. The remaining sections of the report include Section 2 (Sampling Locations), Section 3 (Quality Assurance), Section 4 (Summary of Results), Section 5 (Comparison of PCB Results to Risk-Based Air Concentrations), Section 6 (Comparison of VOC Results to Comparison Criteria), Section 7 (Conclusions), and Section 8 (References). Supporting appendices include Appendix A (Summary of Field Sampling Program, Analytical Program and Quality Assurance), Appendix B (Field Sampling Data Sheets), Appendix C (Field Reduced Data), Appendix D (Equipment Calibration Sheets), Appendix E (Laboratory Data Reports), Appendix F (Laboratory Data Validation Memoranda), Appendix G (Discussion of Risk-Based Comparison Criteria) and Appendix H (Indoor Air Risk Calculations – Commercial Worker).

1.2 Scope of Work

Sampling and analysis of vent stack and indoor air is required as part of United States Environmental Protection Agency (EPA) approved *Long-Term Monitoring and Maintenance Plan* (LTMMIP), revision 4, dated October 20, 2006. The LTMMIP was prepared by The BETA Group, Incorporated (BETA) in accordance with the August 31, 2005 *Approval for Risk-Based PCB Cleanup and Disposal under 40 CFR §761.6(c)* letter issued by EPA to the City. The LTMMIP set forth a vent stack and indoor air sampling schedule consisting of three monitoring events per year for the first year (July/August, December, April 2007), with the understanding that the City may submit a written request to EPA to reduce the indoor air sampling frequency after the first year of monitoring. However, per the order of the Mayor of the City, vent stack and indoor air monitoring took place monthly during the period of September 2006 to July/August 2007. Following the July/August sampling event, monitoring was reduced to once every four months, consistent with the LTMMIP. The April 2009 sampling event was the fifth subsequent event following the July/August 2007 event. Monitoring from September 2006 through February 2007 was conducted by BETA and is reported elsewhere.

The sampling program consisted of the collection of indoor air quality and vent stack samples for the analysis of PCBs and VOCs. Details concerning the sample collection procedures and analytical methods are described in Appendix A. Sampling data sheets are provided in Appendix B and the reduced data are presented in Appendix C. The calibration certifications can be found in Appendix D. Laboratory analytical results are presented in Appendix E.

Field sampling data were validated by the Field Team Leader and/or the Field Quality Control Coordinator based on their review of adherence to each approved sampling protocol and written sample collection procedure. Details concerning quality assurance procedures are described in Appendix A. The laboratory data validation memoranda can be found in Appendix F.

The following sections describe those features of the field sampling program, quality assurance/quality control (QA/QC) program, and data analysis that are specific to the April 2009 event. Generic information on the sampling and QA/QC programs and data analysis procedures can be found in Appendices A and G, respectively.

2.0 SAMPLING LOCATIONS

2.1 Indoor Air Quality Sample Locations

During the sampling event, one indoor air quality sample was collected from the ground floor of each of the three school building sections (Building A, Building B, and Building C). Each sampling location was selected to be representative of portions of the school building normally occupied by students and teachers. The Building A sampling location is located within a hallway in an area of student classrooms. The Building B sampling location is located in the school auditorium. The Building C sampling location is in a faculty dining area. These indoor air quality sampling locations have remained consistent throughout TRC's sampling program, with the exception of the December 2007 Building B sample which was collected in the school cafeteria at the request of the City. One sample and a duplicate were also collected immediately outside of the school to provide comparative background results for ambient air.

Figure 2-1 presents the approximate locations of the indoor air quality sample locations. Table 2-1 summarizes the indoor air quality samples collected during the April 2009 sampling event. Indoor air quality samples collected during the April 2009 sampling event were designated with the letter A, B, or C to identify the building section from which the sample was collected and a unique sample identification suffix, indicating the sampling event number (e.g., A-19).

2.2 Foundation Vent Air Monitoring Sample Locations

The KMS foundation venting system is comprised of six sub-slab vapor collection zones, each vented by two or four vent stacks penetrating the roof. A total of four vent stacks are sampled during each round, including VS-1 and VS-4 which vent from the two collection zones located under building Section A (classrooms), and two other vent stacks which are rotated to cover the remaining collection zones. One air sample is collected immediately outside of the school during each round to provide comparative background results.

Figure 2-2 presents the approximate locations of the vent stack sample locations. Table 2-1 summarizes the vent stack samples collected during the April 2009 sampling event. Vent stack samples collected during the April 2009 sampling event were designated with the vent stack number (e.g., VS-1) and a unique sample identification suffix indicating the sampling event number (e.g., VS-1-19).

It should be noted that collocated samplers were set up at the VS-8 location (Building B). Upon collection of the collocated SUMMA canisters it was discovered that the original sample did not actually collect any air, due to a clogged flow meter. The original sample was voided and therefore, there are no results to compare with the VS-8-DUP sample.

3.0 QUALITY ASSURANCE

This section highlights the results of the QA/QC review for the April 2009 sampling event. Please refer to Appendix A for additional QA/QC details.

3.1 Data Validation Summary

In general, the TO-4A data from samples collected April 22, 2009 and TO-10A data from samples collected April 23, 2009 appear to be valid as reported and may be used for decision-making purposes.

Potential high bias did exist for trichlorobiphenyl and total PCBs in samples C-19(PUF) and B-19(PUF) and trichlorobiphenyl, tetrachlorobiphenyl and total PCBs in sample A-19(PUF) on account of high surrogate recoveries. The results for these analytes in the aforementioned samples should be considered estimated (identified in data summary tables presented herein with a "J" qualifier) due to this nonconformance. The results for all PCBs in samples BG-19(PUF) and VS-4-19 also had the potential to be influenced by the high bias. However, target PCBs were not detected in these samples and therefore not affected by the potential high bias so validation of the results for BG-19(PUF) and VS-4-19 was not required.

In addition, a number of homolog groups in the Laboratory Control Spikes and Duplicate Spikes (LCS/LCSD) exhibited high recoveries (see Appendix F for details). Although the potential for high biased results did exist on account of this nonconformance, validation of the results was not required since the affected sample results were all nondetect and therefore not affected by the potential high bias.

The TO-15 data also appear to be valid as reported and may be used for decision-making purposes.

2-Butanone, hexachlorobutadiene and methyl tert-butyl ether Laboratory Control Sample (LCS) results were above acceptance criteria, and signify the potential for high biased results. The LCS is a clean matrix (i.e., air media) spiked with the target analytes. The LCS is prepared and analyzed in the same manner as the samples and the recoveries of the target analytes are measured. The LCS is used to monitor the accuracy of the analytical method. All detected results for 2-butanone and methyl tert-butyl ether should be considered estimated (identified in data summary tables presented herein with a "J" qualifier) due to this nonconformance. The results for hexachlorobutadiene in all samples were nondetect and therefore validation of the data for methylene chloride was not required.

Acetone and methylene chloride were detected in the indoor air quality trip blank. Trip blanks are used as a check on shipping and laboratory-related sources of contamination. An Action Level (AL) of ten (10) times the blank contamination level was established to determine the need for qualification. The results for acetone in samples C-19, B-19, BG-19 and BG-19 DUP were all below the AL and therefore should be considered as nondetect (identified in data summary

tables presented herein with a “*”) due to this nonconformance. The results for methylene chloride in all samples were nondetect and therefore validation of the data for methylene chloride was not required.

3.2 TO-15 - Persistent Laboratory Contaminants

Based upon review of quality control data, TRC has determined that the results for four compounds reported throughout this report (acetone, ethanol, isopropanol, and methylene chloride) were influenced by laboratory-derived contamination and hence do not reflect actual vent stack and indoor air concentrations at KMS. This conclusion is supported by: 1) the high concentrations of these compounds in contrast to other VOCs within samples; 2) TRC experience with these same compounds when using EPA Method TO-15A on prior programs; and 3) concentrations over time do not follow trends observed for other VOCs known to be associated with products in storage and use at the KMS.

3.3 Collocated Sampler Precision

The collocated sampler data for the two pairs collected at the KMS during the April 2009 sampling event are summarized in Tables 3-1 and 3-2 for the indoor air and vent stack air samples, respectively. Results are provided for each of the analytes measured in the sampler pair in units of micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). Method precision is expressed as the relative percent difference (RPD) value derived on a parameter specific basis.

EPA Method TO-15 identifies a data quality goal/objective of $\pm 25\%$ RPD for analytes measured in replicate or collocated samples. RPDs were calculated for four compounds detected in the indoor air samples, as shown on Table 3-1. RPDs were not able to be calculated and/or reported for vent stack samples (VS-8-19 and VS-8-DUP-19) on account of the original sample, VS-8-19, being voided as discussed previously. RPDs were not calculated for most of the compounds analyzed since the majority of results were reported as non-detects (i.e., very few compounds were detected) and RPDs are not calculated when one or both of the collocated results are non-detect. However, the collocated non-detects show good agreement, although values in both samples could not be quantified (analyte not detected in both samples of collocated pair). For the results for which an RPD could be calculated, all of the calculated RPDs were less than 25% for the sampling event conducted in April 2009. RPD data can be used to identify if differences in measured concentrations are attributable to actual concentration differences or if they are within the precision of the sampling and analytical procedure.

4.0 SUMMARY OF RESULTS

The following section describes the findings from the sampling events conducted by TRC at the KMS during April 2009. The April sampling occurred during the school vacation time period. Table 2-1 provides a summary of the types, numbers, and locations of the samples collected. Appendices E and F contain the laboratory data reports and data validation memoranda, respectively. Along with the samples, TO-4A, TO-15, and TO-10A trip blanks were analyzed as a quality assurance measure. PCBs were not detected in the trip blank. No compounds were detected in the vent stack trip blank. However, acetone and methylene chloride were detected in the indoor air quality trip blank. Trip blanks are used as a check on shipping and laboratory-related sources of contamination. Methylene chloride was not detected in any samples and therefore not affected by the contamination. Acetone, however was detected below the Action Level and qualified as nondetect in samples C-19, B-19, BG-19 and BG-19 DUP.

TRC believes that the results for four compounds reported throughout this report (acetone, ethanol, methylene chloride and isopropanol) were influenced by laboratory derived contamination and hence do not reflect actual vent stack and indoor air concentrations at the KMS, as previously discussed in more detail in Section 3.2.

A trend analysis of VOC concentrations over time is presented in Section 6.4. VOCs detected in the indoor air samples are believed to be associated with the storage and use of cleaners, adhesives, paint, and other VOC-containing products as well as building construction materials. This finding is based upon sporadic measurements of slightly higher VOC concentrations noted during the spring and summer school vacation periods when the building is experiencing lower than normal air exchange and the indoor use of VOC-containing cleaning products and repair materials increases. Overall, VOC concentrations are decreasing in indoor air suggesting that off-gassing from the newly constructed school building is diminishing over time. Low level fluctuations of PCB concentrations in indoor air are generally consistent with urban indoor background levels. Measured concentrations of PCBs and VOCs in vent stack air are expected, and indicate that the passive ventilation system is performing as designed.

4.1 Indoor Air Quality Results

On April 23, 2009, TRC collected three indoor and one outdoor background (with duplicate) 24-hour TO-4A and TO-15 air samples at the KMS. Table 4-1 provides a summary of results for all compounds that have been found one or more times within the indoor air quality samples.

PCBs were detected in the three indoor air samples collected, but not in the background outdoor air samples. Total PCB detections ranged from 0.0034 $\mu\text{g}/\text{m}^3$ in the Building B sample to 0.013 $\mu\text{g}/\text{m}^3$ in the Building A sample. The detection limit for the background outdoor air samples was 0.000079 $\mu\text{g}/\text{m}^3$.

A total of 19 VOCs were detected in the three indoor air quality samples and/or outdoor air background samples collected during April 2009. Five VOCs (2-butanone, acetone, benzene, difluorodichloromethane, and trichlorofluoromethane) were detected in one or more of the three

indoor air samples and at the background location. The indoor air concentrations of these VOCs were similar to those detected in the outdoor air background samples. The highest concentrations of acetone, benzene, and difluorodichloromethane were observed in the Building A sample and the highest concentration of 2-butanone was observed in the Building B sample, while the highest concentration of trichlorofluoromethane was observed in one of the background location samples. Ethanol, isopropanol, tetrachloroethene, and toluene were detected in the three indoor air samples, but not in the background samples. The highest concentration of ethanol and toluene were observed in the Building A sample, the highest concentration of tetrachloroethene was observed in the Building B sample, and the highest concentration of isopropanol was observed in the Building C sample. Ethylbenzene, p/m-xylene, o-xylene, heptanes, n-hexane, and trichloroethene were detected in the Building A and Building B samples with the highest concentration of each observed in the Building A sample. Chloroform was detected in the Building A and Building C samples, with the highest concentration detected in the Building C sample. Three VOCs were detected in only one of the three indoor air samples. Methyl isobutyl ketone and 1,2,4-trimethylbenzene were observed in the Building B sample, and styrene was observed in the Building C sample. Chloromethane was detected in the background outdoor air sample, but was not detected in any of the indoor air samples.

Acetone, isopropanol, and ethanol are common laboratory contaminants while all of the other VOCs detected in the indoor air samples are found in cleaning products, adhesives, paints and other VOC-containing products, and as components of building materials. Their presence in indoor air may not be representative of site conditions (i.e., soil, groundwater), but rather a result of off-gassing from building materials, the use of VOC-containing materials within the school, or partially contributed by ambient concentrations in the vicinity of the school.

4.2 Vent Stack Air Results

On April 23, 2009, TRC collected four (plus one duplicate) vent stack and one ground level outdoor background 4-hour TO-10A and TO-15 samples at the KMS. Table 4-2 provides a summary of results for the vent stack samples.

In April 2009, PCBs were not detected in the vent stack samples or in the outdoor air background sample.

A total of 23 VOCs were detected in the vent stack air samples and/or background sample, including the common laboratory contaminants acetone, isopropanol, and ethanol. Two of the detected VOCs (acetone and benzene) were detected in the four vent stack air samples and at the outdoor air background sampling location. Three additional VOCs (chloromethane, difluorodichloromethane, and trichlorofluoromethane), though detected in less than four of the subsurface collection zones, were also detected at the outdoor air background sampling location. For these five VOCs, similar concentrations (i.e., less than 3-fold different) were observed in the vent stack air and outdoor air samples, except for acetone which displayed concentrations up to 4-fold the background concentration in one of the vent stack air samples. 2-Butanone, chloroform, tetrachloroethene, tetrahydrofuran, toluene, and trichloroethene were detected in the four vent stack air samples collected, but not at the outdoor air background sampling location, which may indicate that these compounds are being released from the subsurface ventilation

system and/or uniformly from the subsurface and vented by the system. 1,2-Dichloroethane, 1,3-dichlorobenzene, carbon disulfide, cis-1,2-dichloroethene, cyclohexane, ethanol, ethylbenzene, isopropanol, methyl tert butyl ether, p/m-xylene, o-xylene, and n-hexane were detected in less than four of the subsurface collection zones and not at the outdoor air background sampling location, indicating a more localized subsurface presence.

5.0 COMPARISON OF PCB RESULTS TO RISK-BASED AIR CONCENTRATIONS

This section of the report discusses the PCB indoor air and vent stack air sampling results, relative to site-specific outdoor air concentrations and risk-based air concentrations (RBACs). Air sampling results, background outdoor air results, and RBACs are presented in Tables 5-1 and 5-2 for the April 2009 sampling event. Compound-specific results exceeding RBACs are highlighted on these tables. Measured concentrations of compounds exceeding RBACs are discussed in Sections 5.1 and 5.2 for indoor air and vent stack air, respectively. A detailed discussion of the RBACs can be found in Appendix G.

Two PCB RBACs have been developed for the KMS. The first RBAC is the Action Level (AL; 0.05 ug/m^3) used as an initial indicator that PCB air concentrations above background levels have been detected. The second RBAC is the Acceptable Long-Term Average Exposure Concentration (ALTAEC; 0.3 ug/m^3), indicative of the maximum acceptable air concentration that should not be exceeded for an extended time period. The ALTAEC could be exceeded over the short-term and still result in acceptable risk levels.

The LTMMIP specifies that both indoor air and vent stack air total PCB concentrations are to be compared to RBACs. This comparison is appropriate for indoor air results since exposures to indoor air at the KMS are occurring over a similar duration and frequency as that assumed for RBAC development. However, this comparison is less appropriate for vent stack air results since little if any human exposure to air within the vent stack system itself is taking place. Air from the vent stack is released to outdoor air where the PCBs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to RBACs is highly conservative, if not conceptually irrelevant. The results of the comparison of vent stack air results to RBACs should be interpreted with caution due to the significantly reduced degree of exposure to vent stack air that can be experienced by individuals in comparison to indoor air.

5.1 Indoor Air

Indoor air sampling results, outdoor air background results, and RBACs are presented in Table 5-1. PCBs were detected at all three of the three indoor air sampling locations (Buildings A, B, and C), but not in the outdoor air background samples. The highest indoor air total PCB concentration (Building A sample), was approximately 4-fold lower than the PCB AL and roughly 20-fold lower than the ALTAEC; the Building B and Building C samples displayed concentrations of PCBs roughly between 5- and 15-fold lower than the AL and between 30- and 100-fold lower than the ALTAEC. Because the PCB AL is used as an initial indicator that PCB air concentrations above background levels have been detected and the detected concentrations of PCBs are significantly less than the AL, concentrations of PCBs in indoor air are consistent with levels associated with ambient conditions. Because there are no indoor air PCB concentrations in excess of the RBACs, no specific follow-up actions are recommended at this time.

Temporal trends for total PCB indoor air concentrations at the sampling locations in Building A (classrooms), Building B (auditorium), and Building C (faculty dining area) are shown in Figure

5-1. Figure 5-1 also shows concentration trends at the outdoor air background sampling location. Data included on this figure are for the time period August 2006 to April 2009. The highest indoor air total PCB concentration was detected during the April 2009 sampling event when the school was likely experiencing lower than normal air exchange (school vacation) and the potential for volatilization of PCBs from outdoor ambient sources is greatest due to the warmer weather. The lowest indoor air total PCB concentration was detected during the April 2008.

No clear trends are noted for total PCB concentrations in indoor air. Measured concentrations fluctuate over time, with slightly higher concentrations noted during the summer school vacation period when the building is experiencing lower than normal air exchange and the potential for volatilization of PCBs from outdoor ambient sources is greatest due to warmer weather. The low level PCB indoor air concentrations are generally consistent with urban indoor background conditions. However, TRC will continue to monitor the PCB concentrations in indoor air to determine whether the higher concentrations detected in April 2009 relative to previous sampling rounds are an anomaly or part of a trend.

5.2 Vent Stack Air

Vent stack air sampling results, outdoor air background results, and RBACs are presented in Table 5-2. PCBs were not detected in the four vent stack samples. PCBs were also not detected in the outdoor air background sample. Because there are no exceedances of the RBACs, no specific follow-up actions are recommended at this time.

Vent stack air reporting limits were higher than those for indoor air, ranging from $<0.021 \text{ ug/m}^3$ to $<0.023 \text{ ug/m}^3$. The higher reporting limit could mask the presence of PCBs in the vent stack air system compared to indoor air results. However, reporting limits were 2-fold below the AL indicating that PCBs, even if not detected by the analytical method, were present at concentrations less than the RBACs.

Temporal trends for total PCB vent stack air concentrations are shown in Figure 5-2. Two vent stack locations were consistently sampled on a monthly basis so as to establish concentration trends. The vents selected were VS-1 and VS-4 which were chosen because they both vent from the Building A vapor collection zone and Building A consists of classrooms where children spend most of the day. Figure 5-2 also shows concentration trends at the outdoor air background sampling location. Data included on this figure are for the time period August 2006 to April 2009. All of the vent stack air samples collected during this time period displayed non-detect levels of total PCBs. Total PCB concentrations in VS-1 are consistent over time and similar to levels present at the outdoor air background location. Total PCB concentrations in VS-4 displayed somewhat greater variability with slightly higher concentrations coinciding with warmer ambient temperatures. However, total PCB concentrations in VS-4 are consistent over the past five sampling events and are similar to levels present at the outdoor air background location. The low level fluctuations in PCB vent stack air concentrations suggest that the range of measured concentrations is representative of typical conditions within the subsurface ventilation system.

6.0 COMPARISON OF VOC RESULTS TO COMPARISON CRITERIA

This section of the report discusses the VOC indoor air and vent stack air sampling results, relative to site-specific outdoor air and generic indoor air background concentrations and available comparison criteria. Air sampling data, background data, and comparison criteria are presented in Tables 6-1 and 6-2. Compound-specific results exceeding comparison criteria are highlighted on these tables. The detected concentrations of compounds exceeding comparison criteria are discussed in Section 6.1 for indoor air quality samples and Section 6.2 for vent stack air samples, followed by a discussion in Section 6.3 of the findings of a risk characterization conducted to evaluate the significance of the comparison criteria exceedances. Risk-based comparison criteria are discussed below, with greater detail provided in Appendix G. Section 6.4 presents the observed trends in contaminant concentrations over time.

