SUMMARY REPORT

FOR THE

NEW YORK CITY SCHOOL CONSTRUCTION AUTHORITY
PILOT STUDY TO
ADDRESS PCB CAULK IN NEW YORK CITY SCHOOL BUILDINGS

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EXECUTIVE SUMMARY

On January 19, 2010, The City of New York and the New York City School Construction Authority (SCA) reached an agreement regarding the assessment and remediation of PCB caulk and, in certain circumstances, other potential sources of PCBs, in public school buildings with the United States Environmental Protection Agency (USEPA), Region 2 (Consent Agreement and Final Order (CAFO), Docket Number TSCA-02-2010-9201). As a result of the agreement, the City has undertaken a comprehensive Pilot Study to gain further understanding regarding the possible presence of PCB caulk in school buildings and develop preferred remedial remedies for addressing such presence. As a result of the City's initial findings, the Pilot Study also evaluated some non-caulk sources of PCBs, such as fluorescent light ballasts. Results of the Pilot Study work requirements are presented in TRC's Interim Remedial Investigation Report (IRIR) dated June 15, 2011 and Final Remedial Investigation Report (RIR) dated August 21, 2012.

In accordance with the Work Plan in the CAFO, the City must prepare a summary report with appropriate backup information and data on the remediation of the Pilot Schools. Therefore this Summary Report is being presented.

This Summary Report is based on the key findings of the IRIR, RIR and results of Pilot Study activities performed in 2012 and 2013 after the RIR was submitted. This Summary Report is also based on USEPA's report (EPA/600/R-12/051/September 30, 2012), entitled, Polychlorinated Biphenyls (PCBs) in School Buildings: Sources, Environmental Levels, and Exposures.

Pilot Study Results and Findings

In consultation with the USEPA, four different remedial alternatives for use in three (3) of the five (5) schools were selected for study during the first phase of the Pilot Study as follows: 1) Patch and repair of caulk (i.e., remove loose and deteriorating caulk and replace with new caulk); 2) Encapsulation of caulk; 3) Removal of all caulk and replacement with new caulk; and 4) Best management practices (i.e., use pre-remedial sampling data from each Pilot School Building to evaluate the effectiveness of current operation and maintenance practices).

During the second phase of the pilot study the initial remedial alternatives were further evaluated on a whole-school basis and two (2) remedial alternatives were added. These included PCB caulk removal associated with window frame removal and replacement and removal and replacement of light fixtures that housed PCB containing ballasts.

Some of the more significant findings based upon the Pilot Study Data and USEPA's analyses of the SCA/TRC data and deemed relevant to the Preferred Citywide Remedy are as follows:

- Since the various PCB caulk remedial alternatives did not result in corresponding significant reductions in PCB concentrations in room air it is likely that caulking does not represent the only significant source at those locations where remediation took place. USEPA analyses of data from these same four (4) schools concluded that room air PCB concentrations in two (2) of the schools were higher than the maximum estimated air concentrations attributable to emissions from caulk sources alone. Both SCA/TRC and USEPA data suggest that other non-caulk PCB containing materials represent significant emissions sources of PCBs in a number of the pilot schools examined.