Comparison criteria for VOC data include MassDEP Threshold Effects Exposure Limits (TELS) and Allowable Ambient Limits (AALs), published in December 1995, consistent with the LTMMIP. TELS are developed to be applicable to short-term exposure concentrations (average 24-hour levels) while AALs are developed to be protective of long-term exposure concentrations (average annual levels over 30 years). Indoor air and vent stack air VOC concentrations are conservatively compared to both criteria even though it is unlikely that actual exposures to measured air concentrations would occur for either an entire 24-hour day or continually for 30 years.

Because TELS and AALs have not been revised since 1995 and may not include the most up-to-date toxicity information available, VOC concentrations in excess of AALs and TELS are discussed relative to alternate comparison criteria. The alternate comparison criteria are primarily residential and commercial EPA screening levels (EPA SLs) developed by Oak Ridge National Laboratory (April 2009) using the most current toxicity information available. Similar to AALs, residential EPA SLs are applicable to continuous long-term exposures. Commercial EPA SLs are more applicable to the actual exposures occurring at the KMS. In interpreting concentrations in excess of residential EPA SLs, it is important to consider how the frequency and duration of actual exposures may differ from continuous long-term exposures assumed for residential EPA SL development.

Because AALs, TELS, and EPA SLs are set at risk levels that are only a portion of the MassDEP risk management criteria (see Appendix G for additional information on this), concentrations that slightly exceed (i.e., less than 5-fold) one or more comparison criteria may not be cause for concern, especially considering that actual exposures may be of lesser duration and frequency than assumed in comparison criteria development.

For compounds lacking comparison criteria, detected concentrations are discussed relative to available comparison criteria for a surrogate compound, selected based on similarities in chemical structure and/or known toxicity. Surrogate assignments are identified in footnotes on Tables 6-1 and 6-2.

To account for anticipated background conditions at the KMS, VOC concentrations in excess of comparison criteria are framed relative to site-specific outdoor air background concentrations, indicating ambient conditions in the vicinity of the site. To provide additional perspective, VOC concentrations in excess of comparison criteria are also discussed relative to MassDEP indoor air background values, used by MassDEP in the development of the Massachusetts Contingency Plan (MCP) numeric standards (MassDEP, 2008) and Indoor Air Threshold Values (IATVs; June 2009) developed by MassDEP considering typical indoor air background concentrations and MassDEP risk management criteria. Indoor air concentrations below the IATVs indicate that the vapor intrusion pathway is incomplete and does not require further evaluation. Therefore, the presence of one or more VOCs at concentrations that exceed comparison criteria should be interpreted with caution and may not indicate the need for immediate action.

The LTMMIP specifies that both indoor air and vent stack air VOC concentrations are to be compared to comparison criteria. This comparison is appropriate for indoor air results since exposures to indoor air at the KMS are occurring over a similar though lesser duration and frequency as that assumed for comparison criteria development. However, this comparison is less appropriate for vent stack air results since little if any human exposure to air within the vent stack system itself is taking place. Air from the vent stack is released to outdoor air where the VOCs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to comparison criteria is highly conservative, if not conceptually irrelevant. The results of the comparison of vent stack air results to comparison criteria should be interpreted with caution due to the significantly reduced degree of exposure to vent stack air that can be experienced by individuals in comparison to indoor air.

6.1 Indoor Air

As presented in Table 6-1, concentrations of eight VOCs in the indoor air samples exceeded one or more comparison criteria. The compounds are 1,2,4-trimethylbenzene, benzene, chloroform, ethylbenzene, isopropanol, p/m-xylene, o-xylene and tetrachloroethene. Methylene chloride was also detected at a concentration in excess of comparison criteria, but it was only detected in the trip blank sample. Benzene, chloroform and tetrachloroethene were detected at concentrations below MassDEP indoor air background concentrations and IATVs, indicating that the presence of these compounds in indoor air is not a site-related finding.

Benzene concentrations detected in the three indoor air samples exceed comparison criteria developed assuming long-term continuous exposure. However, the concentrations do not exceed the TEL and commercial EPA SL, most applicable to actual exposures occurring at the KMS. Therefore, the benzene concentrations in the indoor air samples are unlikely to be of concern. This conclusion is supported by the risk characterization presented in Section 6.3. Furthermore, concentrations of benzene at the outdoor air background location also exceed comparison criteria. The presence of this compound at similar concentrations in both the indoor air and outdoor air background samples indicates that their presence is likely related to ambient conditions in the vicinity of the KMS.

The concentration of chloroform in the Building A and Building C samples exceeds its AALs and EPA residential SL, but does not exceed the TEL or its EPA commercial SLs based on the most current toxicity information available. Therefore, this compound is unlikely to be of concern, which is further evidenced by the risk characterization presented in Section 6.3.

Tetrachloroethene concentrations detected in the three indoor air samples exceed its AAL, based on outdated toxicity information. However, the concentrations do not exceed the TEL and EPA SLs based on the most current toxicity information available. Therefore, the tetrachloroethene concentrations in the indoor air samples are unlikely to be of concern, as supported by the risk characterization presented in Section 6.3.

Xylene concentrations detected in the Building A sample exceed its AAL and TEL, based on outdated toxicity information. However, the concentrations do not exceed the EPA SLs based on the most current toxicity information available. Therefore, the xylene concentrations in the indoor air sample are unlikely to be of concern, as supported by the risk characterization presented in Section 6.3.

The ethylbenzene concentration detected in the Building A sample exceeds both the EPA commercial and residential SLs, while the Building B sample concentration only exceeds the EPA residential SL, based on continuous long-term exposure. Because the ethylbenzene concentration in the Building A is only 2-fold higher than the EPA commercial, the ethylbenzene concentrations in the indoor air sample are unlikely to be of concern, as supported by the risk characterization presented in Section 6.3.

The 1,2,4-trimethylbenzene concentration detected in the Building A indoor air samples slightly exceeds its EPA residential SL, assuming long-term continuous exposure. However, the concentration does not exceed the commercial EPA SL, most applicable to actual exposures occurring at the KMS. Therefore, the 1,2,4-trimethylbenzene concentration in the indoor air sample is unlikely to be of concern. This conclusion is supported by the risk characterization presented in Section 6.3.

Isopropanol, which lacks compound-specific comparison criteria, was also detected in all three indoor air samples at concentrations above the outdoor air background reporting limit. There are no published comparison criteria for this compound. However, a comparison to the AAL/TEL for isobutyl alcohol can give some perspective on the significance of the detected isopropanol concentrations, based on similarities in chemical structure and toxicity. Only the Building C indoor air concentration marginally (i.e., less than 2-fold) exceeds the AAL/TEL for isobutyl alcohol, suggesting that the detected concentrations are unlikely to be of concern. Therefore, the isopropanol concentration in the indoor air sample is unlikely to be of concern. This conclusion is supported by the risk characterization presented in Section 6.3.

6.2 Vent Stack Air

As indicated on Table 6-2, concentrations of ten VOCs in vent stack air samples exceeded one or more comparison criteria. The compounds include 1,2-dichloroethane, 1,3-dichlorobenzene, 2-

butanone, benzene, carbon disulfide, chloroform, ethylbenzene, methyl tert butyl ether, tetrachloroethene, and trichloroethene. Comparison of vent stack air results to risk-based comparison criteria assumes that exposures to the air within the vent system are occurring at the same duration and intensity as indoor air, which is unlikely as previously noted. Therefore, VOC concentrations measured in excess of comparison criteria for VOCs in the vent stack system are unlikely to be indicative of a health concern since individuals are experiencing little, if any exposure to vent stack air.

2-Butanone, benzene, ethylbenzene, methyl tert butyl ether, tetrachloroethene and trichloroethene concentrations detected in vent stack air samples only exceed comparison criteria developed assuming continuous exposure (i.e., AALs and/or residential EPA SLs). Because the concentrations of these compounds do not exceed TELs and commercial EPA SLs, these concentrations in the vent stack air samples are unlikely to be of concern. Furthermore, the concentration of benzene at the outdoor air background location also exceeds comparison criteria. The presence of benzene at similar concentrations in both the vent stack air and outdoor air background samples indicates that its presence is likely related to ambient conditions in the vicinity of the KMS.

1,2-Dichloroethane and chloroform vent stack air concentrations do not exceed their TELs, applicable to short-term exposures, though the detected concentrations do exceed their AALs and residential/commercial EPA SLs. 1,3-Dichlorobenzene concentrations exceed its residential/commercial EPA SLs. No AAL or TEL is available for this compound. Because exposure to vent stack air is negligible or non-existent, the presence of these compounds in vent stack air is unlikely to be of concern.

Thirteen of the 23 compounds present in vent stack air were detected in the December 2001 subsurface soil gas sampling event conducted by BETA, including 2-butanone, benzene, carbon disulfide, ethylbenzene, methyl tert butyl ether, and tetrachloroethene. The presence of these compounds in vent stack air indicates that the passive foundation venting system is performing as designed and limiting or preventing the migration of subsurface VOCs to indoor air.

6.3 Risk Characterization for Indoor Air

The LTMMIP specifies that the LSP-of-Record should submit the indoor air data to a toxicologist/risk assessor for further assessment if indoor air VOC concentrations exceed TELs, AALs, or 150% of outdoor air background concentrations. Therefore, non-carcinogenic hazards and excess lifetime cancer risks have been estimated to determine whether a condition of no significant risk exists within the school. All compounds detected in indoor air samples between March 2007 and April 2009 were included in the risk characterization. Exposure point concentrations are either maximum detected concentrations or 95 percent upper confidence limits (95% UCLs) on the arithmetic mean, using sampling data for Buildings A through C combined. The use of maximum detected concentrations or 95% UCLs as exposure point concentrations provides a reasonable upper bound of the contaminant concentrations an individual may be exposed to, over the specified time period. A commercial worker scenario was used which assumed exposures for 8 hours/day, 250 days/year for 25 years, consistent with the assumptions used in the development of the site-specific PCB action levels. Appendix H

contains a data summary table detailing the derivation of the exposure point concentrations and a calculation spreadsheet presenting the exposure assumptions and toxicity values used in the assessment.

The results presented in Appendix H document that a condition of no significant risk exists associated with commercial worker indoor air exposures at the KMS. Because workers are the most highly exposed individuals at the KMS, exposures of school children and staff would also be associated with a condition of no significant risk. The risk and hazard to the commercial worker is overestimated due to the assumption that a worker would be continuously exposed to the maximum detected or 95% UCL concentrations over 25 years. VOC concentrations associated with off-gassing from building materials have been demonstrated to be trending downward (see discussion in Section 6.4).

The LTMMIP also specified that the LSP-of-Record should submit the vent stack air data to a toxicologist/risk assessor for further assessment if vent stack air VOC results exceed TELs and AALs. Because exposures to vent stack air are negligible or non-existent, further quantitative assessment of the vent stack air VOC results was not required.

6.4 Trend Analysis for VOCs

Temporal trends for VOC indoor air concentrations at the sampling location in Building A (classrooms), Building B (auditorium), and Building C (faculty dining area) are shown in Figures 6-1 through 6-3, respectively. Five VOCs were selected for data presentation including 2-butanone, methyl tert butyl ether, tetrahydrofuran, toluene, and total xylenes (the sum of m/p-xylene and o-xylene isomers). These VOCs were selected because they are not common laboratory contaminants, were frequently detected in indoor air samples, and were noted as exceeding one or more comparison criteria. Data included on these figures are for the time period August 2006 to April 2009. Bars on the figures outlined in black indicate that the compound was not detected during the specific sampling event, and the value presented on the figure is half the analytical detection limit.

Although some degree of temporal fluctuation is observed, there are clearly decreasing concentration trends for 2-butanone, toluene, and total xylenes over time in the Building B and C indoor air quality samples. The other two indicator compounds, tetrahydrofuran and methyl tert butyl ether, were only detected once in the samples collected from the Building B and C samples, respectively. For the Building A samples, most concentrations for the selected compounds have been consistently low, with the sporadic detection of slightly higher VOC concentrations noted during the spring and summer school vacation periods when the building is experiencing lower than normal air exchange and the indoor use of VOC-containing cleaning products and repair materials increases. These sporadic higher concentrations were also observed within the Building B and C samples. Overall, the decreasing trends in Buildings B and C suggest that off-gassing from the newly constructed school building is diminishing. The trend is less apparent in Building A since concentrations have been consistently low over time with some fluctuations.

Temporal trends for VOC vent stack air concentrations are shown in Figures 6-4 and 6-5 for VS-1 and VS-4, respectively. The same five VOCs selected for trend analysis in indoor air were also used for vent stack air. Data included on these figure are for the time period August 2006 to April 2009. All five indicator VOCs display clearly decreasing trends overtime at both vent stack air sampling locations. Though some degree of temporal fluctuation is observed, the sporadic presence of slightly higher vent stack air VOC concentrations is noted during times of warmer ambient temperatures, likely caused by the subsurface release of VOCs or the off-gassing of VOCs from the ventilation system.

6.5 Recommended Modifications to the LTMMIP

The LTMMIP specifies follow-up actions to be taken if VOC air data exceed the comparison criteria. However, the response actions set forth in the LTMMIP are excessive and unnecessary for the April 2009 data set for the following reasons:

- Risk calculations presented herein and in prior TRC reports (encompassing ten sampling events of monitoring data collected over 27 months) show that the maximum or 95% UCL on the arithmetic mean concentrations of detected VOCs do not pose a significant risk to human health and further that VOC concentrations are trending downward;
- Most of the VOCs detected in indoor air are associated with the storage and use of cleaners, adhesives, paints, and other VOC-containing products within the KMS; and
- The comparison of vent stack air to comparison criteria (e.g., TELs and AALs) is inappropriate because human exposure to air within the vent stack is highly unlikely, rendering the comparison to such criteria conceptually irrelevant.

The LTMMIP will be revised to reflect TRC's detailed understanding of the site conceptual model (e.g., impacts from indoor use of commercially available cleaners, paints, adhesives, etc.), the relationship between vent measurements and historical soil gas measurements that illustrate the proper functioning of the passive sub-slab ventilation system, and long-term downward trends for indoor air and passive vent system concentrations for VOCs originating from building materials. The revised LTMMIP will also include more appropriate response actions and response action schedules that reflect TRC's comprehensive understanding of human health risk, sources, and air measurements. In addition, a new methodology for evaluation of vent stack air concentrations is recommended for the proposed revised LTMMIP, which will be more appropriate than the presently required review against comparison criteria. A draft revision to the LTMMIP is planned for regulatory review in 2009.

7.0 CONCLUSIONS

Indoor air quality and vent stack air sampling was conducted at the KMS during April 2009 for total PCBs and VOCs. Data were evaluated for quality and reliability, discussed relative to risk-based air concentrations, and analyzed for concentration trends over the period of sampling from August 2006 to April 2009. The following summarizes the conclusions of the air sampling data evaluation.

In general, all TO-10A and TO-15 data collected during April 2009 were determined to be valid as reported and usable for decision-making purposes. Again, it should be noted that collocated samplers were set up at the VS-8 location (Building B). Upon collection of the collocated SUMMA canisters it was discovered that the original sample did not actually collect any air due to a clogged flow controller. The original sample was voided and therefore, there are no results to compare with the VS-8-DUP sample.

PCBs were detected in the three indoor air samples collected in April 2009. The detected PCB concentrations for these samples were below risk-based action levels. Detected concentrations of 1,2,4-trimethylbenzene, benzene, chloroform, ethylbenzene, isopropanol, p/m-xylene, o-xylene and tetrachloroethene in indoor air samples exceeded one or more risk-based comparison criteria. However, further assessment of the indoor air data indicated that the 95% UCL on the arithmetic mean or maximum VOC concentrations measured between March 2007 and April 2009 were associated with a condition of no significant risk to exposed individuals at the KMS.

PCBs were not detected in the four vent stack air samples collected in April 2009. There were more VOC exceedances of comparison criteria in vent stack samples as compared to indoor air samples. However, the comparison to risk-based criteria is not appropriate for vent stack air results. The vent system is designed to capture VOCs being released from the subsurface beneath the KMS and transport the gases through PVC piping to outdoor air, preventing migration through the building slab and into indoor air. Little if any human exposure to air within the vent stack system itself is taking place. Air from the vent stack is released to outdoor air on the roof of KMS where the VOCs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to comparison criteria developed assuming short-term (24-hour) and long-term exposure is highly conservative, if not conceptually irrelevant.

Some VOCs are likely present in indoor air due to off-gassing from building materials and the storage and use of cleaners, adhesives, paints, and other VOC-containing products indoors at the school. Levels of PCBs and VOCs in indoor air were found to fluctuate overtime likely due to: 1) the degree of building air exchange that occurs during normal school operation (i.e., open conditions) versus vacation periods when the school is not in session (i.e., closed conditions); 2) changes in ambient temperatures that may increase or decrease the off-gassing of contaminants from indoor building materials; 3) the degree to which activities within the school building (e.g., cleaning and repairs) are contributing to indoor air concentrations of VOCs, and 4) reductions in building material related VOC emission sources over time. The low level fluctuations of PCB indoor air concentrations are generally consistent with concentrations found in urban indoor environments. However, TRC will continue to monitor the PCB concentrations

in indoor air to determine whether the higher concentrations detected in April 2009 relative to previous sampling rounds are an anomaly or part of a trend. Overall, VOC concentrations are decreasing in indoor air suggesting that off-gassing from the aggregate of sources within the newly constructed school building is diminishing. The sporadic presence of slightly higher VOC concentrations noted during the spring and summer school vacation periods is likely attributable to the building experiencing lower than normal air exchange in combination with increased use of VOC-containing cleaning products and repair materials indoors.

VOCs are consistently detected in the sub-slab passive vent stacks, while PCBs are sporadically detected in the vent stacks. The presence of PCBs and VOCs in vent stack air is expected, and indicates that the passive ventilation system is performing as designed. VOCs detected in vent stack air samples may also have been released from the ventilation system. The low PCB vent stack air concentrations and decreasing vent stack air VOC concentrations are likely representative of typical conditions within the subsurface ventilation system and indicate that off-gassing from the system is diminishing overtime.

It is recommended that the LTMMIP be revised to reflect TRC's detailed understanding of the site conceptual model (e.g., impacts from indoor use of commercially available cleaners, paints, adhesives, etc.), the relationship between vent measurements and historical soil gas measurements that illustrate the proper functioning of the passive sub-slab ventilation system, and long-term downward trends for indoor air and passive vent system concentrations for VOCs originating from building materials. The revised LTMMIP will also include more appropriate response actions and response action schedules that reflect TRC's comprehensive understanding of human health risk, sources, and air measurements. In addition, a new methodology for evaluation of vent stack air concentrations is recommended for the proposed revised LTMMIP, which will be more appropriate than the presently required review against comparison criteria. A draft revision to the LTMMIP is planned for regulatory review in 2009.

July/August is the date for the next sampling event.

8.0 REFERENCES

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TABLES

**Table 2-1. April 2009 Sample Summary
Keith Middle School
New Bedford, Massachusetts**

Sample ID	Sample Location	Sampling Events (suffix) Dec (-18)	Sample Type
A	Building A, center of west hallway	X	IAQ
B	Building B, Auditorium	X	IAQ
C	Building C, Faculty Dining Room	X	IAQ
BG	Background, flagpole area outside main entrance to Building A	XX	IAQ
VS-1	Building A, vent stack 1	X	Vent Stack
VS-4	Building A, vent stack 4	X	Vent Stack
VS-5	Building B, vent stack 5		Vent Stack
VS-7	Building B, vent stack 7		Vent Stack
VS-8	Building B, vent stack 8	XX ^a	Vent Stack
VS-9	Building B, vent stack 9		Vent Stack
VS-10	Building B, vent stack 10		Vent Stack
VS-11	Gymnasium , vent stack 11	X	Vent Stack
VS-12	Gymnasium, vent stack 12		Vent Stack
VS-14	Gymnasium, vent stack 14		Vent Stack
VS-16	Building A , vent stack 16		Vent Stack
VS-BG	On the ground at main entrance to Building A	X	Vent Stack

Note:

a - The analysis of the original VOC sample from VS-8 was cancelled on account of a faulty flow controller.

**Table 3-1. Comparison of VOC Indoor Air Sample Results - Collocated Sampler Precision
Keith Middle School
New Bedford, Massachusetts**

Analysis	Analyte	Apr-09				
		BG-19		BG-19 Dup		RPD (%)
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 1.48	UJ	< 1.48	UJ	NC
	1,2,4-trimethylbenzene	< 0.982		< 0.982		NC
	1,2-dichloroethane	< 0.809		< 0.809		NC
	1,3-dichlorobenzene	< 1.20		< 1.20		NC
	2,2,4-trimethylpentane	< 0.934		< 0.934		NC
	2-butanone	0.810	J	0.775	J	4.42
	acetone ⁽¹⁾	7.19	U	5.55	U	NC
	benzene	0.463		0.485		4.64
	carbon disulfide	< 0.622		< 0.622		NC
	chloroform	< 0.098		< 0.098		NC
	chloromethane	1.08		1.16		NC
	cis-1,2-dichloroethene	< 0.792		< 0.792		NC
	cyclohexane	< 0.688		< 0.688		NC
	difluorodichloromethane	2.46		2.53		2.81
	ethanol ⁽¹⁾	< 4.71		< 4.71		NC
	ethylbenzene	< 0.868		< 0.868		NC
	ethyl acetate	< 1.80	UJ	< 1.80	UJ	NC
	freon-113	< 1.53		< 1.53		NC
	isopropanol ⁽¹⁾	< 1.23		< 1.23		NC
	methylene chloride ⁽¹⁾	< 1.74		< 1.74		NC
	methyl isobutyl ketone (MIBK)	< 0.819	UJ	< 0.819	UJ	NC
	methyl tert butyl ether	< 0.720	UJ	< 0.720	UJ	NC
	p/m-xylene	< 1.74		< 1.74		NC
	o-xylene	< 0.868		< 0.868		NC
	heptane	< 0.819		< 0.819		NC
	n-hexane	< 0.704		< 0.704		NC
	styrene	< 0.851		< 0.851		NC
	tetrachloroethene	< 0.136		< 0.136		NC
tetrahydrofuran	< 0.589	UJ	< 0.589	UJ	NC	
toluene	< 0.753		< 0.753		NC	
trichloroethene	< 0.107		< 0.107		NC	
trichlorofluoromethane	1.28		1.42		10.37	
PCBs (ug/m ³)						
	Total PCBs	< 0.000079		< 0.000079		NC

Notes:

RPD - Relative Percent Difference = $ABS(Dup-Sample)/((Dup+Sample)/2)*100$

NC - RPD could not be calculated due to a non-detect in one or both of the collocated samples

Detected values are shown in bold

J - Concentration should be considered estimated.

R- Result rejected due to calibration non-conformances.

UJ - Non-detect concentration should be considered estimated.

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

**Table 3-2. Comparison of VOC Vent Stack Air Sample Results - Collocated Sampler Precision
Keith Middle School
New Bedford, Massachusetts**

Analysis	Analyte	Apr-09			
		VS-8-19 DUP		VS-8-19	RPD (%)
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 1.48	UJ	NA	N/A
	1,2,4-trimethylbenzene	< 0.982		NA	N/A
	1,2-dichloroethane	1.08		NA	N/A
	1,3-dichlorobenzene	< 1.20		NA	N/A
	2,2,4-trimethylpentane	< 0.934		NA	N/A
	2-butanone	6.85	J	NA	N/A
	acetone ⁽¹⁾	9.99		NA	N/A
	benzene	0.377		NA	N/A
	carbon disulfide	< 0.622		NA	N/A
	chloroform	0.556		NA	N/A
	chloromethane	< 0.413		NA	N/A
	cis-1,2-dichloroethene	< 0.792		NA	N/A
	cyclohexane	1.36		NA	N/A
	difluorodichloromethane	< 0.988		NA	N/A
	ethanol ⁽¹⁾	< 4.71		NA	N/A
	ethylbenzene	< 0.868		NA	N/A
	ethyl acetate	< 1.80	UJ	NA	N/A
	freon-113	< 1.53		NA	N/A
	isopropanol ⁽¹⁾	< 1.23		NA	N/A
	methylene chloride ⁽¹⁾	< 1.74		NA	N/A
	methyl isobutyl ketone (MIBK)	< 0.819	UJ	NA	N/A
	methyl tert butyl ether	< 0.720	UJ	NA	N/A
	p/m-xylene	< 1.74		NA	N/A
	o-xylene	< 0.868		NA	N/A
	heptane	< 0.819		NA	N/A
	n-hexane	< 0.704		NA	N/A
	styrene	< 0.851		NA	N/A
	tetrachloroethene	0.264		NA	N/A
	tetrahydrofuran	5.24	J	NA	N/A
	toluene	1.16		NA	N/A
trichloroethene	0.698		NA	N/A	
trichlorofluoromethane	2.49		NA	N/A	
PCBs (ug/m ³)					
	Total PCBs	< 0.021		< 0.021	NC

Notes:

RPD - Relative Percent Difference = $ABS(Dup-Sample)/((Dup+Sample)/2)*100$

NC - RPD could not be calculated due to a non-detect in one or both of the collocated samples

NA - Not Applicable; no air sample was actually collected at this location in a SUMMA canister on account of a clogged flow controller.

Detected values are shown in bold

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

J - Concentration should be considered estimated.

R- Result rejected due to calibration non-conformances.

UJ - Non-detect concentration should be considered estimated.

Table 4-1. Indoor Air Quality Sample Results - April 2009
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations						Background Locations		QA/QC Trip Blank		
		A-19		B-19		C-19		BG-19	BG-19 Dup			
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 1.48	UJ	< 1.48	UJ	< 1.48	UJ	< 1.48	UJ	< 1.48	< 1.48	
	1,2,4-trimethylbenzene	1.66		< 0.982		< 0.982		< 0.982		< 0.982	< 0.982	
	1,2-dichloroethane	< 0.809		< 0.809		< 0.809		< 0.809		< 0.809	< 0.809	
	1,3-dichlorobenzene	< 1.20		< 1.20		< 1.20		< 1.20		< 1.20	< 1.20	
	2,2,4-trimethylpentane	< 0.934		< 0.934		< 0.934		< 0.934		< 0.934	< 0.934	
	2-butanone	2.05	J	2.70	J	1.58	J	0.810	J	0.775	J	< 0.589
	acetone ⁽¹⁾	15.4		< 13.3 *		< 9.06 *		< 7.19 *		< 5.55 *		1.50
	benzene	0.942		0.680		0.699		0.463		0.485		< 0.223
	carbon disulfide	< 0.622		< 0.622		< 0.622		< 0.622		< 0.622		< 0.622
	chloroform	0.127		< 0.098		0.146		< 0.098		< 0.098		< 0.098
	chloromethane	< 0.413		< 0.413		< 0.413		1.08		1.16		< 0.413
	cis-1,2-dichloroethene	< 0.792		< 0.792		< 0.792		< 0.792		< 0.792		< 0.792
	cyclohexane	< 0.688		< 0.688		< 0.688		< 0.688		< 0.688		< 0.688
	difluorodichloromethane	2.54		2.31		2.32		2.46		2.53		< 0.988
	ethanol ⁽¹⁾	35.9		17.6		13.0		< 4.71		< 4.71		< 4.71
	ethylbenzene	10.1		1.99		< 0.868		< 0.868		< 0.868		< 0.868
	ethyl acetate	< 1.80	UJ	< 1.80	UJ	< 1.80	UJ	< 1.80	UJ	< 1.80	UJ	< 1.80
	freon-113	< 1.53		< 1.53		< 1.53		< 1.53		< 1.53		< 1.53
	isopropanol ⁽¹⁾	5.01		3.71		42.6		< 1.23		< 1.23		< 1.23
	methylene chloride ⁽¹⁾	< 1.74		< 1.74		< 1.74		< 1.74		< 1.74		3.39
	methyl isobutyl ketone (MIBK)	< 0.819	UJ	1.33	J	< 0.819	UJ	< 0.819	UJ	< 0.819	UJ	< 0.819
	methyl tert butyl ether	< 0.720	UJ	< 0.720	UJ	< 0.720	UJ	< 0.720	UJ	< 0.720	UJ	< 0.720
	p/m-xylene	39.0		6.89		< 1.74		< 1.74		< 1.74		< 1.74
	o-xylene	13.0		2.68		< 0.868		< 0.868		< 0.868		< 0.868
	heptane	1.05		0.987		< 0.819		< 0.819		< 0.819		< 0.819
	n-hexane	1.63		0.715		< 0.704		< 0.704		< 0.704		< 0.704
	styrene	< 0.851		< 0.851		1.14		< 0.851		< 0.851		< 0.851
tetrachloroethene	0.156		0.163		0.142		< 0.136		< 0.136		< 0.136	
tetrahydrofuran	< 0.589	UJ	< 0.589	UJ	< 0.589	UJ	< 0.589	UJ	< 0.589	UJ	< 0.589	
toluene	4.05		2.34		1.02		< 0.753		< 0.753		< 0.753	
trichloroethene	0.215		0.215		< 0.107		< 0.107		< 0.107		< 0.107	
trichlorofluoromethane	1.34		1.38		1.21		1.28		1.42		< 1.12	
PCBs (ug/m ³)												
	Total PCBs	0.013	J	0.0034	J	0.0095	J	< 0.000079		< 0.000079		< 0.025 ug

Notes:

J - Concentration should be considered estimated.

R- Result rejected due to calibration non-conformances.

UJ - Non-detect concentration should be considered estimated.

ND - Non-detect

* - Concentration should be considered non-detect on account of blank contamination.

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

PCBs - polychlorinated biphenyls

ug - micrograms; trip blank results are presented in micrograms (ug) due to no air volume being collected during analysis.

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

Reporting Limit for Total PCBs is the highest individual homolog PQL (practical quantitation limit) per sample.

Table 4-2. Vent Stack Sample Results - April 2009
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations					Background	QA/QC
		VS-8-19 DUP	VS-8-19	VS-11-19	VS-1-19	VS-4-19	VS-BG-19	Trip Blank-VS
VOCs (ug/m ³)	1,2,4-trichlorobenzene	< 1.48 UJ	NA	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48
	1,2,4-trimethylbenzene	< 0.982	NA	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982
	1,2-dichloroethane	1.08	NA	< 0.809	0.825	< 0.809	< 0.809	< 0.809
	1,3-dichlorobenzene	< 1.20	NA	< 1.20	3.52	3.13	< 1.20	< 1.20
	2,2,4-trimethylpentane	< 0.934	NA	< 0.934	< 0.934	< 0.934	< 0.934	< 0.934
	2-butanone	6.85 J	NA	10.6 J	7.19 J	8.42 J	< 0.589 UJ	< 0.589
	acetone ⁽¹⁾	9.99	NA	12.7	27.4	22.2	6.04	< 1.19
	benzene	0.377	NA	0.586	0.610	0.696	0.408	< 0.223
	carbon disulfide	< 0.622	NA	< 0.622	< 0.622	0.684	< 0.622	< 0.622
	chloroform	0.556	NA	0.742	2.80	1.64	< 0.098	< 0.098
	chloromethane	< 0.413	NA	< 0.413	< 0.413	< 0.413	1.23	< 0.413
	cis-1,2-dichloroethene	< 0.792	NA	< 0.792	< 0.792	7.07	< 0.792	< 0.792
	cyclohexane	1.36	NA	2.26	< 0.688	< 0.688	< 0.688	< 0.688
	difluorodichloromethane	< 0.988	NA	< 0.988	< 0.988	< 0.988	2.56	< 0.988
	ethanol ⁽¹⁾	< 4.71	NA	< 4.71	6.44	9.28	< 4.71	< 4.71
	ethylbenzene	< 0.868	NA	< 0.868	< 0.868	1.75	< 0.868	< 0.868
	ethyl acetate	< 1.80 UJ	NA	< 1.80 UJ	< 1.80 UJ	< 1.80 UJ	< 1.80 UJ	< 1.80
	freon-113	< 1.53	NA	< 1.53	< 1.53	< 1.53	< 1.53	< 1.53
	isopropanol ⁽¹⁾	< 1.23	NA	< 1.23	2.31	4.82	< 1.23	< 1.23
	methylene chloride ⁽¹⁾	< 1.74	NA	< 1.74	< 1.74	< 1.74	< 1.74	< 1.74
	methyl isobutyl ketone (MIBK)	< 0.819 UJ	NA	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819
	methyl tert butyl ether	< 0.720 UJ	NA	15.0 J	< 0.720 UJ	< 0.720 UJ	< 0.720 UJ	< 0.720
	p/m-xylene	< 1.74	NA	1.75	2.11	5.44	< 1.74	< 1.74
	o-xylene	< 0.868	NA	< 0.868	< 0.868	1.74	< 0.868	< 0.868
	heptane	< 0.819	NA	< 0.819	< 0.819	< 0.819	< 0.819	< 0.819
	n-hexane	< 0.704	NA	1.75	< 0.704	< 0.704	< 0.704	< 0.704
	styrene	< 0.851	NA	< 0.851	< 0.851	< 0.851	< 0.851	< 0.851
tetrachloroethene	0.264	NA	0.237	1.29	2.09	< 0.136	< 0.136	
tetrahydrofuran	5.24 J	NA	6.99 J	2.06 J	9.47 J	< 0.589 UJ	< 0.589	
toluene	1.16	NA	1.67	1.38	1.52	< 0.753	< 0.753	
trichloroethene	0.698	NA	0.134	0.204	0.231	< 0.107	< 0.107	
trichlorofluoromethane	2.49	NA	1.52	< 1.12	1.89	1.61	< 1.12	
PCBs (ug/m ³)	Total PCBs	< 0.021	< 0.021	< 0.023	< 0.023	< 0.021	< 0.021	< 0.025 ug

Notes:

J - Concentration should be considered estimated.

R - Result rejected due to calibration non-conformances.

UJ - Non-detect concentration should be considered estimated.

ND - Non-detect

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

PCBs - polychlorinated biphenyls

ug - micrograms; trip blank results are presented in micrograms (ug) due to no air volume being collected during analysis.

NA - Not Applicable; no air sample was actually collected at this location in a SUMMA canister on account of a clogged flow controller.

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

Table 5-1. Comparison of PCB Indoor Air Quality Sample Results to Risk-Based Air Concentrations - April 2009
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations			Background Locations		QA/QC Trip Blank	MassDEP Background	Comparison Values	
		A-19	B-19	C-19	BG-19	BG-19 Dup			AL*	ALTAEC*
PCBs ($\mu\text{g}/\text{m}^3$)									AL*	ALTAEC*
	Total PCBs	0.013	0.0034	0.0095	< 0.000079	< 0.000079	< 0.025 ug	--	0.05	0.3

Notes:

$\mu\text{g}/\text{m}^3$ - micrograms per cubic meter

PCBs - polychlorinated biphenyls

ug - micrograms; trip blank results are presented in micrograms (ug) since no air volume is collected for the trip blank

PCB results for indoor air are compared to contemporary outdoor air (background) sample and MassDEP indoor air background values.

* PCBs are compared to the EPA site specific Action Level (AL) and the Acceptable Long-Term Average Exposure Concentration (ALTAEC).

Reporting Limit for Total PCBs is the highest individual homolog PQL (practical quantitation limit) per sample.

Table 5-2. Comparison of PCB Vent Stack Sample Results to Risk-Based Air Concentrations - April 2009
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations					Background	QA/QC	Comparison Values	
		VS-8-19 DUP	VS-8-19	VS-11-19	VS-1-19	VS-4-19	VS-BG-19	Trip Blank-VS	AL*	ALTAEC*
PCBs ($\mu\text{g}/\text{m}^3$)	Total PCBs	< 0.021	< 0.021	< 0.023	< 0.023	< 0.021	< 0.021	< 0.025 ug	0.05	0.3

Notes:

$\mu\text{g}/\text{m}^3$ - micrograms per cubic meter

PCBs - polychlorinated biphenyls

ug - micrograms; trip blank results are presented in micrograms (ug) since no air volume is collected for the trip blank

PCB results for vent stack air are compared to contemporary outdoor air (background) sample.

* PCBs are compared to the EPA site specific Action Level (AL) and the Acceptable Long-Term Average Exposure Concentration (ALTAEC).

Reporting Limit for Total PCBs is the highest individual homolog PQL (practical quantitation limit) per sample.

Table 6-1. Comparison of VOC Indoor Air Quality Sample Results to Comparison Criteria - April 2009
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations						Background Locations		QA/QC Trip Blank	MassDEP Background	MassDEP IATV	Comparison Values					
		A-19		B-19		C-19		BG-19	BG-19 Dup				TEL*	AAL*	EPA SL (residential)	EPA SL (commercial)		
VOCs (µg/m ³)	1,2,4-trichlorobenzene	< 1.48	UJ	< 1.48	UJ	< 1.48	UJ	< 1.48	UJ	< 1.48	UJ	< 1.48	0.59	3.4	--	--	0.22 (e)	1.1 (e)
	1,2,4-trimethylbenzene	1.66		< 0.982		< 0.982		< 0.982		< 0.982		< 0.982	--	--	--	--	1.46 (a)	6.2 (a)
	1,2-dichloroethane	< 0.809		< 0.809		< 0.809		< 0.809		< 0.809		< 0.809	--	0.09	11.01	0.04	0.094 (a)	0.47 (a)
	1,3-dichlorobenzene	< 1.20		< 1.20		< 1.20		< 1.20		< 1.20		< 1.20	--	0.6	--	--	0.22 (e)	1.1 (e)
	2,2,4-trimethylpentane	< 0.934		< 0.934		< 0.934		< 0.934		< 0.934		< 0.934	--	--	--	--	146 (b)	620 (b)
	2-butanone	2.05	J	2.70	J	1.58	J	0.810	J	0.775	J	< 0.589	42.18	12	200	10	1040 (a)	4400 (a)
	acetone ⁽¹⁾	15.4		< 13.3 ⁽²⁾		< 9.06 ⁽²⁾		< 7.19 ⁽²⁾		< 5.55 ⁽²⁾		1.50	27.04	91	160.54	160.54	6400 (a)	28000 (a)
	benzene	0.942		0.680		0.699		0.463		0.485		< 0.223	21	2.3	1.74	0.12	0.31 (a)	1.6 (a)
	carbon disulfide	< 0.622		< 0.622		< 0.622		< 0.622		< 0.622		< 0.622	--	--	0.1	0.1	146 (a)	620 (a)
	chloroform	0.127		< 0.098		0.146		< 0.098		< 0.098		< 0.098	3.36	1.9	132.76	0.04	0.11 (a)	0.53 (a)
	chloromethane	< 0.413		< 0.413		< 0.413		1.08		1.16		< 0.413	--	--	--	--	18.8 (a)	78 (a)
	cis-1,2-dichloroethene	< 0.792		< 0.792		< 0.792		< 0.792		< 0.792		< 0.792	--	0.8	215.62	107.81	12.6 (f)	52 (f)
	cyclohexane	< 0.688		< 0.688		< 0.688		< 0.688		< 0.688		< 0.688	--	--	280.82	280.82	1260 (a)	5200 (a)
	difluorodichloromethane	2.54		2.31		2.32		2.46		2.53		< 0.988	--	--	--	--	42 (a)	176 (a)
	ethanol ⁽¹⁾	35.9		17.6		13.0		< 4.71		< 4.71		< 4.71	--	--	51.24	51.24	--	--
	ethylbenzene	10.1		1.99		< 0.868		< 0.868		< 0.868		< 0.868	9.62	7.4	300	300	0.97 (a)	4.9 (a)
	ethyl acetate	< 1.80	UJ	< 1.80	UJ	< 1.80	UJ	< 1.80	UJ	< 1.80	UJ	< 1.80	--	--	391.84	391.84	--	--
	freon-113	< 1.53		< 1.53		< 1.53		< 1.53		< 1.53		< 1.53	--	--	--	--	6200 (a)	26000 (a)
	isopropanol ⁽¹⁾	5.01		3.71		42.6		< 1.23		< 1.23		< 1.23	--	--	--	--	41.22 (c)	41.22 (c)
	methylene chloride ⁽¹⁾	< 1.74		< 1.74		< 1.74		< 1.74		< 1.74		3.39	600	5.0	9.45	0.24	5.2 (a)	26 (a)
	methyl isobutyl ketone (MIBK)	< 0.819	UJ	1.33	J	< 0.819	UJ	< 0.819	UJ	< 0.819	UJ	< 0.819	--	2.2	55.7	55.7	620 (a)	2600 (a)
	methyl tert butyl ether	< 0.720	UJ	< 0.720	UJ	< 0.720	UJ	< 0.720	UJ	< 0.720	UJ	< 0.720	--	39	--	--	9.4 (a)	47 (a)
	p/m-xylene	39.0		6.89		< 1.74		< 1.74		< 1.74		< 1.74	72.41**	20	11.8**	11.8**	146 (a)	620 (a)
	o-xylene	13.0		2.68		< 0.868		< 0.868		< 0.868		< 0.868	72.41**	20	11.8**	11.8**	146 (a)	620 (a)
	heptane	1.05		0.987		< 0.819		< 0.819		< 0.819		< 0.819	--	--	--	--	146 (d)	620 (d)
	n-hexane	1.63		0.715		< 0.704		< 0.704		< 0.704		< 0.704	--	--	--	--	146 (a)	620 (a)
	styrene	< 0.851		< 0.851		1.14		< 0.851		< 0.851		< 0.851	2.79	1.4	200	2	200 (a)	880 (a)
	tetrachloroethene	0.156		0.163		0.142		< 0.136		< 0.136		< 0.136	11.01	1.4	922.18	0.02	0.41 (a)	2.1 (a)
	tetrahydrofuran	< 0.589	UJ	< 0.589	UJ	< 0.589	UJ	< 0.589	UJ	< 0.589	UJ	< 0.589	--	--	160.35	80.18	--	--
	toluene	4.05		2.34		1.02		< 0.753		< 0.753		< 0.753	28.65	54	80	20	1040 (a)	4400 (a)
	trichloroethene	0.215		0.215		< 0.107		< 0.107		< 0.107		< 0.107	4.49	0.8	36.52	0.61	1.2 (a)	6.1 (a)
	trichlorofluoromethane	1.34		1.38		1.21		1.28		1.42		< 1.12	--	--	--	--	146 (a)	620 (a)

Notes:

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

IATV - Indoor Air Threshold Value; Mass DEP review draft June 2009

EPA SL - EPA Screening Level; April 2009

- (a) EPA Screening Level (ELCR of 1E-06 for carcinogens; hazard of 0.2 for noncarcinogens)
- (b) EPA SL for n-hexane used as surrogate for 2,2,4-trimethylpentane
- (c) AAL/TEL for isobutyl alcohol used as surrogate for isopropanol
- (d) EPA SL for n-hexane used as surrogate for heptane
- (e) EPA SL for 1,4-dichlorobenzene used as surrogate for 1,2,4-trichlorobenzene and 1,3-dichlorobenzene
- (f) EPA SL for trans-1,2-dichloroethene used as surrogate for cis-1,2-dichloroethene

Highlighted values show exceedances of comparison values and the value which was exceeded

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

⁽²⁾ Concentration should be considered non-detect on account of blank contamination.