- Bulk samples collected from replacement non-PCB caulk nine and nineteen months after the caulk was installed indicate that PCBs from the original caulk appear to have contaminated the underlying substrates, and those PCBs have penetrated and contaminated the replacement caulk. These results suggest that removal and replacement of PCB caulk, without additional remedial measures to isolate and/or treat (e.g. chemically) the underlying substrate prior to installing the new caulk, is of limited benefit. The effectiveness of isolating the substrate requires further evaluation.
- Long-term monitoring results consisting of wipe samples from surfaces of PCB caulk that were encapsulated at P.S. 309K indicate that PCBs from the caulk have migrated through the encapsulant layer to the surface over time. These results indicate that the coatings used and methods employed in the pilot study do not represent an effective remedial measure for encapsulation of PCB caulk. USEPA ORD laboratory tests performed with ten (10) commercially available coatings indicated that encapsulation was not effective when high concentrations of PCBs were present in the caulk. Furthermore, none of the ten (10) encapsulants examined by USEPA ORD were found to be truly impenetrable to PCBs. As a result, encapsulation of PCB caulk using commercial products that are currently available may only represent a short term or interim control measure and not a long term or permanent remedial measure, especially when high concentrations of PCBs are present.
- Removal and replacement of light fixtures that use or used PCB light ballasts had a pronounced effect in terms of lowering PCB levels in air in the three Pilot School Buildings in which more than one remedy was implemented (i.e., P.S. 199M, P.S. 178X/176 and P.S. 309K). An important source of airborne PCB in these schools appears to have been leaking light fixture ballasts, rather than caulk. USEPA regards lighting ballasts as a primary source of PCBs present in NYC schools. Leaking and failed ballasts represent significant sources of PCBs to the indoor air, as well as, residues that remain on lighting fixtures after PCB-containing ballasts and capacitors have been removed.
- In all five (5) Pilot School Buildings, despite the significant variability in the quantity and concentration of PCB caulk concentrations in the study areas, pre- and post-remediation wipe samples were consistently below the USEPA guidance value of 10 $\mu g/100\ cm^2$. Based on these results, surface exposure through ingestion or dermal contact with PCB-laden dust has not been identified as a concern and current housekeeping/cleaning methods employed by the schools adequately address this issue.
- Based on air sample results at P.S. 178X, which is the only Pilot School with a Heating Ventilation and Air Conditioning (HVAC) system, an increase in the amount of fresh air introduced into the building via the ventilation system helped reduce indoor air PCB concentrations. USEPA corroborates this finding as it predicted that a linear relationship exists

between room air concentrations (predicted using PCB emission rates from caulk) and room air exchange rates (AER). Concentrations increased as AER decreased. USEPA thus regards building ventilation as an important factor in the reduction of PCB concentrations found in school buildings. These data serve to emphasize the importance of adequate building forced air ventilation in reducing PCB concentrations indoors.

- Test results confirm that the addition of carbon filtration was effective in reducing airborne concentrations of PCBs present in classrooms. In the case of both rounds of measurements at P.S. 199M, the mean PCB concentration was less than the guidance value for elementary-age students.
- Soil contamination encountered at P.S. 199M, P.S. 178X/176 and P.S. 309K was successfully mitigated through the process of delineation, excavation, and off-site disposal. Soil contamination at P.S. 3R and P.S. 183Q has been isolated pending implementation of soil excavation and disposal.
- PCB caulk contributions from historical construction projects (prior to the use of current PCB caulk containment and removal procedures) is thought to represent be the primary source of the PCBs encountered in surface soils rather than releases from existing PCB caulk.
- Based upon data analyses performed by USEPA, the majority of the interior caulk samples (82% of the 427 samples collected) representing the six (6) participant schools contained PCBs less than 50 ppm PCBs. Only 6% of the samples contained greater than 100,000 ppm PCBs.
- The field data confirm that dust removal represents a significant remedial measure for the mitigation of PCBs present in indoor environments. These remedial measures should include removal of both bulk and surface dusts. Dusts represent an important exposure pathway that includes inhalation, non-dietary ingestion and dermal contact. Routine cleaning of schools will continue to reduce dust levels and in turn reduce exposures to PCBs found in indoor air and on dust laden surfaces.
- Indoor air PCB data from the five (5) NYC Schools (P.S. 178X/176, 199M, 309K, 183Q and 3R) indicated that median concentrations had decreased 72% in comparison of pre and post remedial levels. Average or mean concentrations indicated a decrease of 74%. These data suggest that the multiple remedial measures employed (caulk remediation, light fixture and ballast removal, cleaning, ventilation, etc.) effected significant reductions in PCB concentrations present in indoor air within the five (5) pilot schools that were evaluated.

Preferred Citywide Remedy

Based on the Pilot Study and EPA's review of PCBs in School Buildings, the City of New York and SCA have developed a Preferred Citywide Remedy to address PCB exposures in the school environment. The Preferred Citywide Remedy presented in this Report is subject to review and comment on the basis of the input of the EPA, the independent peer review committee, the public as described in the CAFO, and future data collection and evaluation. Following these comment and review periods for the Citywide Preferred Remedy, the CA/FO requires EPA and the City negotiate for a period of no less than 60 days on a Citywide PCB Management Plan to implement to the Preferred Remedy.