VOC results for indoor air are compared to contemporary outdoor air (background) sample and MassDEP indoor air background values.

* Threshold Effects Exposure Limits (TELS) and Allowable Ambient Limits (AALs) for ambient air currently in effect (December, 1995)

** - Value for xylenes (m-, o-, and p-isomers)

-- - No corresponding comparison criterion.

J - Concentration should be considered estimated.

R - Result rejected due to calibration non-conformances.

UJ - Non-detect concentration should be considered estimated.

Table 6-2. Comparison of VOC Vent Stack Sample Results to Comparison Criteria - April 2009
Keith Middle School
New Bedford, Massachusetts

Analysis	Analyte	Sample Locations					Background VS-BG-19	QA/QC Trip Blank-VS	Comparison Values			
		VS-8-19 DUP	VS-8-19	VS-11-19	VS-1-19	VS-4-19			TEL*	AAL*	EPA SL (residential)	EPA SL (commercial)
VOCs (µg/m ³)	1,2,4-trichlorobenzene	< 1.48 UJ	NA	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48 UJ	< 1.48	--	--	0.22 (e)	1.1 (e)
	1,2,4-trimethylbenzene	< 0.982	NA	< 0.982	< 0.982	< 0.982	< 0.982	< 0.982	--	--	1.46 (a)	6.2 (a)
	1,2-dichloroethane	1.08	NA	< 0.809	0.825	< 0.809	< 0.809	< 0.809	11.01	0.04	0.094 (a)	0.47 (a)
	1,3-dichlorobenzene	< 1.20	NA	< 1.20	3.52	3.13	< 1.20	< 1.20	--	--	0.22 (e)	1.1 (e)
	2,2,4-trimethylpentane	< 0.934	NA	< 0.934	< 0.934	< 0.934	< 0.934	< 0.934	--	--	146 (b)	620 (b)
	2-butanone	6.85 J	NA	10.6 J	7.19 J	8.42 J	< 0.589 UJ	< 0.589	200	10	1040 (a)	4400 (a)
	acetone ⁽¹⁾	9.99	NA	12.7	27.4	22.2	6.04	< 1.19	160.54	160.54	6400 (a)	28000 (a)
	benzene	0.377	NA	0.586	0.610	0.696	0.408	< 0.223	1.74	0.12	0.31 (a)	1.6 (a)
	carbon disulfide	< 0.622	NA	< 0.622	< 0.622	0.684	< 0.622	< 0.622	0.1	0.1	146 (a)	620 (a)
	chloroform	0.556	NA	0.742	2.80	1.64	< 0.098	< 0.098	132.76	0.04	0.11 (a)	0.53 (a)
	chloromethane	< 0.413	NA	< 0.413	< 0.413	< 0.413	1.23	< 0.413	--	--	18.8 (a)	78 (a)
	cis-1,2-dichloroethene	< 0.792	NA	< 0.792	< 0.792	7.07	< 0.792	< 0.792	215.62	107.81	12.6 (f)	52 (f)
	cyclohexane	1.36	NA	2.26	< 0.688	< 0.688	< 0.688	< 0.688	280.82	280.82	1260 (a)	5200 (a)
	difluorodichloromethane	< 0.988	NA	< 0.988	< 0.988	< 0.988	2.56	< 0.988	--	--	42 (a)	176 (a)
	ethanol ⁽¹⁾	< 4.71	NA	< 4.71	6.44	9.28	< 4.71	< 4.71	51.24	51.24	--	--
	ethylbenzene	< 0.868	NA	< 0.868	< 0.868	1.75	< 0.868	< 0.868	300	300	0.97 (a)	4.9 (a)
	ethyl acetate	< 1.80 UJ	NA	< 1.80 UJ	< 1.80 UJ	< 1.80 UJ	< 1.80 UJ	< 1.80 UJ	391.84	391.84	--	--
	freon-113	< 1.53	NA	< 1.53	< 1.53	< 1.53	< 1.53	< 1.53	--	--	6200 (a)	26000 (a)
	isopropanol ⁽¹⁾	< 1.23	NA	< 1.23	2.31	4.82	< 1.23	< 1.23	--	--	41.22 (c)	41.22 (c)
	methylene chloride ⁽¹⁾	< 1.74	NA	< 1.74	< 1.74	< 1.74	< 1.74	< 1.74	9.45	0.24	5.2 (a)	26 (a)
	methyl isobutyl ketone (MIBK)	< 0.819 UJ	NA	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	< 0.819 UJ	55.7	55.7	620 (a)	2600 (a)
	methyl tert butyl ether	< 0.720 UJ	NA	15.0 J	< 0.720 UJ	< 0.720 UJ	< 0.720 UJ	< 0.720 UJ	--	--	9.4 (a)	47 (a)
	p/m-xylene	< 1.74	NA	1.75	2.11	5.44	< 1.74	< 1.74	11.8**	11.8**	146 (a)	620 (a)
	o-xylene	< 0.868	NA	< 0.868	< 0.868	1.74	< 0.868	< 0.868	11.8**	11.8**	146 (a)	620 (a)
	heptane	< 0.819	NA	< 0.819	< 0.819	< 0.819	< 0.819	< 0.819	--	--	146 (d)	620 (d)
	n-hexane	< 0.704	NA	1.75	< 0.704	< 0.704	< 0.704	< 0.704	--	--	146 (a)	620 (a)
styrene	< 0.851	NA	< 0.851	< 0.851	< 0.851	< 0.851	< 0.851	200	2	200 (a)	880 (a)	
tetrachloroethene	0.264	NA	0.237	1.29	2.09	< 0.136	< 0.136	922.18	0.02	0.41 (a)	2.1 (a)	
tetrahydrofuran	5.24 J	NA	6.99 J	2.06 J	9.47 J	< 0.589 UJ	< 0.589	160.35	80.18	--	--	
toluene	1.16	NA	1.67	1.38	1.52	< 0.753	< 0.753	80	20	1040 (a)	4400 (a)	
trichloroethene	0.698	NA	0.134	0.204	0.231	< 0.107	< 0.107	36.52	0.61	1.2 (a)	6.1 (a)	
trichlorofluoromethane	2.49	NA	1.52	< 1.12	1.89	1.61	< 1.12	--	--	146 (a)	620 (a)	

Notes:

µg/m³ - micrograms per cubic meter

VOCs - volatile organic compounds

EPA SL - EPA Screening Level; April 2009

(a) EPA Screening Level (ELCR of 1E-06 for carcinogens; hazard of 0.2 for noncarcinogens)

(b) EPA SL for n-hexane used as surrogate for 2,2,4-trimethylpentane

(c) AAL/TEL for isobutyl alcohol used as surrogate for isopropanol

(d) EPA SL for n-hexane used as surrogate for heptane

(e) EPA SL for 1,4-dichlorobenzene used as surrogate for 1,2,4-trichlorobenzene and 1,3-dichlorobenzene

(f) EPA SL for trans-1,2-dichloroethene used as surrogate for cis-1,2-dichloroethene

Highlighted values show exceedances of comparison values and the value which was exceeded

⁽¹⁾ Compound is a common laboratory contaminant as discussed in Section 3.

VOC results for indoor air are compared to contemporary outdoor air (background) sample and MassDEP indoor air background values.

* Threshold Effects Exposure Limits (TELS) and Allowable Ambient Limits (AALs) for ambient air currently in effect (December, 1995)

** - Value for xylenes (m-, o-, and p-isomers)

-- - No corresponding comparison criterion.

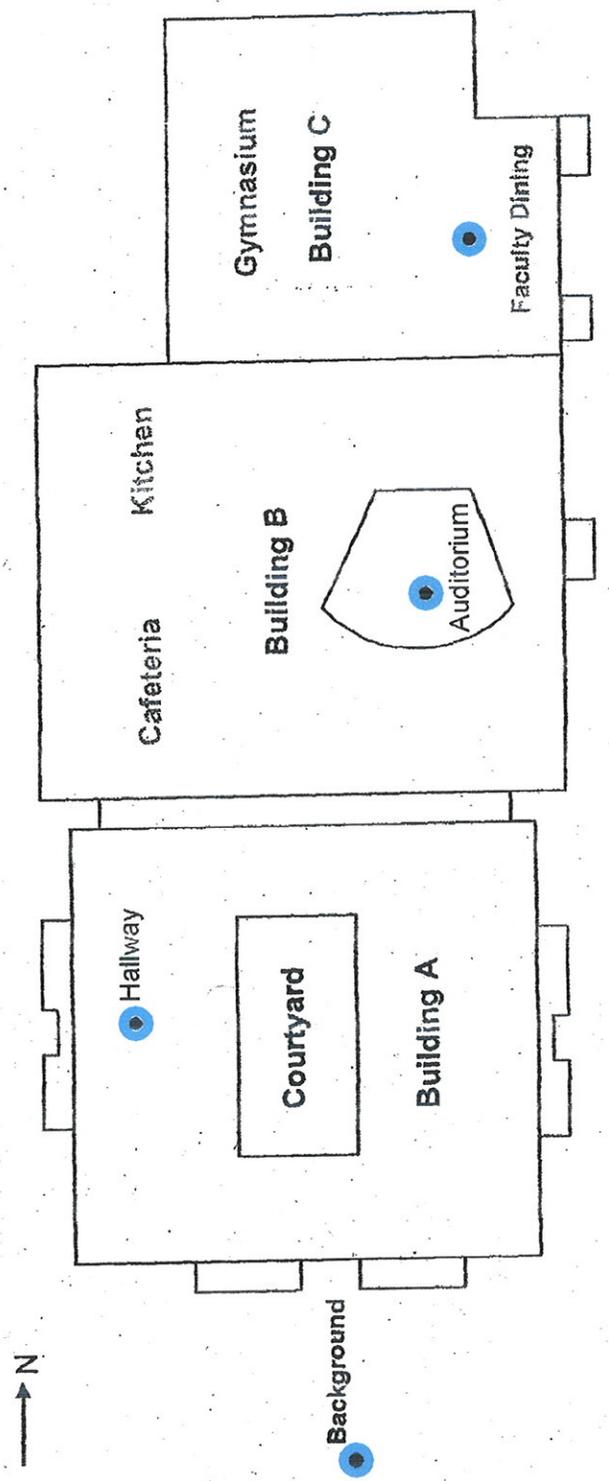
J - Concentration should be considered estimated.

R - Result rejected due to calibration non-conformances.

UJ - Non-detect concentration should be considered estimated.

FIGURES

Keith Middle School Indoor Air Sampling Locations

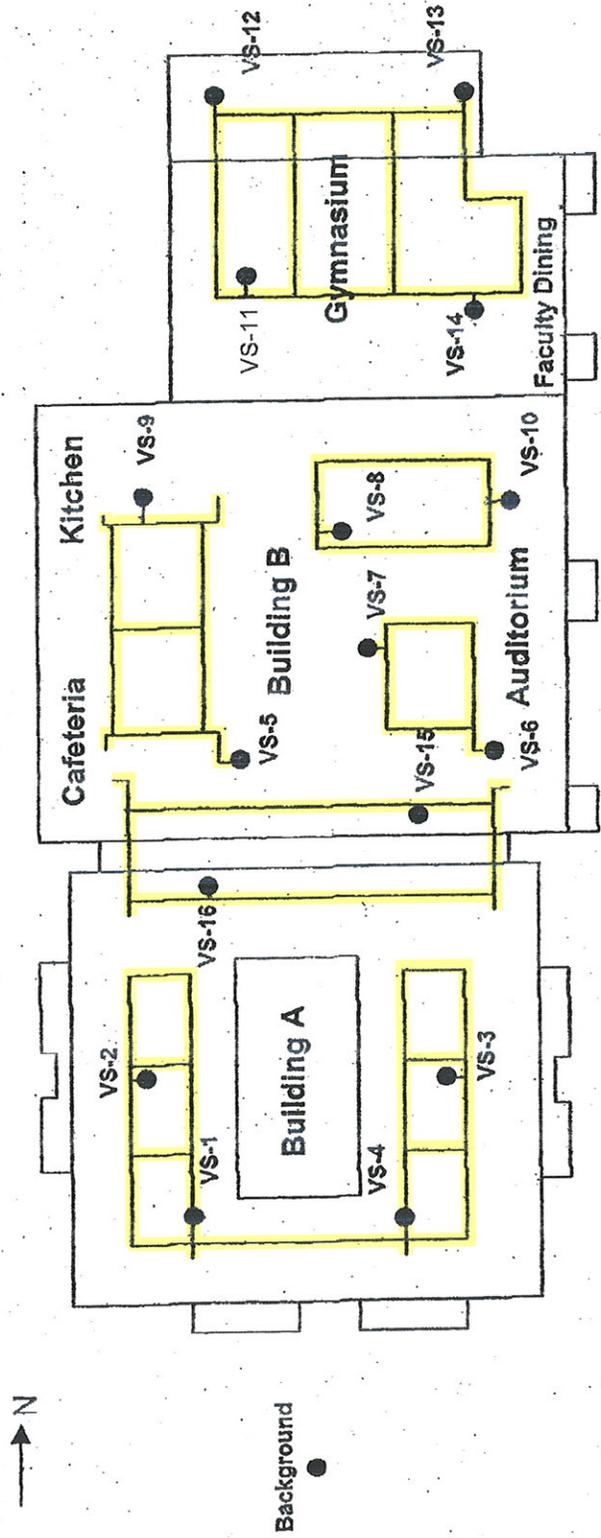


KEITH MIDDLE SCHOOL NEW BEDFORD, MASSACHUSETTS	
INDOOR AIR SAMPLING LOCATIONS	
Wannancit Mills 650 Suffolk Street Lowell, MA 01854 (978) 970-5600	
DRAWN BY: ---	DATE: MAY 2008
CHECKED BY: DMS	

FIGURE
2-1

- = Indoor Air Sampling Point
- = Sample Locations

Keith Middle School Foundation Venting System



Hathaway Boulevard

- = Vent Riser / Vent Stack Sampling location
- = Passive Venting and Collection System

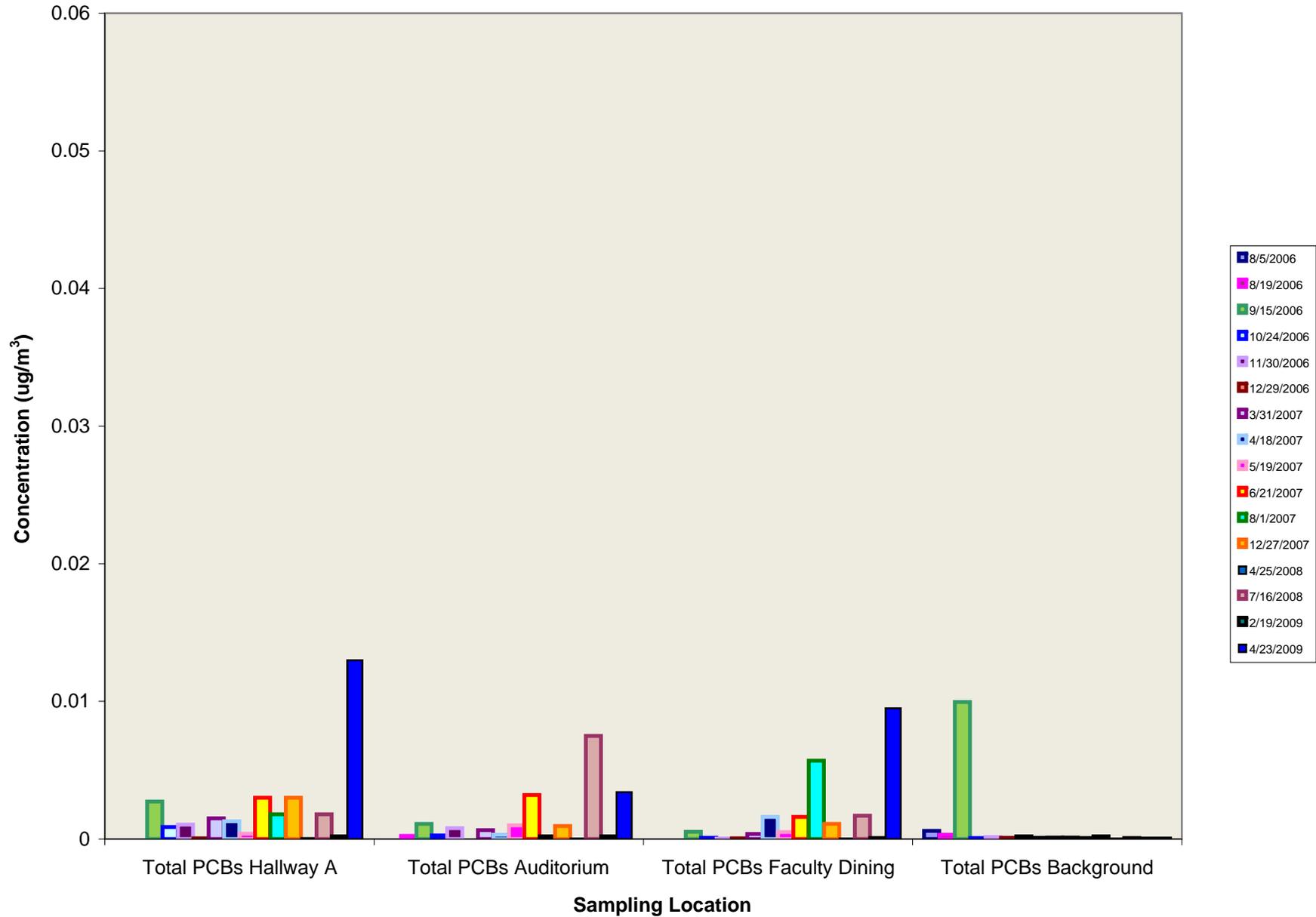
KEITH MIDDLE SCHOOL
NEW BEDFORD, MASSACHUSETTS

VENT STACK SAMPLE LOCATIONS

CTRC
Wannalancit Mills
650 Suffolk Street
Lowell, MA 01854
(978) 970-5600

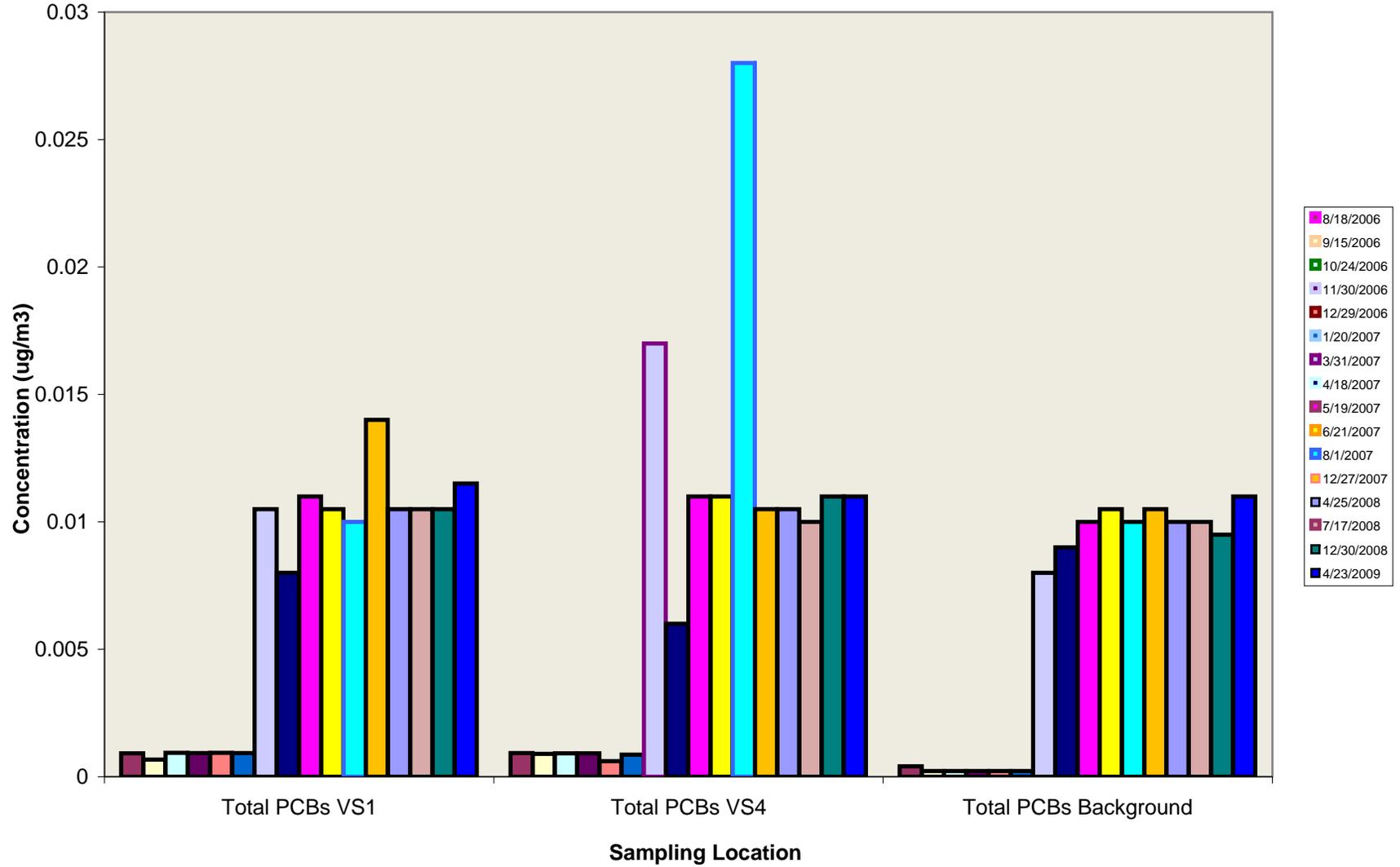
FIGURE 2-2
DRAWN BY: --- DATE: MAY 2008
CHECKED BY: DMS

Figure 5-1. Total PCB Trends in KMS Indoor Air Quality (IAQ) Samples - August 2006 through April 2009



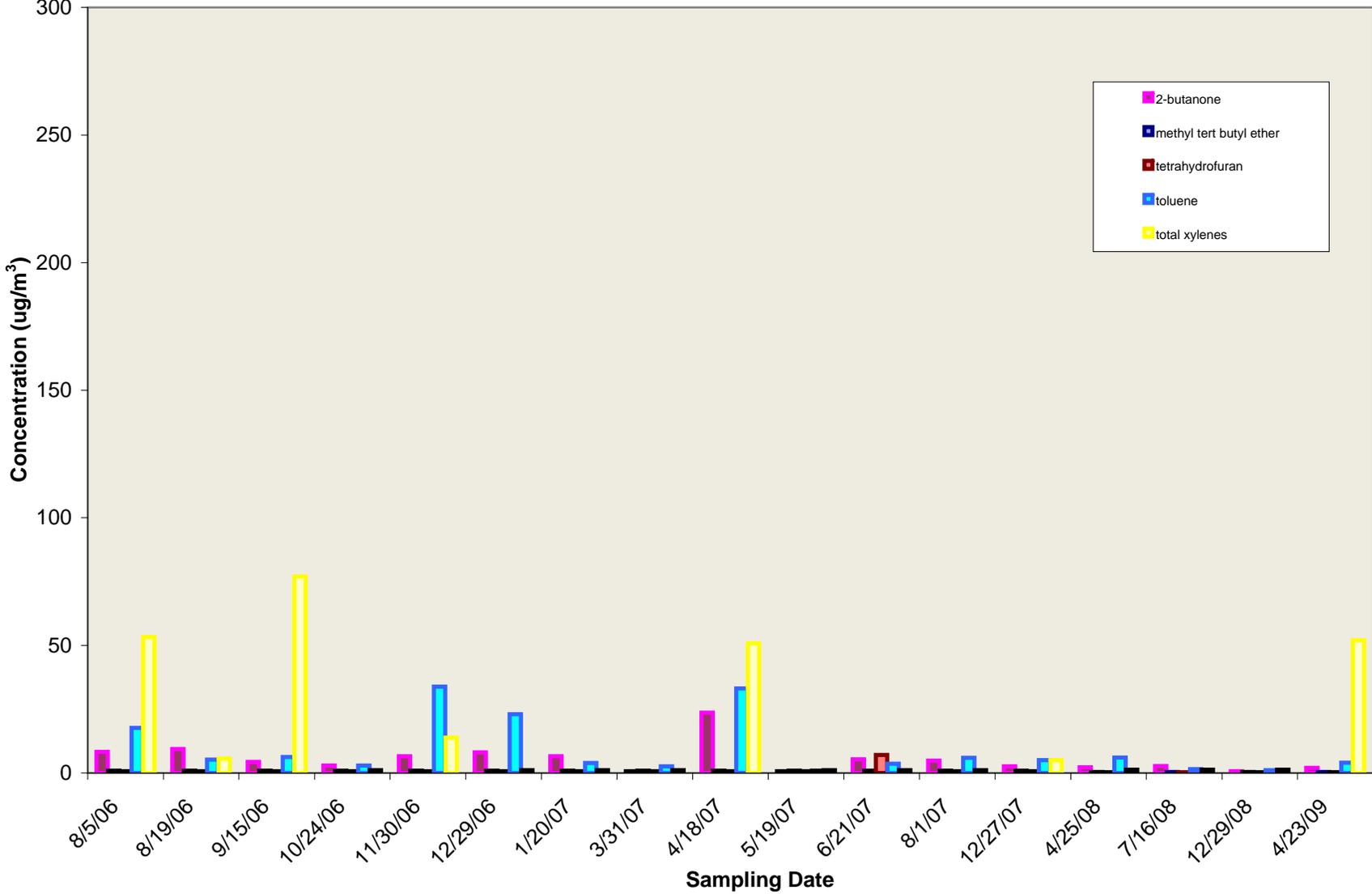
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 5-2. KMS Vent Stack PCB Trends - August 2006 through April 2009



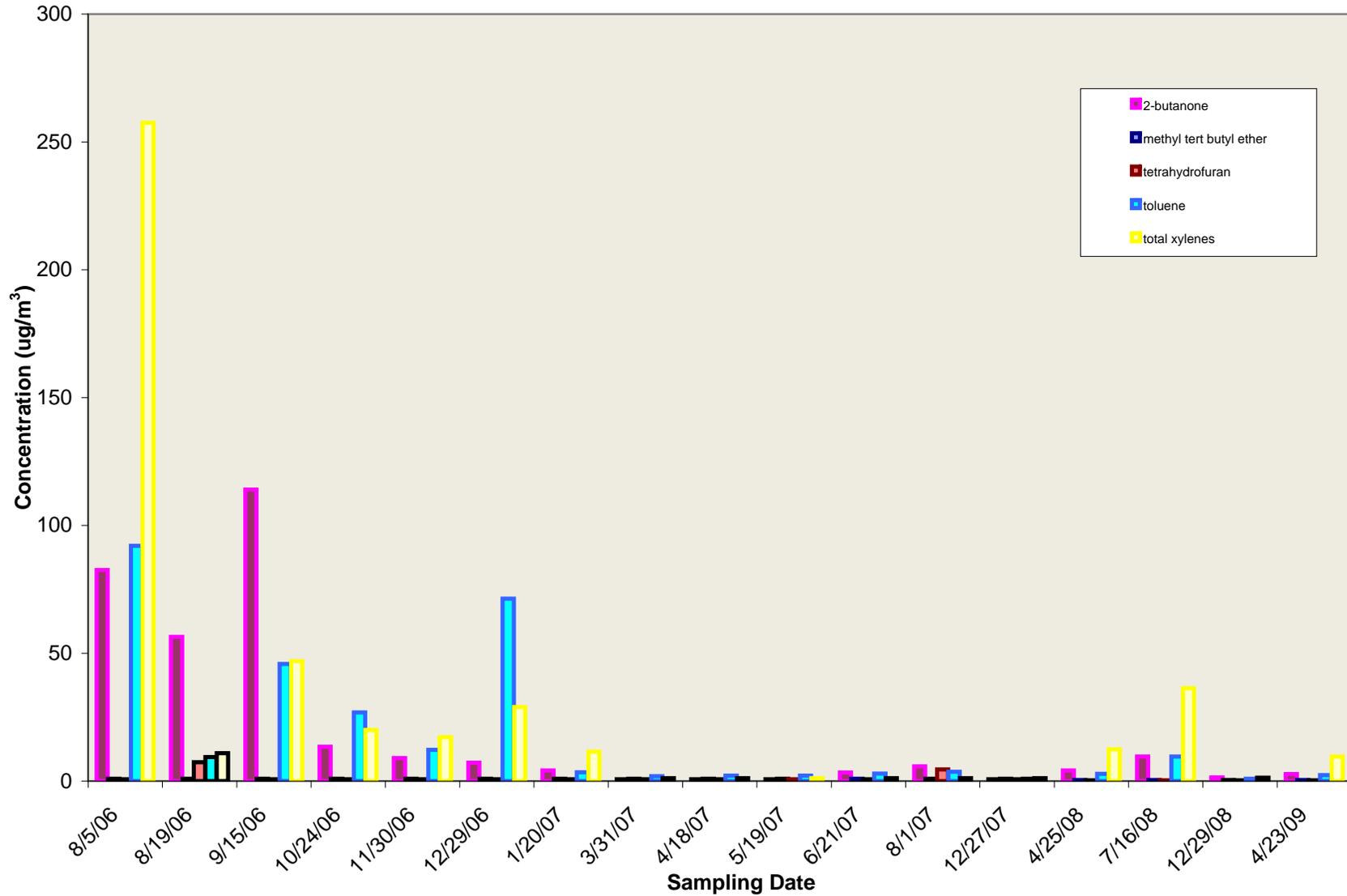
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 6-1. VOC Trends in KMS Building A (IAQ) - August 2006 through April 2009



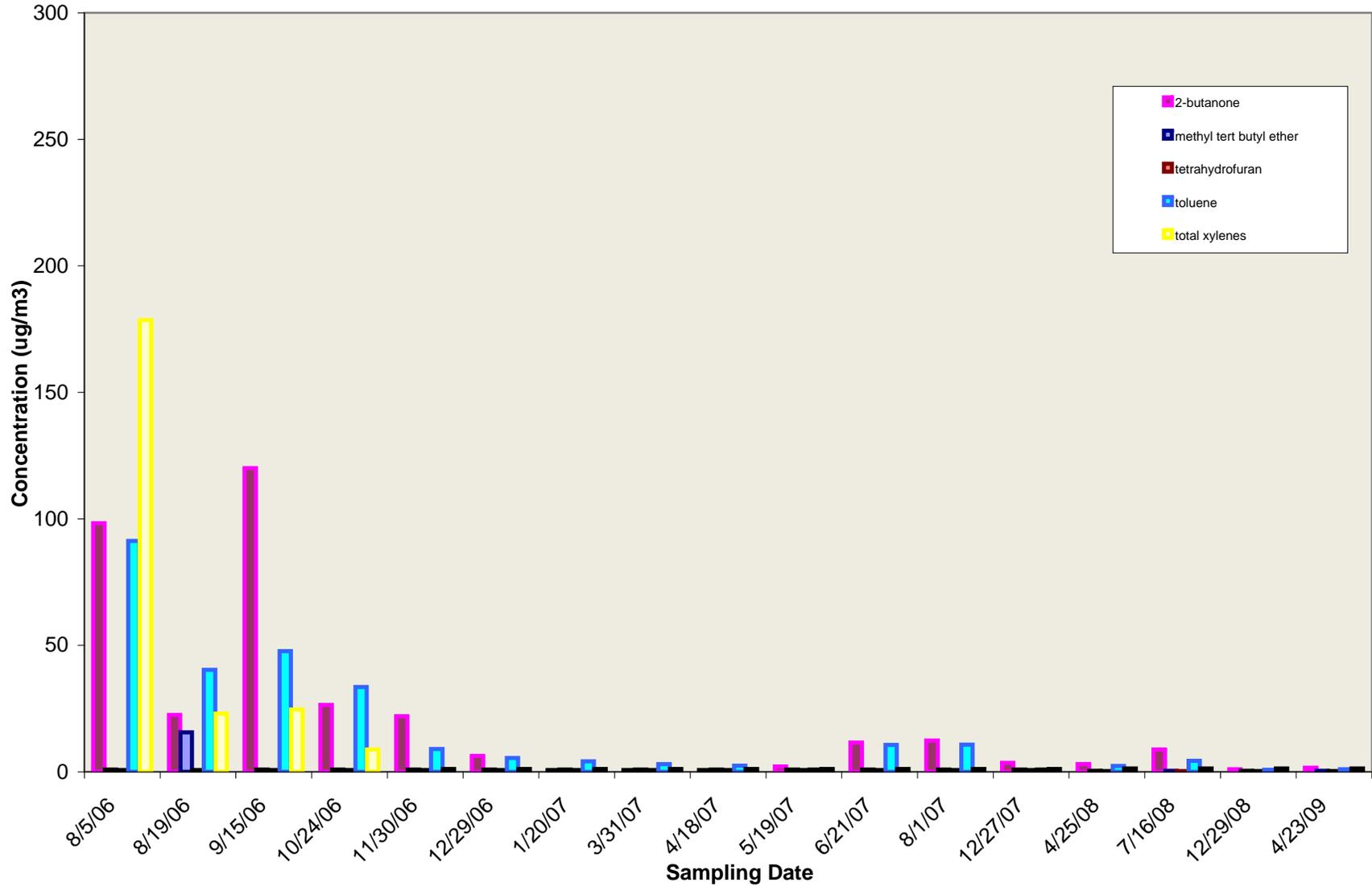
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 6-2. VOC Trends in KMS Building B (IAQ) - August 2006 through April 2009



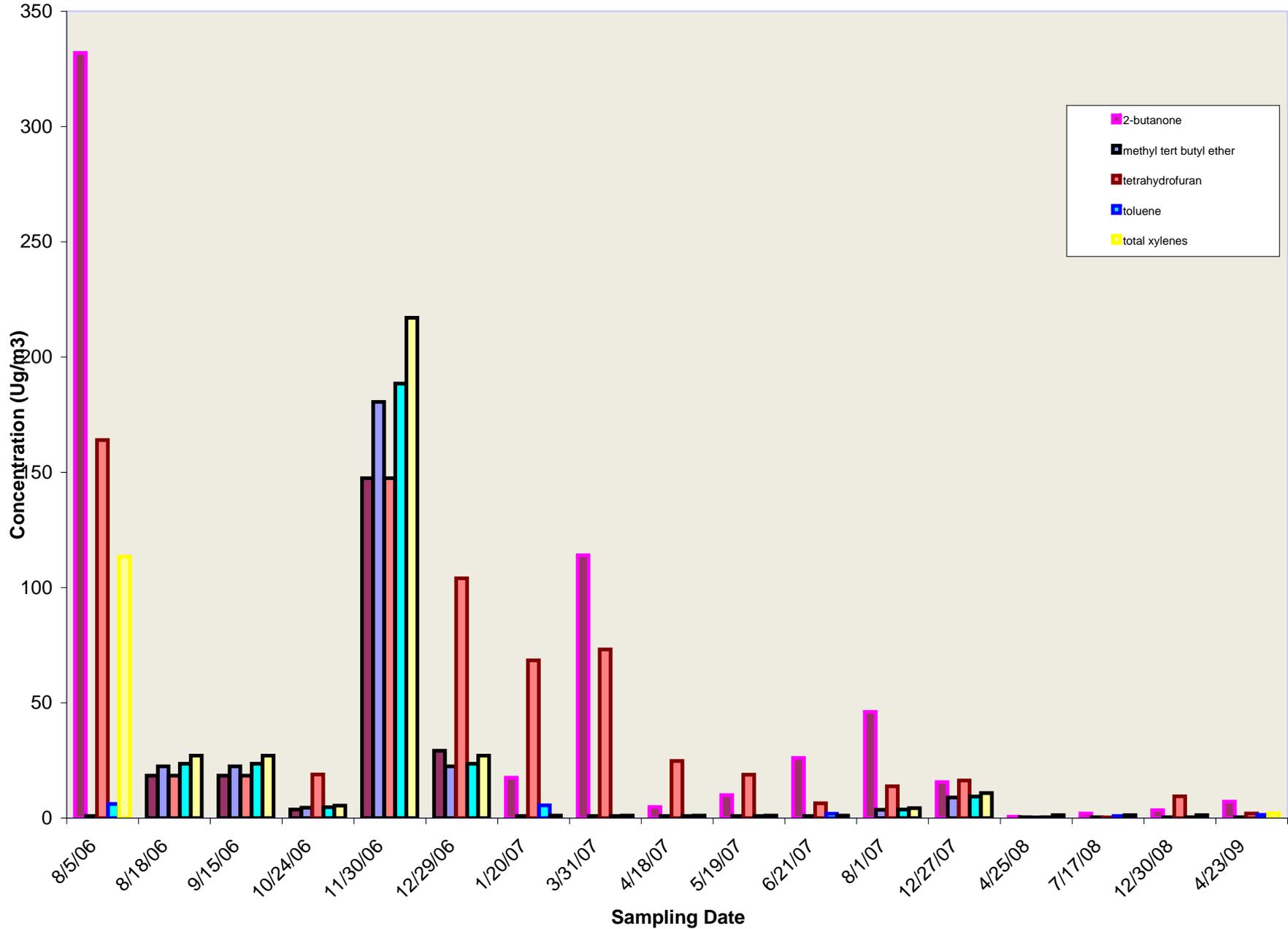
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 6-3. VOC Trends in KMS Building C (IAQ) - August 2006 through April 2009



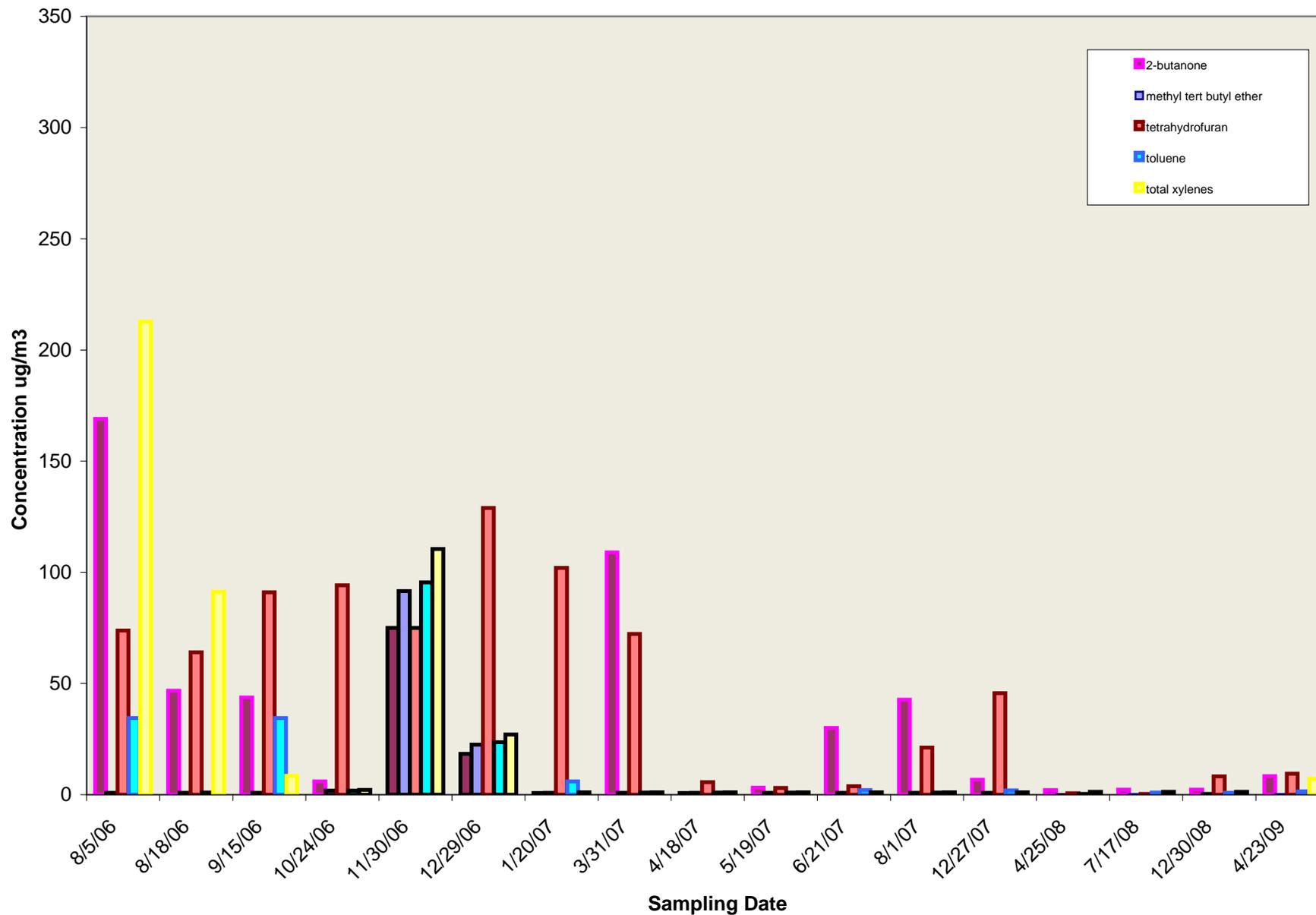
Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 6-4. VOC Trends in KMS Vent Stack VS-1 - August 2006 through April 2009



Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

Figure 6-5. VOC Trends in KMS Vent Stack VS-4 - August 2006 through April 2009



Each bar represents a single measurement. Bars outlined in black represent values reported by the laboratory as nondetect. For charting purposes these nondetect values are plotted as one half the reporting limit.