The elements of the proposed Preferred Citywide Remedy include:

- **PCB Ballast and Associated Light Fixture Management and Replacement** - The City will continue to implement its ongoing program whereby all light fixtures that use or used PCB ballasts and associated light fixtures in New York City public school buildings are removed and replaced on a prioritized basis. All light fixture replacements projects will be completed by December 31, 2016.

- **Interim Visual Inspection and PCB Response Action Program**: The City will also continue its program whereby T12 lighting fixtures (which may contain PCB ballasts) are inspected on a regular basis by custodial staff for evidence of brownish black residue on any of the following: light diffuser (lens), light housing, or any area directly below lighting fixtures (furniture or floor). If leaks are observed, the fixture and the intact ballast or the ballast alone (if only the ballast has PCBs and there are no stains on the fixture) is removed by an electrician. Finally, procedures are in place and will continue to be implemented for the limited cases when PCB ballast leakage occurs outside the fixture (housing or diffuser) or when smoke is emitted from ballasts. This procedure includes the expedited removal of the ballasts and/or fixtures, aggressive ventilation, and cleaning or removal and disposal of any additional impacted items, with confirmatory wipe sampling for PCBs. Both protocols are annexed hereto and would be interim components of the preferred remedy.

- **Continued Assessment with EPA on Potential Caulk Remedial Measures**: While the measures thus far evaluated in the Pilot Study have yet to yield an effective remedy for PCB caulk, the work performed during the pilot study has yielded invaluable data and information on potential remedial measures designed to address this complex issue. As part of the preferred remedy, the City would like to continue this work under EPA's oversight by performing evaluations of new remedial approaches for PCB caulk. The City would perform this work in schools where fixtures containing PCB light ballasts have already been removed.

- **Best Management Practices** – The Best Management Practices (BMP), as approved by EPA in April 2012, will be implemented. This includes employing strategies for managing PCB caulk and ensuring safe and proper operation of all heating, air conditioning, ventilating and similar equipment (collectively "HVAC").

  - PCB caulk Management- Measures and practices will be used to protect interior and exterior PCB caulk from accidental damage and to identify the potential for deterioration through routine inspections requiring further action on an ongoing basis during school maintenance, repair and renovation. The BMPs also reference remediation of deteriorated PCB caulk by removal and replacement, patch and repair, or encapsulation.

  - **Heating Ventilating and Air Conditioning Maintenance** Building Air exchange rates will be maintained per design by ensuring that the HVAC and general ventilation systems are operating properly in accordance with the requirements contained in Appendix F of the Collective Bargaining Agreement. HVAC and general ventilation supply and exhaust fans will be operated while schools are occupied. Heating stacks, where designed primarily for ventilation rather than heating, shall be used to provide tempered fresh air while buildings are occupied. The City will maintain, adjust and make minor repairs to systems as needed. If there are problems identified with the systems that are beyond the ability of the appropriate building staff to directly rectify, a work request will be submitted on an expedited priority of a time sensitive nature.

- **Removal, Replacement and Encapsulation of Caulk -** As presented in the BMP, capital projects to renovate schools will be performed by the New York City School Construction Authority (SCA) in accordance with standard construction specifications which have been developed to properly manage and dispose of PCB caulk when it is disturbed during renovation activities. These protocols require rigorous dust control measures during the work, followed by cleaning and inspection at the conclusion of every work shift to minimize the potential exposure to PCB-containing dust during construction.

- **Soil Evaluation, Excavation and Replacement** - SCA will evaluate the presence of PCBs in the surface soil within outside exposure areas (i.e., soil within ten feet of the building face), following the completion of construction projects that disturb exterior PCB caulk. Any surface soil within ten feet of the building found to contain PCBs at a concentration of greater than the 1 ppm guidance value will be the subject of remediation by excavation and off-site disposal. Confirmatory post-excavation soil results will be obtained. After removing contaminated soil, the excavation will be backfilled using clean fill.