APPENDIX A

SUMMARY OF FIELD SAMPLING PROGRAM, ANALYTICAL PROGRAM, AND QUALITY ASSURANCE

1.0 FIELD SAMPLING PROGRAM

1.1 Overview

This section describes the procedures that TRC followed during the field sampling program.

1.2 Indoor Air Quality Sampling

Each of the indoor air quality field samples was collected by TRC over the course of one 24-hour test period. Indoor air quality samples were collected for analysis of PCBs by EPA Method TO-4A and VOCs by EPA Method TO-15.

1.2.1 Method TO-4A

Indoor air quality (IAQ) samples were collected for PCBs following the procedures described in the EPA Compendium Method TO-4A, *Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using High Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic/Multi-Detector Detection (GC/MD)*, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*, USEPA, January 1999.

TRC placed a high volume sampler at each PCB indoor air sampling location. A multi-point calibration was performed on each high volume sampler prior to sample collection using a calibrated orifice. A polyurethane foam (PUF) sampling cartridge was then unsealed and inserted into the high volume sampler and the sampler turned on. The start time, elapsed hours counter reading, and flow rate (magnehelic reading) were then recorded on a data sheet. After 24 hours of sampling, the elapsed hours counter reading and flow rate (magnehelic reading) were recorded on a data sheet along with the stop time. The PUF cartridge was then removed from the sampler, sealed, and labeled. A single-point post sampling calibration audit was performed to document that the high volume sampler remained calibrated.

Following the collection of the TO-4A samples, the total volume of ambient air sampled for each cartridge was calculated based on the duration of sampling and the average flow rate, as determined from the initial and final flow rates.

The data sheets are provided in Appendix B and the reduced data are presented in Appendix C. The calibration certifications of the critical orifice can be found in Appendix D.

1.2.2 Method TO-15

IAQ samples were collected for VOCs following the procedures described in the EPA Compendium Method TO-15, *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)*, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*, USEPA, January 1999.

At each sampling location a six-liter evacuated SUMMA™ canister was set up with a flow-controller set to collect a sample over a 24-hour sampling period, and the canister valve opened. The flow controllers are pre-set by the laboratory performing the VOC analysis. The start time, SUMMA™ canister and flow-controller serial numbers, and SUMMA™ canister initial vacuum are then recorded on a data sheet. After 24 hours of sampling, the SUMMA™ canister valve was closed and the final SUMMA™ canister vacuum and stop time recorded

The data sheets can be found in Appendix B and the reduced data can be found in Appendix C.

1.3 Foundation Vent Air Sampling

Each of the vent air field samples was collected by TRC over the course of a 4-hour test period. Vent air samples were collected for analysis of PCBs by EPA Method TO-10A and VOCs by EPA Method TO-15. Prior to sampling, all of the foundation vents were temporarily capped for approximately 24 hours. Just prior to sampling, TRC removed the caps from all vent stacks that were not being sampled to allow for the inflow of air. This approach is a modification to the procedure outlined in the LTMMIP to improve representativeness by allowing sample air to be drawn from the entire vent stack zone without potential stagnation of flow impacted by capped vent stacks.

1.3.1 Method TO-10A

Vent stack air samples were collected for PCBs following the procedures described in the EPA Compendium Method TO-10A, *Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using High Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic/Multi-Detector Detection (GC/MD)*, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, USEPA, January 1999.

In order to sample each vent stack without collecting ambient air, a cap with Teflon™ tubing penetrating through it was placed over the vent stack. Prior to capping the stack, a PUF sampling cartridge was unsealed and connected to the length of tubing that would extend inside the vent stack. The tubing on the opposite side of the cap (that would be outside of the vent stack after the cap was installed) was attached to a Dawson® vacuum pump. A vacuum was applied to the tubing and cartridge using the pump and the vacuum was adjusted so that a flow rate of five liters per minute (LPM) of air was flowing through the PUF. The flow rate was confirmed using a Bios Defender™ 520 primary gas flow calibrator. The cap was then placed over the vent stack with the PUF cartridge suspended in the stack. The start time and flow rate was then recorded on a data sheet. After 4 hours of sampling, the flow rate was confirmed using the bubble meter. The final flow rate and stop time are then recorded on the data sheet. The PUF cartridge was then disconnected from the tubing, sealed with the supplied end caps, placed into a sample jar and labeled.

Following the collection of all the TO-10A samples, the total volume of ambient air sampled for each cartridge was calculated based on the duration of sampling and the average flow rate, as determined from the initial and final flow rates.

The data sheets can be found in Appendix B and the reduced data can be found in Appendix C. The calibration certifications of the Bios Defender™ 520 primary gas flow calibrator can be found in Appendix D.

1.3.2 Method TO-15

Foundation vent stack samples were collected for VOCs following the procedures described in the EPA Compendium Method TO-15, *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)*, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition*, USEPA, January 1999.

At each sampling location a 2.75-liter evacuated SUMMA™ canister was set up (connected to the vent stack air space via Teflon™ tubing) with a flow-controller set to collect a sample over a 4-hour sampling period, and the canister valve opened. The flow controllers are pre-set by the laboratory performing the VOC analysis. The start time, SUMMA™ canister and flow-controller serial numbers, and SUMMA™ canister initial vacuum are then recorded on a data sheet. After 4 hours of sampling, the SUMMA™ canister valve was closed and the final SUMMA™ canister vacuum and stop time recorded.

The data sheets can be found in Appendix B and the reduced data can be found in Appendix C.

2.0 ANALYTICAL PROGRAM

Samples collected by EPA Method TO-10A and TO-4A were prepared by the Soxhlet Extraction Method (EPA Method 3540C/TO-4A) and analyzed by gas chromatography/mass spectroscopy (EPA Method 680) for PCB Homologue distribution. Though the LTMMIP specified that PCBs were to be analyzed by the congener analytical method, the homologue analytical method is as reliable as the congener analytical method in quantifying total PCBs which is the basis for the EPA Action Level ($0.05 \mu\text{g}/\text{m}^3$) and Acceptable Long-Term Average Exposure Concentration ($0.3 \mu\text{g}/\text{m}^3$) described in Section 5 and Appendix G. In addition, by quantifying PCB homologues, total PCB air data gathered at the KMS are directly comparable to total PCB air data gathered at the high school since both are based on homologues rather than congeners, which greatly facilitates communication and discussion with the general public on the results of analyses.

Samples collected by EPA Method TO-15 were analyzed by gas chromatography/mass spectroscopy (EPA Method TO-15) for volatile organic compounds. Laboratory analytical results are presented in Appendix E.

3.0 QUALITY ASSURANCE

3.1 Overview

TRC management is fully committed to an effective Quality Assurance/Quality Control (QA/QC) Program whose objective is the delivery of a quality product. For much of TRC's work, that product is data developed from field measurements, sampling and analysis activities, engineering assessments, and the analysis of gathered data for planning purposes. TRC's QA/QC Program works to provide complete, precise, accurate, representative data in a timely manner for each project, considering both the project's needs and budget.

This section highlights the specific QA/QC procedures that were followed during this sampling and analysis program.

3.2 Field Quality Control Summary

Calibrations of the field sampling equipment were performed prior to the field sampling effort. Copies of the calibration sheets were submitted to the Field Team Leader to take onsite and placed in the project file. Calibrations were performed as described in the EPA 40 CFR Part 50 Appendix B. All calibrations were available for review during the test program. Copies of the equipment calibration forms can be found in Appendix D. All instrument calibrations met the performance criteria defined in 40 CFR 50 Appendix B.

3.3 Data Reduction and Validation

Specific QC measures were used to ensure the generation of reliable data from sampling and analysis activities. Proper collection and organization of accurate information followed by clear and concise reporting of the data is a primary goal in all projects.

3.3.1 Field Data Reduction

Appendix B of this document presents the standardized forms that were used to record field sampling data. The data collected was reviewed in the field by the Field Team Leader and at least one other field crewmember. Errors or discrepancies were noted in the field book.

3.3.2 Data Validation

TRC supervisory and QC personnel used validation methods and criteria appropriate to the type of data and the purpose of the measurement. Records of all data were maintained, including that judged as an "outlying" or spurious value. The persons validating the data have sufficient knowledge of the technical work to identify questionable values.

Field sampling data was validated by the Field Team Leader and/or the Field QC Coordinator based on their review of adherence to each approved sampling protocol and written sample collection procedure.

The following criteria were used to evaluate the field sampling data:

- Use of approved test procedures;
- Proper operation of the process being tested;
- Use of properly operating and calibrated equipment;
- Proper chain-of-custody maintained.

Laboratory analytical data was validated by TRC chemists. The sample results were assessed using the EPA New England Data Validation Functional Guidelines for Evaluating Environmental Analyses, revised December 1996. Modification of these guidelines was performed to accommodate the non-CLP methodology.

Sample data were reviewed for the following parameters:

- Agreement of analyses conducted with TRC requests
- Holding times and sample preservation
- Gas chromatography/mass spectrometry (GC/MS) tunes
- Initial and continuing calibrations
- Method blanks
- System Monitoring Compound recoveries
- Laboratory control sample (LCS) and LCS Duplicate (LCSD) results
- Internal standard performance
- Field duplicate results
- Quantitation limits and sample results

The laboratory data validation memoranda can be found in Appendix F. All data are reported in standard units depending on the measurement and the ultimate use of the data.

3.4 Collocated Sampler Precision

Single collocated sampler pairs were included for both indoor and vent stack air (PCBs and VOCs) during each sampling event. Collocated samplers were operated for the same duration at near identical flow rates and were in close proximity to each other so as to represent near identical air space. The data resulting from the analyses of the collocated sampler pairs were used to define the precision of the combined sample collection and analyses scheme.

Precision was determined by the collection and analysis of replicate samples and is expressed as the relative percent difference (RPD), which is determined according to the following equation:

$$RPD = \left[\frac{X_1 - X_2}{\frac{X_1 + X_2}{2}} \right] \times 100$$

where X_1 and X_2 are the measurement results of each replicate sample expressed as an absolute value (always positive).

4.0 INVENTORY OF CLEANING SUPPLIES AND INGREDIENTS

The following bulleted list provides an inventory of cleaning supplies and their ingredients which are likely contributing to the detection of VOCs in the indoor air quality samples:

- Butchers Heptagon Disinfectant Spray
 - Active ingredients:
 - n-alkyl(60% C₁₄, 30% C₁₆, 5% C₁₂, 5% C₁₈)dimethylbenzyl ammonium chlorides
 - n-alkyl(68% C₁₂, 32% C₁₄)dimethylbenzyl ammonium chlorides
- Eclipse Neutral All Purpose Cleaner
 - Water
 - modified amine condensate
 - tetrapotassium
 - pyrophosphate
- Rebound Cleaner/Enhancer
 - Water
 - Polyethylene glycol
 - Nonionic surfactant
 - Monoethanol amine
- Concentrate 117 – oxidizing multipurpose cleaner
 - Active ingredient:
 - Hydrogen Peroxide – 3.95%
- Misco Disinfectant cleaner -- mint -- HI-Con 64
 - Active ingredients:
 - Didecyldimethyl ammonium chloride (2.54%)
 - N-alkyl(C₁₄ 50%, C₁₂ 40%, C₁₆ 10%)dimethyldibenzyl ammonium chloride
- Butchers Command Center Breakdown
 - Water
 - Alcohol ethoilate
 - Sodium xylene sulfonate
 - Bacillus spores
- Butchers Command Center Look
 - “see MSDS MS040015”
- Butchers Major Max Spray Buff
 - Water
 - Triethylene glycol
 - Dipropylene glycol

- First Step Sealer Acrylic Floor Sealer
 - Water
 - Aqueous acrylic emulsion
 - Ethanol 2-(2-methoxy ethoxy)
 - Ethanol 2-(2-ethoxy ethoxy)
 - Tributoxo ethyl phosphate
- Simplex Shine Up
 - Water
 - Petroleum distillates
 - Isobutene/propane blend
 - Petroleum solvent

APPENDIX B

SAMPLING DATA

Keith Middle School Sampling Data Sheet Ambient Air Sampling

Setup Date: 4/22/09
Recovery Date: 4/23/09

Sampler(s): ML/MG
Sampler(s): ML/MG

TO-15						
Location	Time		Vacuum (in Hg)		SUMMA	Flow Controller
	Start	Stop	Start	Finish	Serial No.:	Serial No.:
C-19 (fac din)	13:39	1343	30.5	1.5	2854	0439
B-19 (bud)	13:37	1339	29.0	0.0	7648	0372
A-19 (A-119)	13:33	1333	29.5	2.0	7628	0346
BG-19	13:30	9:15	29.5	2.0	7643	0438
BG dup-19	13:30	1324	30.5	0.0	8071	0181

378.69 ML 4/23/09

TO-4A								
Location	Time		PUF Number	Serial Number	Counter (Hrs)		Flow Rate (Mag Reading)	
	Start	Stop			Start	Finish	Initial	Final
C-19	13:39	1343	4	820	354.63	357.65	55	49
B-19	13:37	1339	1	822	341.29	365.34	59	54
B-19 A-19	13:33	1333	2	821	342.18	366.21	56	51
BG-19	13:30	1330	3	823	341.80	365.82	48	46
BG dup-19	13:30	1330	5	825	361.97	385.98	48	46

set to 54.5
" " 59.2
57.1
53.9
54.9



APPENDIX C

FIELD REDUCED DATA

INDOOR SAMPLING LOCATIONS

Average Temp (oF/ K): **20.6** 266.7

Average Baro. Press ("Hg / mmHg): **29.75** 755.7

Thursday April 23, 2009

Location	Serial #	m _s	b _s	Start Reading ("H ₂ O)	Start Reading (lpm)	Stop Reading ("H ₂ O)	Stop Reading (lpm)	Avg. Reading ("H ₂ O)	RPD of Start and Stop Readings	Avg. Flow (lpm)	Start time (hr)	Stop Time (hr)	Total Sample Time (min)	Total Actual Sample Volume (m ³)
C-19, Faculty Lounge	TO-4A 820	0.039	-2.434	55		49		52	11.54	230	354.63	378.69	1444	332.6
A-19, Hallway outside rm A-119	TO-4A 821	0.042	-2.897	56		51		53.5	9.35	230	342.18	366.21	1442	331.1
B-19 (Auditorium)	TO-4A 822	0.040	-2.405	59		54		56.5	8.85	231	341.29	365.34	1443	332.8

OUTDOOR SAMPLING LOCATIONS

Average Temp (oF/ K): 16.1 264.2

Average Baro. Press ("Hg / mmHg): 29.75 755.7

Thursday April 23, 2009

Location	Serial #	m _s	b _s	Start Reading ("H2O)	Start Reading (lpm)	Stop Reading ("H2O)	Stop Reading (lpm)	Avg. Reading ("H2O)	RPD of Start and Stop Readings	Avg. Flow (lpm)	Start time (hr)	Stop Time (hr)	Total Sample Time (min)	Total Actual Sample Volume (m ³)
BG-19	TO-4A	825	0.033	-0.785	48	46	47	4.26	4.26	218	341.8	365.82	1441	314.8
BG-19-DUP	TO-4A	823	0.038	-2.063	48	46	47	4.26	4.26	221	361.97	385.98	1441	317.7
VS-8-19 DUP	TO-10A				5.00	4.73	5.55	4.87	8:15	12:15	240.00	1.2		
VS-8-19	TO-10A				5.02	4.57	9.38	4.80	8:15	12:15	240.00	1.2		
VS-11-19	TO-10A				5.02	4.16	18.74	4.59	8:21	12:21	240.00	1.1		
VS-1-19	TO-10A				4.97	4.42	11.71	4.70	8:57	12:57	240.00	1.1		
VS-4-19	TO-10A				4.96	5.05	1.80	5.01	9:02	13:02	240.00	1.2		
VS-BG-19	TO-10A				5.07	5.09	0.39	5.08	9:14	13:16	240.00	1.2		

APPENDIX D

EQUIPMENT CALIBRATION SHEETS

PS1 Calibration Data Sheet

Network: Keith Middle School

Site: New Bedford, MA

Serial #: 0820

Station # FacDir-C19

Technician: ML/MG

Date: 4/22/09

Calibration Orifice

S/N: 1125

Orif. Cal. Data: 1/23/09

Reason for Calibration (Circle One):

New Instrument

Brush Change

Motor Change

Quarterly Recal

Amb. Temp, T1 (°C): 19.7

Bar.press (in Hg): 29.7

Thermometer Serial #: L001247

ΔH_0 ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
3.9	3.6	7.5	80.00
3.5	3.3	6.8	70.00
3.2	3.0	6.2	60.00
2.7	2.6	5.3	50.00
2.3	2.1	4.4	40.00



PS1 Calibration Data Sheet

Network: Keith Middle School

Site: New Bedford, MA

Serial #: 0822

Station # Auditorium-B19

Technician: NLMG

Date: 4/22/09

Calibration Orifice S/N: 1125

Orif. Cal. Data: 1/23/09

Reason for Calibration (Circle One):

New Instrument

Brush Change

Motor Change

Quarterly Recal

Amb. Temp, T1 (°C): 20.0

Bar.press (in Hg): 29.7

Thermometer Serial #: 4001247

ΔH_0 ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
3.5	3.4	6.9	80.00
3.3	3.2	6.5	70.00
3.0	2.9	5.9 5.9	60.00
2.5	2.5	5.0	50.00
2.1	2.0	4.1	40.00

PS1 Calibration Data Sheet

Network: Keith Middle School

Site: New Bedford, MA

Serial #: 821

Station # A-19 (Hall A-119)

Technician: MLMG

Date: 4/22/09

Calibration Orifice S/N: 1125

Orif. Cal. Data: 1/23/09

Reason for Calibration (Circle One): New Instrument Brush Change Motor Change Quarterly Recal

Amb. Temp, T1 (°C): 22.7

Bar. press (in Hg): 29.7

Thermometer Serial #: 1001247

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
3.3 3.5	3.4 3.7	6.4 7.2	80.00
3.4	3.2	6.6	70.00
3.1	2.9	6.0	60.00
2.27	2.6	5.3	50.00
2.2	2.1	4.3	40.00



PS1 Calibration Data Sheet

Network: Keith Middle School

Site: New Bedford, MA

Serial #: 823

Station # BG-19

Technician: ML/MG

Date: 4/22/09

Calibration Orifice
S/N: 1125

Orif. Cal. Data: 1/23/09

Reason for Calibration (Circle One):

New Instrument

Brush Change

Motor Change

Quarterly Recal

Amb. Temp, T1 (°C): 17.3

Bar. press (in Hg): 29.7

Thermometer Serial #: L001247

ΔH_0 ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) MagnaHelic
3.6 3.7	3.6 3.9	7.6	80.00
3.3	3.5	6.8	70.00
3.2	3.1	6.3	60.00
2.5	2.7	5.2	50.00
2.1	2.3	4.4	40.00

PS1 Calibration Data Sheet

Network: Keith Middle School

Site: New Bedford, MA

Serial #: 0825

Station # BG-dup-19

Technician: MLMG

Date: 4/22/09

Calibration Orifice

S/N: 1125

Orif. Cal. Data: 1/23/09

Reason for Calibration (Circle One):

New Instrument

Brush Change

Motor Change

Quarterly Recal

Amb. Temp, T1 (°C): 17.3

Bar.press (in Hg): 29.7

Thermometer Serial #: 2001247

ΔH_0 ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
4.1	3.8	7.9	80.00
3.5	3.4	6.9	70.00
3.0	3.1	6.1	60.00
2.6	2.7	5.3	50.00
2.0	2.1	4.1	40.00

PS1 Post-Sampling Flow Audit

Network: Keith Middle School Site: New Bedford, MA Serial #: 821 Station #: A-19 (Hall A-119)
Technician: MLING Date: 4/23/05 Calibration Orifice S/N: 1125 Orif. Cal. Data: 1/23/09

Amb. Temp, T1 (°C): 20.8 Bar.press (in Hg): 29.79
Thermometer Serial #: L001247

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
<u>2.5 2.2</u>	<u>2.4 2.2</u>	<u>4.9</u>	50.00



PS1 Post-Sampling Flow Audit

Network: Keith Middle School Site: New Bedford, MA Serial #: 822 Station # B-19(land)
Technician: ML/MG Date: 4/23/09 Calibration Orifice S/N: 1125 Orif. Cal. Data: 1/23/09

Amb. Temp, T1 (°C): 20.9 Bar.press (in Hg): 29.79
Thermometer Serial #: L001247

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
2.6	2.5	5.1	50.00

PS1 Post-Sampling Flow Audit

Network: Keith Middle School Site: New Bedford, MA Serial #: 825 Station # BG-19-DUP
Technician: ML/MG Date: 4/23/09 Calibration Orifice S/N: 1125 Orif. Cal. Data: 1/23/09

Amb. Temp, T1 (°C): 14.9 Bar.press (in Hg): 29.79
Thermometer Serial #: L001247

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
2.7	2.5	5.2	50.00

PS1 Post-Sampling Flow Audit

Network: Keith Middle School Site: New Bedford, MA Serial #: 820 Station # C-19 (Acad.)
Technician: ML/MG Date: 4/23/09 Calibration Orifice S/N: 1125 Orif. Cal. Data: 1/23/09

Amb. Temp, T1 (°C): 19.3

Bar.press (in Hg): 29.79

Thermometer Serial #: L001247

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelic
2.5	2.4	4.9	50.00

PS1 Post-Sampling Flow Audit

Network: Keith Middle School

Site: New Bedford, MA

Serial #: X 823

Station # BG-19

Technician: ML/MG

Date: 4/23/09

Calibration Orifice
S/N: 1125

Orif. Cal. Data: 1/23/09

Amb. Temp, T1 (°C): 14.9

Bar.press (in Hg): 29.79

Thermometer Serial #: L001247

ΔH_o ("H2O) Calibration Orifice

Left	Right	Total	I ("H2O) Magnahelec
2.5	2.4	4.9	50.00



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AIR POLLUTION MONITORING EQUIPMENT

ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5040A

Date - Jan 23, 2009 Rootsometer S/N 9833620 Ta (K) - 293
 Operator: Jim Tisch Orifice I.D. - 1125 Pa (mm) - 748.03

PLATE OR VDC #	VOLUME START (m3)	VOLUME STOP (m3)	DIFF VOLUME (m3)	DIFF TIME (min)	METER DIFF Hg (mm)	ORFICE DIFF H2O (in.)
1	NA	NA	1.00	6.6580	3.6	2.00
2	NA	NA	1.00	3.9720	10.0	5.50
3	NA	NA	1.00	3.1970	15.3	8.50
4	NA	NA	1.00	2.7270	20.7	11.50
5	NA	NA	1.00	2.4180	26.1	14.50
6	NA	NA	1.00	2.2590	29.7	16.50

DATA TABULATION

Vstd	(x axis) Qstd	(y axis)	Va	(x axis) Qa	(y axis)
0.9961	0.1496	1.4150	0.9951	0.1494	0.8851
0.9876	0.2486	2.3464	0.9866	0.2483	1.4678
0.9805	0.3067	2.9170	0.9795	0.3063	1.8247
0.9733	0.3569	3.3929	0.9722	0.3565	2.1224
0.9660	0.3995	3.8099	0.9650	0.3991	2.3832
0.9613	0.4255	4.0641	0.9603	0.4251	2.5422
Qstd slope (m) =		9.60919	Qa slope (m) =		6.01711
intercept (b) =		-0.03116	intercept (b) =		-0.01949
coefficient (r) =		0.99994	coefficient (r) =		0.99994

y axis = $\sqrt{H_2O(Pa/760)(298/Ta)}$

y axis = $\sqrt{H_2O(Ta/Pa)}$

CALCULATIONS

Vstd = Diff. Vol [(Pa-Diff. Hg)/760] (298/Ta)
 Qstd = Vstd/Time

Va = Diff Vol [(Pa-Diff Hg)/Pa]
 Qa = Va/Time

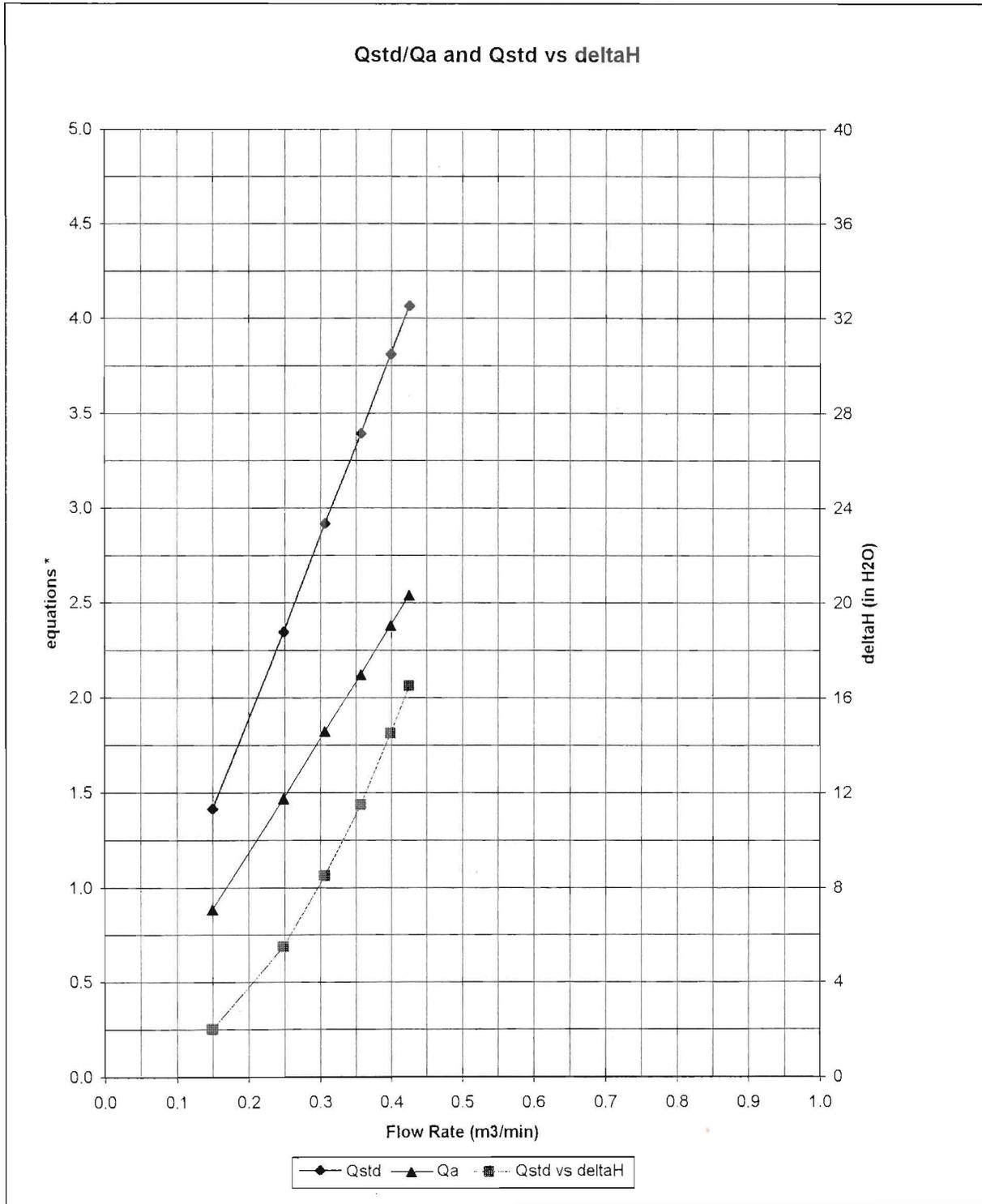
For subsequent flow rate calculations:

Qstd = 1/m { [SQRT (H2O (Pa/760) (298/Ta))] - b }
 Qa = 1/m { [SQRT H2O (Ta/Pa)] - b }



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AIR POLLUTION MONITORING EQUIPMENT



* y-axis equations:

Qstd series:
$$\sqrt{\Delta H \left(\frac{P_a}{P_{std}} \right) \left(\frac{T_{std}}{T_a} \right)}$$

Qa series:
$$\sqrt{(\Delta H (T_a / P_a))}$$

#1125



Bios

Driving a Higher Standard
in Flow MeasurementSM

Calibration Certificate

Certificate No.	34676	Sold to:	TRC Environmental Corporation - Lowell
Product	Defender 520 High Flow		Wannalancit Mills
Serial No.	112218		650 Suffolk Street
Cal. Date	12/12/2008		Lowell, MA 01854
			USA

All calibrations are performed in accordance with ISO 17025 at Bios International Corporation, 10 Park Place, Butler, NJ, 07405, 800-663-4977, an ISO 17025:2005 – accredited laboratory through NVLAP. This report shall not be reproduced except in full without the written approval of the laboratory. Results only relate to the items calibrated. This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

All units tested in accordance with Bios International Corporation test number PR17-13 using high-purity bottled nitrogen or dry

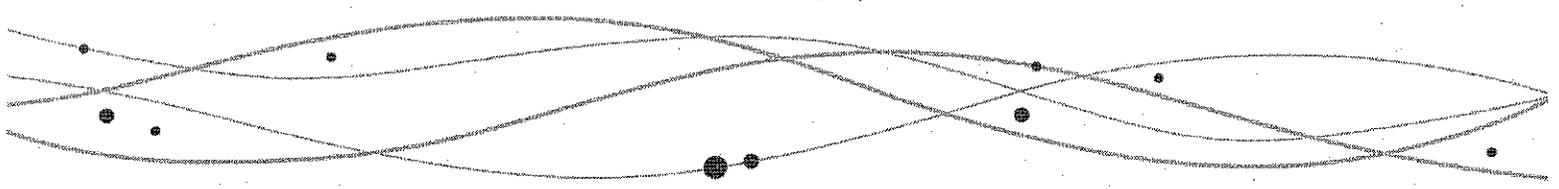
As Received Calibration Data

Technician	Sonia Otero	Lab. Pressure	761 mmHg
		Lab. Temperature	22.2 °C

Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Received
502.61 ccm	500.31 ccm	0.46%	1.00%	In Tolerance
5022.3 ccm	5005 ccm	0.35%	1.00%	In Tolerance
29968 ccm	29998 ccm	-0.1%	1.00%	In Tolerance
21.7 °C	22.2 °C	-0.5%	±0.8°C	In Tolerance
759 mmHg	761 mmHg	-2%	±3.5mmHg	In Tolerance

Bios International Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML 500-44	113761	5/1/2008	5/1/2009
Precision Thermometer	305460	8/6/2008	8/6/2009
Precision Barometer	431/98-07	4/8/2008	4/8/2009



Bios

Driving a Higher Standard
in Flow MeasurementSM

As Shipped Calibration Data

Certificate No. 34676
Technician Sonia Otero

Lab. Pressure 739 mmHg
Lab. Temperature 22.2 °C

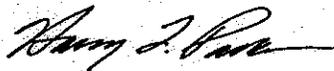
Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Shipped
501.58 ccm	500.035 ccm	0.31%	1.00%	In Tolerance
5004.0 ccm	5001.55 ccm	0.05%	1.00%	In Tolerance
29831 ccm	30022.5 ccm	-0.64%	1.00%	In Tolerance
22.3 °C	22.3 °C	-	±0.8°C	In Tolerance
739 mmHg	739 mmHg	-	±3.5mmHg	In Tolerance

Bios International Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML-500-44	113761	5/1/2008	5/1/2009
Precision Thermometer	305460	8/6/2008	8/6/2009
Precision Barometer	431/98-07	4/8/2008	4/8/2009

Calibration Notes

Bios is an ISO 17025-accredited metrology laboratory. Each Bios primary gas flow standard is dynamically verified by comparing it to one of our laboratory standards, which is a Proven DryCat® Technology volumetric piston prover of much higher accuracy but of similar operating principles. For this purpose, a flow generator of ±0.03% stability is used. Our laboratory standards are qualified by direct measurement of their dimensions (diameter, length and time) using NIST-traceable precision gauges and instruments, such as depth micrometers and laser micrometers. NIST numbers for these gauges and instruments are available upon request. Rigorous analyses of our laboratory standards' uncertainties have been performed, in accordance with The Guide to the Expression of Uncertainty in Measurement (the GUM), assuring their traceable accuracy.



Harvey Padden, President and Chief Metrologist

APPENDIX E

LABORATORY DATA REPORTS (ON CD)

APPENDIX F

**LABORATORY DATA VALIDATION
MEMORANDA**



Memo

To: David Sullivan
From: Lorie MacKinnon
CC:
Date: 06/04/09
Re: Data Validation Review: Air Samples: Keith Middle School/New Bedford, MA: SDG 09040226

SUMMARY

Limited (Tier II) validation was performed on the data for 16 air samples and three trip blank samples collected at the Keith Middle School in New Bedford, Massachusetts. The samples were collected on April 23, 2009 and submitted to Northeast Analytical, Inc. (NEA) in Schenectady, New York for analysis. All air vent samples were collected on polyurethane foam (PUF) cartridges in accordance with EPA method TO-10A; all ambient air samples were collected on particulate filters and PUF cartridges in accordance with EPA method TO-4A. The samples were analyzed for polychlorinated biphenyl (PCB) homologues using EPA method 680. NEA reported the results under job number 09040226.

The sample results were assessed using the *EPA New England Data Validation Functional Guidelines for Evaluating Environmental Analyses*, revised December 1996. Modification of these guidelines was performed to accommodate the non-CLP methodology.

In general, the data appear to be valid as reported and may be used for decision-making purposes. Potential high bias exists for trichlorobiphenyl and total PCBs in samples C-19 (PUF) and B-19 (PUF) and trichlorobiphenyl, tetrachlorobiphenyl, and total PCBs in sample A-19 (PUF) due to high surrogate recoveries. These issues have a minor impact on the data usability; all results are still usable for project objectives.

SAMPLES

Samples included in this review are listed below:

VS-8-19-DUP (1)	VS-8-19	VS-11-19
VS-1-19	VS-4-19	VS-TB-19
VS-BG-19	C-19 (PUF)	B-19 (PUF)
A-19 (PUF)	BG-19 (PUF)	BG-19-DUP (PUF) (2)

Trip blank-19 (PUF)
A-19 (Filter)
Trip blank-19 (Filter)

C-19 (Filter)
BG-19 (Filter)

B-19 (Filter)
BG-19-DUP (Filter) (3)

- (1) Field duplicate of VS-18-19
- (2) Field duplicate of BG-19 (PUF)
- (3) Field duplicate of BG-19 (Filter)

REVIEW ELEMENTS

Sample data were reviewed for the following parameters:

- Agreement of analyses conducted with TRC requests
- Holding times and sample preservation
- Gas chromatography/mass spectrometry (GC/MS) tunes
- Initial and continuing calibrations
- Blanks
- Surrogate spike recoveries
- Laboratory control sample (LCS) results
- Internal standard performance
- Field duplicate results
- Quantitation limits and sample results

DISCUSSION

Agreement of Analyses Conducted with TRC Requests

Sample reports were checked to verify that the results corresponded to analytical requests as designated on the chain-of-custody and any correspondence between TRC and the laboratory. There were no discrepancies noted.

Holding Times and Sample Preservation

All samples were extracted and analyzed within the method-specified holding time.

GC/MS Tunes

The frequency and abundance of all decafluorotriphenylphosphine (DFTPP) tunes were within the acceptance criteria. The samples were analyzed within 12 hours from the DFTPP tunes. Window defining mixtures were analyzed following each DFTPP tune.

Initial and Continuing Calibrations

The %RSDs and %Ds of all PCB congeners used in the initial and continuing calibrations were within the acceptance criteria.

Blanks

Target compounds were not detected in the laboratory method blanks or trip blanks associated with the PCB homologue analyses.

Target compounds were not detected in the VER PUF Lot#29775, VER PUF Lot#040309-1, and VER Filter Lot#040409-4 samples, which were analyzed and reported under job number 09040040.

Surrogate Spike Recoveries

Select samples exhibited recoveries of the surrogate tetrachloro-m-xylene (TCMX) which were outside the acceptance criteria of 27-91.8% for TCMX. The following table summarizes the surrogate recoveries in the affected samples.

Sample ID	TCMX	DCB	Validation Actions
C-19 (PUF)	138%	Criteria met	Estimate (J) the positive results for trichlorobiphenyl and total PCB in sample C-19 (PUF).
B-19 (PUF)	134%	Criteria met	Estimate (J) the positive results for trichlorobiphenyl and total PCB in sample B-19 (PUF).
A-19 (PUF)	106%	Criteria met	Estimate (J) the positive results for trichlorobiphenyl, tetrachlorobiphenyl, and total PCB in sample A-19 (PUF).
BG-19 (PUF)	103%	Criteria met	Validation action was not required as sample results were nondetect and therefore not affected by the potential high bias.
VS-4-19	103%	Criteria met	Validation action was not required as sample results were nondetect and therefore not affected by the potential high bias.

LCS Results

An LCS and LCSD was extracted and analyzed with each extraction batch. The following table summarizes the LCS/LCSD recoveries outside of control limits.

LCS ID	Homolog Group	Recovery	Control Limits	Associated Samples	Validation Actions
LCSD-59	Chlorobiphenyl	79.2	29-79	VS-8-19-DUP, VS-8-19, VS-11-19, VS-1-19, VS-4-19, VS-TB-19, VS-BG-19	Validation actions were not required as the affected results were nondetect and therefore not affected by the high bias.
LCSD-61	Chlorobiphenyl	84.4	29-79	PUF Samples: C-19, B-19, A-19, BG-19, BG-19-DUP, Trip blank-19	Validation actions were not required as the affected results were nondetect and therefore not affected by the high bias.
LCS-60/ LCSD60	Chlorobiphenyl	92.7, 86.8	29-79	Filter samples: C-19, B-19, A-19, BG-19, BG-19-DUP, Trip blank-19	Validation actions were not required as the affected results were nondetect and therefore not affected by the high bias.
	Dichlorobiphenyl	91.3, 83.9	31-83		
	Trichlorobiphenyl	100, 88.9	34-87		
	Tetrachlorobiphenyl	99.0, 90.3	35-87		
	Pentachlorobiphenyl	LCS 98.0	37-92		
	Hexachlorobiphenyl	LCS 102	41-95		
	Heptachlorobiphenyl	LCS 105	42-98		

Internal Standard Performance

The percent difference for the internal standard Phenanthrene-d10 was above the laboratory established limits for sample BG-19 Filter). Validation action was not required on this basis as the internal standard Chrysene-d12 was used for quantitation.

Field Duplicate Results

Samples VS-8-19/VS-8-19-DUP, BG-19/BG-19-DUP, and BG-19/BG-19-DUP were submitted as the field duplicate (collocated) pairs with this sample set. No PCBs were detected in these samples.

Quantitation Limits and Sample Results

The quantitation limits met the requirements in the Sampling Plan for this program.



Memo

To: David Sullivan
From: Lorie MacKinnon
CC:
Date: 06/10/09
Re: Data Validation Review: Air Samples: Keith Middle School/New Bedford, MA: SDG L0905202

SUMMARY

Limited (Tier II) validation was performed on the data for 10 air samples and two trip blank samples collected at the Keith Middle School, Massachusetts. The samples were collected on April 23, 2009 and submitted to Alpha Woods Hole Labs (Alpha) in Westborough, MA for analysis. All air vent samples were collected in 2 liter SUMMA® canisters in accordance with EPA method TO-15A; all ambient air samples were collected in 6 liter SUMMA® canisters in accordance with EPA method TO-15A. The samples were analyzed for volatile organic compounds using EPA method TO-15A.

The sample results were assessed using the *EPA New England Data Validation Functional Guidelines for Evaluating Environmental Analyses*, revised December 1996. Modification of these guidelines was performed to accommodate the non-CLP methodology.

In general, the data appear to be valid as reported and may be used for decision-making purposes. The results for methyl tert-butyl ether, 2-butanone, ethyl acetate, tetrahydrofuran, 1,4-dioxane, 4-methyl-2-pentanone, 1,2,4-trichlorobenzene, and hexachlorobutadiene in all samples should be qualified as estimated (J/UJ) due to calibration nonconformances. The positive results for acetone in samples C-19, B-19, BG-19, and BG-19 DUP were qualified as nondetect (U) due to trip blank contamination. The results for 2-butanone in samples C-19, B-19, A-19, BG-19, BG-19 DUP, VS-8-19 DUP, VS-11-19, VS-1-19, and VS-4-19 and methyl tert-butyl ether in sample VS-11-19 should be qualified as estimated (J) due to high recoveries in the LCS sample.

SAMPLES

Samples included in this review are listed below:

C-19	B-19	A-19
BG-19	BG-19 DUP (1)	TB-19
VS-8-19 DUP (2)	VS-11-19	VS-1-19
VS-4-19	VS-BG-19	VS-TB-19

- 1) Field duplicate of BG-19
- 2) Due to a faulty valve, the canister for duplicate sample VS-8-19 was received empty; the analysis for sample VS-8-19 was cancelled.

REVIEW ELEMENTS

Sample data were reviewed for the following parameters:

- Agreement of analyses conducted with TRC requests
- Holding times and sample preservation
- Gas chromatography/mass spectrometry (GC/MS) tunes
- Initial and continuing calibrations
- Method blanks
- System Monitoring Compound recoveries
- Laboratory Duplicate results
- Laboratory control sample (LCS) results
- Internal standard performance
- Field duplicate results
- Quantitation limits and sample results

DISCUSSION

Agreement of Analyses Conducted with TRC Requests

Sample reports were checked to verify that the results corresponded to analytical requests as designated on the chain-of-custody and any correspondence between TRC and the laboratory. Due to a faulty valve, the canister for sample VS-8-19 was received empty. The analysis for sample VS-8-19 was cancelled.

Holding Times and Sample Preservation

All samples were extracted and analyzed within the method-specified holding time.

GC/MS Tunes

The frequency and abundance of all bromofluorobenzene (BFB) tunes were within the acceptance criteria.

Initial and Continuing Calibrations

The percent relative standard deviation (%RSD) for 1,2,4-trichlorobenzene (37.4) was outside of the acceptance criteria in the low level calibration associated with all samples. The nondetect results for 1,2,4-trichlorobenzene in all samples were estimated (UJ) due to initial calibration nonconformances.

The percent differences (%Ds) for methyl tert-butyl ether (30.7), 2-butanone (37.7), ethyl acetate (30.5), tetrahydrofuran (27.7), 1,4-dioxane (25.4), 4-methyl-2-pentanone (25.4), 1,2,4-trichlorobenzene (30.6), and hexachlorobutadiene (39.1) were outside of the acceptance criteria in the continuing calibration associated with all samples. The positive and nondetect results for methyl tert-butyl ether, 2-butanone, ethyl acetate, tetrahydrofuran, 1,4-dioxane, 4-methyl-2-pentanone, 1,2,4-trichlorobenzene, and hexachlorobutadiene were estimated (J/UJ) in these samples due to continuing calibration nonconformances.

Blanks

Target compounds were not detected in the laboratory method blanks associated with the volatile organic compound analyses.

Acetone and methylene chloride were detected in the ambient Trip blank sample, TB-19. The following table summarizes the contamination detected.

Compound	Blank Level	Action Level	Blank ID Associated Samples	Validation Action
Acetone	1.5 ug/m3	15 ug/m3	TB-19: C-19, B-19, A-19, BG-19, BG-19 DUP	Qualify the positive results for acetone in samples C-19, B-19, BG-19, and BG-19 DUP as nondetect (U).
Methylene chloride	3.39 ug/m3	33.9 ug/m3		Qualification was not required as all affected sample results were nondetect.

Qualification of the data was performed as follows:

- Sample results < the quantitation limit (QL) were qualified as nondetects (U) at the QL if detected in the associated blank.
- Sample results \geq QL were qualified as nondetects (U) at the reported concentration if the result was <BAL (blank action level) which was determined to be 10x (for common contaminants) the concentration detected in the blank.
- Qualification was not required for nondetect results or for positive results >BAL.

System Monitoring Compound Recoveries

System monitoring compounds were not introduced to these samples. Evaluation of the samples based on system monitoring compound recovery was not performed.

Laboratory Duplicate Results

The laboratory performed a duplicate analysis on sample VS-1-19. All relative percent differences (RPDs) were within the laboratory control limit of 25.

LCS Results

LCS samples were analyzed along with the field samples. The following table summarizes the compounds recovered outside of the laboratory control limits of 70-130 and the resulting actions.

Compound	Recovery (%)	LCS ID Associated Samples	Validation Action
2-Butanone	138	LCS WG360865-2: All low level samples	Estimate (J) the positive results for 2-butanone in samples C-19, B-19, A-19, BG-19, BG-19 DUP, VS-8-19 DUP, VS-11-19, VS-1-19, and VS-4-19.
Hexachlorobutadiene	139		Validations were not required as hexachlorobutadiene was nondetect in the samples and therefore not affected by the potential high bias.
Methyl tert-butyl ether	131		Estimate (J) the positive result for methyl tert-butyl ether in sample VS-11-19.

Internal Standard Performance

Internal standards were within the acceptance criteria in all sample analyses.

Field Duplicate Results

Samples BG-19/BG-19 DUP were submitted as the field duplicate (collocated) pair with this sample set. The following table summarizes the relative percent differences (RPDs) of the target VOCs detected in either sample, all of which were within the acceptance criteria of 20%RPD or the difference of <2 times the reporting limit (RL).

VOCs	BG-19 ($\mu\text{g}/\text{m}^3$)	BG-19 DUP ($\mu\text{g}/\text{m}^3$)	RPD (%)
2-Butanone	0.81	0.775	4.5
Chloromethane	1.08	1.16	7.7
Dichlorodifluoromethane	2.46	2.53	2.4
Trichlorofluoromethane	1.28	1.42	10.0
Benzene	0.463	0.485	4.7

Quantitation Limits and Sample Results

The quantitation limits met the requirements in the Sampling Plan for this program.

APPENDIX G

**DISCUSSION OF RISK-BASED COMPARISON
CRITERIA**

DISCUSSION OF RISK-BASED COMPARISON CRITERIA

PCBs

Two PCB risk-based air concentrations (RBACs) have been developed for the KMS, assuming occupational exposures within the school (8 hours/day, 250 days/year, for 25 years). Both non-carcinogenic and carcinogenic health endpoints were considered in the calculation of the RBACs; however, RBACs are based on noncarcinogenic effects as the most sensitive endpoint. The first RBAC is the Action Level (AL; 0.05 ug/m^3) used as an initial indicator that PCB air concentrations above background levels have been detected. The risk basis for the AL is a noncarcinogenic hazard index of approximately 0.2. The second RBAC is the Acceptable Long-Term Average Exposure Concentration (ALTAEC; 0.3 ug/m^3), indicative of the maximum acceptable air concentration that should not be exceeded for an extended time period. The ALTAEC could be exceeded over the short-term and still result in acceptable risk levels. The risk basis for the ALTAEC is a noncarcinogenic hazard index of one.

Both RBACs were developed to be applied to a total PCB air concentration. PCB homologues have been quantified and summed to generate total PCB air concentrations. By quantifying PCB homologues, total PCB air data gathered at the KMS are directly comparable to total PCB air data gathered at the high school since both are based on homologues rather than congeners, which greatly facilitates communication and discussion with the general public on the results of analyses.

The LTMMIP specifies that both indoor air and vent stack air gas-phase total PCB concentrations are to be compared to RBACs. This comparison is appropriate for indoor air results since exposures to indoor air at the KMS are occurring over a similar duration and frequency as that assumed for RBAC development (8 hours/day, 250 days/year for 25 years). However, this comparison is less appropriate for vent stack air results. The vent system is designed to capture gas-phase PCBs being released from the subsurface beneath the KMS and transport the gases through PVC piping to outdoor air, limiting migration through the building slab and into indoor air. Little if any human exposure to air within the vent stack system itself is taking place. Air from the vent stack is released to outdoor air where the PCBs are quickly diluted and dispersed. Therefore, comparison of vent stack air results to RBACs developed assuming exposures of 8 hours/day, 250 days/year for 25 years is highly conservative, if not conceptually irrelevant. The results of the comparison of vent stack air results to RBACs should be interpreted with caution due to the significantly reduced degree of exposure to vent stack air that can be experienced by individuals in comparison to indoor air.

VOCs

Comparison criteria for VOC data include MassDEP Threshold Effects Exposure Limits (TELs) and Allowable Ambient Limits (AALs), published in December 1995, consistent with the LTMMIP. TELs are developed to be applicable to short-term exposure concentrations (average

24-hour levels) while AALs are developed to be protective of long-term exposure concentrations (average annual levels over 30 years). AALs and TELs are risk-based values, corresponding to the lower of a non-carcinogenic hazard of 0.2 or an excess lifetime cancer risk of one in one million (1×10^{-6}) for potentially carcinogenic compounds. Indoor air and vent stack air VOC concentrations are conservatively compared to both criteria even though it is unlikely that actual exposures to measured air concentrations would occur for either an entire 24-hour day or continually for 30 years. Short-term exposures at the KMS are likely to occur for approximately 8 hours per day, while long-term exposures are likely to occur for approximately 250 days/year for an exposure duration of 25 years.

Because TELs and AALs have not been revised since 1995 and may not include the most up-to-date toxicity information available, VOC concentrations in excess of AALs and TELs are discussed relative to alternate comparison criteria. The alternate comparison criteria are primarily residential and commercial EPA screening levels (EPA SLs) developed by Oak Ridge National Laboratory (June 2008) using the most current toxicity information available. Similar to AALs, residential EPA SLs are applicable to continuous long-term exposures. Commercial EPA SLs are more applicable to the actual exposures occurring at the KMS (8 hours/day, 250 days/year for 25 years). Residential and commercial EPA SLs are associated with the same cancer risk threshold used in establishing AALs and TELs. However, EPA SLs are based on a hazard of 1 for non-carcinogenic endpoints. Therefore, EPA SLs provided on Tables 8-1 and 8-2 have been adjusted to a non-carcinogenic hazard of 0.2 to be consistent with AALs and TELs based on non-carcinogenic effects. In interpreting concentrations in excess of residential EPA SLs, it is important to consider how the frequency and duration of actual exposures may differ from continuous long-term exposures assumed for residential EPA SL development.

Because AALs, TELs, and EPA SLs are set at risk levels (i.e., non-carcinogenic hazard of 0.2 and excess lifetime cancer risk of 1×10^{-6}) that are only a portion of the MassDEP risk management criteria of a non-carcinogenic hazard of 1 and an excess lifetime cancer risk of one in one-hundred thousand (1×10^{-5}), concentrations that slightly exceed (i.e., less than 5-fold) one or more comparison criteria may not be cause for concern, especially considering that actual exposures may be of lesser duration and frequency than assumed in comparison criteria development.

For compounds lacking comparison criteria, detected concentrations are discussed relative to available comparison criteria for a surrogate compound, selected based on similarities in chemical structure and/or known toxicity. Compounds lacking comparison criteria are also discussed relative to site-specific outdoor and indoor air background concentrations, as available.

Levels of VOCs in air present as a result of background or ambient conditions were not factored into the establishment of comparison criteria. Therefore, comparison criteria may be set at values that are below typical background levels of VOCs in indoor air, present as a result of off-gassing from building materials or indoor activities unrelated to site-specific releases. To account for anticipated background conditions at the KMS, VOC concentrations in excess of comparison criteria are framed relative to site-specific outdoor air background concentrations, indicating ambient conditions in the vicinity of site. To provide additional perspective, VOC concentrations in excess of comparison criteria are also discussed relative to MassDEP indoor air

background values, used by MassDEP in the development of the Massachusetts Contingency Plan (MCP) numeric standards. Therefore, the presence of one or more VOCs at concentrations that exceed comparison criteria should be interpreted with caution and may not indicate the need for immediate action.

There are a small number of compounds in indoor air, vent air, and outdoor air background samples for which reporting limits exceed comparison criteria set at very low values, which are not readily achievable with standard analytical methods. The comparison criteria for each of the affected compounds (i.e., benzene, chloroform, methylene chloride, styrene, tetrachloroethene, and trichloroethene) are based on an excess lifetime cancer risk of 1×10^{-6} for continuous lifetime exposure. For these compounds, the reporting limit typically exceeds the comparison criteria by 10-fold or less, indicating that the reporting limit is associated with an excess lifetime cancer risk of up to 1×10^{-5} for long-term exposures. However, because the development of comparison criteria does not consider airborne levels present as a result of background or ambient activities, it is important to note that comparison criteria for these compounds are set at levels that are below typical indoor air background levels and cannot be distinguished from levels in site-specific outdoor air samples.

APPENDIX H

INDOOR AIR RISK CALCULATIONS – COMMERCIAL WORKER

**Table 1. Statistics of Detected Analytical Results for Indoor Air Samples - 2007, 2008, and 2009
Keith Middle School
New Bedford, Massachusetts**

Analysis	Analyte	# of Samples	# of Detects	Freq. of Detects	Min. of Detects (ug/m3)	Max. of Detects (ug/m3)	Location of Max. Detected	Min. of Non-Detects (ug/m3)	Max. of Non-Detects (ug/m3)	Mean Concentration (ug/m3)	EPC (ug/m3)	EPC Basis
VOCs	1,2,4-trichlorobenzene	30	2	6.7%	11.7	12.2	A-11	1.48	3.71	2.2E+00	12.2	Max. of Detects
	1,2,4-trimethylbenzene	30	5	16.7%	1.06	4.85	C-13	0.982	2.46	1.2E+00	1.833	95% Chebyshev (Mean, Sd) UCL
	2-butanone	30	22	73.3%	0.744	23.6	A-11	1.47	1.47	4.0E+00	5.62	95% Approximate Gamma UCL
	acetone ⁽¹⁾	30	27	90.0%	3.87	134	A-13	4.75	13.3	2.8E+01	38.2	95% Approximate Gamma UCL
	Benzene	12	12	100.0%	0.459	1.08	C-16	--	--	7.7E-01	0.866	95% Student's-t UCL
	Carbon Disulfide	15	1	6.7%	0.688	0.688	B-17	0.622	1.56	4.3E-01	0.688	Max. of Detects
	Chloroform	12	8	66.7%	0.101	0.245	C-17	0.098	0.098	1.2E-01	0.152	95% Student's-t UCL
	chloromethane	24	4	16.7%	0.866	15	C-13	0.413	1.03	1.4E+00	7.621	99% Chebyshev (Mean, Sd) UCL
	cyclohexane	30	6	20.0%	0.713	7.36	C-13	0.688	1.72	1.1E+00	2.178	95% Chebyshev (Mean, Sd) UCL
	Dichlorodifluoromethane	12	12	100.0%	1.99	2.57	C-18	--	--	2.2E+00	2.338	95% Student's-t UCL
	ethanol ⁽¹⁾	30	29	96.7%	4.16	191	C-17	4.71	4.71	3.2E+01	44.19	95% Approximate Gamma UCL
	ethylbenzene	30	6	20.0%	0.868	10.1	A-19	0.868	2.17	1.8E+00	3.696	95% Chebyshev (Mean, Sd) UCL
	Ethyl Acetate	12	1	8.3%	1.94	1.94	C-17	1.8	1.8	9.9E-01	1.94	Max. of Detects
	Freon-113	12	1	8.3%	2.02	2.02	C-17	1.53	1.53	8.7E-01	1.142	95% Student's-t UCL
	isopropanol ⁽¹⁾	30	18	60.0%	1.32	42.6	C-19	1.23	1.23	4.9E+00	42.6	Max. of Detects
	methylene chloride ⁽¹⁾	24	6	25.0%	3.48	318	C-14	1.74	3.47	1.6E+01	19.53	99% Chebyshev (Mean, Sd) UCL
	Methyl Isobutyl Ketone	12	3	25.0%	1.33	18.8	B-17	0.819	0.819	2.2E+00	18.8	Max. of Detects
	p/m-xylene	30	6	20.0%	5.06	39	A-19	1.74	4.34	5.4E+00	23.19	99% Chebyshev (Mean, Sd) UCL
	o-xylene	30	5	16.7%	2.68	14	B-17	0.868	2.17	2.3E+00	5.333	95% Chebyshev (Mean, Sd) UCL
	n-heptane	30	4	13.3%	0.86	16.5	A-11	0.819	2.05	1.4E+00	3.638	95% Chebyshev (Mean, Sd) UCL
n-hexane	30	9	30.0%	0.715	145	C-14	0.704	3.52	6.4E+00	53.99	99% Chebyshev (Mean, Sd) UCL	
styrene	30	13	43.3%	0.868	7.26	A-14	0.851	2.13	1.9E+00	3.396	95% Chebyshev (Mean, Sd) UCL	
Tetrachloroethylene	12	4	33.3%	0.136	0.163	B-19	0.136	0.136	9.5E-02	0.116	95% Student's-t UCL	
tetrahydrofuran	24	2	8.3%	4.52	7.05	A-13	0.589	1.47	1.0E+00	7.05	Max. of Detects	
toluene	30	26	86.7%	0.777	33.1	A-11	1.88	1.88	4.3E+00	5.935	95% Approximate Gamma UCL	
Trichloroethylene	12	3	25.0%	0.138	0.215	A-19	0.107	0.107	8.7E-02	0.215	Max. of Detects	
trichlorofluoromethane	30	11	36.7%	1.18	3.08	C-14	1.12	2.81	1.4E+00	1.492	95% Student's-t UCL	
PCBs												
	Total PCBs	30	23	76.7%	0.00031	0.013	A-19	0.000071	0.00038	2.2E-03	0.00339	95% Approximate Gamma UCL

Notes:

ug/m3 - micrograms per cubic meter.

Values in **Bold** indicate the compound was detected.

VOCs - Volatile Organic Compounds.

PCBs - polychlorinated biphenyls.

(1) Compound is a common laboratory contaminant and detects may be associated with laboratory contamination for 2007 samples.

EPC - Exposure point concentration.

UCL - Upper concentration limit.

Table 2
Commercial Worker Risk Evaluation
Inhalation of Air Exposure Pathway
Keith Middle School
New Bedford, MA

Constituent	EPC	Estimated Dose		Toxicity Values			Risk Estimates	
	Indoor Air Concentration µg/m ³	ADEcancer (Cancer) µg/m ³	ADEnon-cancer (Non-cancer) µg/m ³	Unit Risk (µg/m ³) ⁻¹	Chronic Noncancer Reference Concentration µg/m ³	Cancer Risk (--)	Hazard Quotient (--)	
1,2,4-Trichlorobenzene	12.2	9.9E-01	2.8E+00	NA	(1) 2.0E+02	(1) NA	1.E-02	
2-Butanone	5.62	4.6E-01	1.3E+00	NA	(1) 5.0E+03	(1) NA	3.E-04	
Acetone	38.2	3.1E+00	8.7E+00	NA	(1) 8.0E+02	(1) NA	1.E-02	
Carbon disulfide	0.688	5.6E-02	1.6E-01	NA	7.0E+02	(2) NA	2.E-04	
Ethyl acetate	1.94	1.6E-01	4.4E-01	NA	3.0E+03	(8) NA	1.E-04	
Benzene	0.866	7.1E-02	2.0E-01	7.8E-06	(1) 3.0E+01	(1) 6.E-07	7.E-03	
Chloroform	0.152	1.2E-02	3.5E-02	2.3E-05	(1) 6.6E+02	(1) 3.E-07	5.E-05	
Chloromethane	7.621	6.2E-01	1.7E+00	NA	(2) 9.0E+01	(2) NA	2.E-02	
Difluorodichloromethane	2.338	1.9E-01	5.3E-01	NA	2.0E+02	(3) NA	3.E-03	
Ethylbenzene	3.696	3.0E-01	8.4E-01	NA	(1) 1.0E+03	(1) NA	8.E-04	
Freon 113	1.142	9.3E-02	2.6E-01	NA	3.0E+04	(3) NA	9.E-06	
Methylene chloride	19.53	1.6E+00	4.5E+00	4.7E-07	(1) 3.0E+03	(1) 7.E-07	1.E-03	
Methyl isobutyl ketone	18.8	1.5E+00	4.3E+00	NA	(1) 3.0E+03	(1) NA	1.E-03	
Styrene	3.369	2.7E-01	7.7E-01	5.7E-07	(1) 1.0E+03	(1) 2.E-07	8.E-04	
Tetrachloroethene	0.116	9.5E-03	2.6E-02	5.5E-05	(1) 4.6E+03	(1) 5.E-07	6.E-06	
Tetrahydrofuran	7.05	5.7E-01	1.6E+00	1.9E-06	(7) 3.0E+02	(7) 1.E-06	5.E-03	
Toluene	5.935	4.8E-01	1.4E+00	NA	(1) 5.0E+03	(1) NA	3.E-04	
Trichlorofluoromethane	1.492	1.2E-01	3.4E-01	NA	7.0E+02	(3) NA	5.E-04	
Trichloroethene	0.215	1.8E-02	4.9E-02	1.7E-06	(1) 1.8E+02	(1) 3.E-08	3.E-04	
Xylenes	28.523	2.3E+00	6.5E+00	NA	(1) 1.0E+02	(1) NA	7.E-02	
n-Hexane	53.99	4.4E+00	1.2E+01	NA	(4) 2.0E+02	(4) NA	6.E-02	
n-Heptane	3.368	2.7E-01	7.7E-01	NA	(4) 2.0E+02	(4) NA	4.E-03	
Cyclohexane	2.178	1.8E-01	5.0E-01	NA	(4) 2.0E+02	(4) NA	2.E-03	
1,2,4-Trimethylbenzene	1.833	1.5E-01	4.2E-01	NA	(5) 5.0E+01	(5) NA	8.E-03	
Ethanol	44.19	3.6E+00	1.0E+01	NA	4.0E+03	(6) NA	3.E-03	
Isopropanol	42.6	3.5E+00	9.7E+00	NA	4.0E+03	(6) NA	2.E-03	
PCBs	0.00339	2.8E-04	7.7E-04	1.0E-04	(1) 2.0E-02	(1) 3.E-08	4.E-02	

Where:

LADecancer = IAC x EF x ED x EP/APcancer
ADEnon-cancer = IAC x EF x ED x EP / APnon-cancer
Cancer Risk = LADecancer x UR
Hazard Quotient = ADEnon-cancer / Inhalation Reference Concentration

	Cancer Risk	Hazard Index
TOTAL:	3E-06	2.E-01

LADE = Life Time Average Daily Exposure
ADE = Average Daily Exposure
EPC = Exposure Point Concentration
µg/m³ = micrograms per cubic meter

Sources of Toxicity Values:
(1) MassDEP 2008; MCP standards derivation
(2) IRIS, 2008
(3) HEAST, 1997
(4) Used C5-C8 aliphatic value from MassDEP 2008
(5) Used C9-C10 aromatic value from MassDEP 2008
(6) California EPA Reference Exposure Level for methanol
(7) EPA provisional value from the Superfund Technical Support Center
(8) Converted from IRIS RfD (0.9 mg/kg-day x 70 kg x 1/20 m³/day x 1000)

Bold = Cancer Risk >1.0E-05 or Hazard Quotient > 1.0E+01

And where:
Exposure Frequency (EF) = 250 days/year (5 days a week for 50 weeks of exposure)
Exposure Duration (ED) = 8 hrs/event [1]
Exposure Period (EP) = 25 yr [1]
Unit Conversion (UC) = 0.04 days/hr
Averaging Period (APcancer) = 25550 days [1]
Averaging Period (APnon-cancer) = 9125 days [1]

[1] MADEP, 2008