- **Public Outreach** - The City will implement public outreach pursuant to Local Laws 68 and Local Laws 69 of 2011 (see Appendix A). In addition, the City shall continue to maintain its updated website, which provides email updates to those who request such notices. The website will, among other things, provide information on the City's progress to remove PCB light fixtures.

Finally, due to existing limitations and data gaps associated with managing PCBs in school buildings additional studies are recommended in the areas of long-term monitoring, encapsulation of caulk and substrate, and activated carbon air filtration. It is anticipated that the proposed approach to managing PCBs in the schools will be subject to change based on future data collection and data evaluation.

1.0 INTRODUCTION

1.1 Purpose

At the request of the New York City School Construction Authority (SCA), TRC Engineers, Inc. (TRC) has prepared this Summary Report for the Polychlorinated Biphenyl (PCB) Pilot Study activities conducted in NYC school buildings. This report is part of the Consent Agreement and Final Order (CAFO) (Docket Number TSCA-02-2010-9201/January 19, 2010) between the City of New York and USEPA Region 2.

The purpose of the Summary Report is to provide a summary of significant findings of the Pilot Study including key findings of the Interim Remedial Investigation Report dated June 15, 2011, Final Remedial Investigation Report (RIR) dated August 12, 2012, and results of Pilot Study activities performed in 2012 and 2013 after the RIR was submitted. This report also summarized relevant findings of USEPA's report on PCBs in School Buildings (EPA/600/R-12/051) dated September 30, 2012. This report presents an effective plan for a Preferred Citywide Remedy, based on the current state of knowledge on these issues.

1.2 Background

1.2.1 PCB Caulk-Description of the Issue

Although the manufacture and most uses of PCBs were banned in 1979, buildings that were constructed or renovated from 1950 to 1978, including schools, may have PCBs in the caulk, lighting fixtures and other building materials. Exposure to PCBs in caulk may occur as a result of their release from the caulk into the air, dust, surrounding surfaces and soil, and through direct contact. In September, 2009, the USEPA published a series of guidance materials pertaining to the management of PCB caulk in older buildings. The guidance materials explained the current state of knowledge regarding PCB caulk and set forth best management practices for addressing PCB caulk. On January 19, 2010, the City, SCA, and USEPA reached an agreement to address the risks posed by PCBs in caulk by performing a Pilot Study to provide information to guide the development of a city-wide approach to assessing and reducing potential exposures to PCBs in caulk in New York City school buildings.

In addition to caulk, older school buildings may contain other building materials containing PCBs. As part of the pilot, the City was required to "track down" these sources in the pilot schools if actions related to the caulk did not reduce levels in air to below EPA's guidance levels. As a result of this "trackdown" provisions, the City identified PCB containing ballasts as significant source of PCBs in the school buildings. PCB ballasts are unconditionally authorized by EPA for continued use. However, as the ballasts get older, EPA has determined that they are more likely to leak PCBs from their housing, and thus has recommended that these ballasts be phased out of use.

1.2.2 Description of Pilot School Buildings

The City of New York identified five (5) school buildings that were built between 1950 and 1978 for inclusion as Pilot School Buildings to be evaluated in the Pilot Study. The Pilot School Buildings included one school in each of the five (5) boroughs of New York City:

Table 1.1
Summary of Five Pilot School Buildings

NYC School ID	School Name	Address and Telephone No.	Current Student Education Levels
178X/176	Dr. Selman Waksman School/ P.S. 176@ P.S. 178X	850 Baychester Ave, Bronx, NY 10475	Grades K-5/ Grades PK – 12
199M	Jessie Isador Straus School	270 West 70th Street Manhattan, NY 10023	Grades K-5
309K	George E. Wibecan Preparatory Academy/Excellence Charter School for Girls	794 Monroe Street Brooklyn, NY 11221	Grades PK – 5/ Grades K – 1
183Q	Dr. Richard R. Green School	2-45 Beach 79th Street Queens, NY 11693	Grades PK-8
3R	The Margaret Gioiosa School	80 South Goff Ave. Staten Island, NY 10309	Grades PK-5

2.0 PCB PILOT SCHOOLS STUDY

2.1 Summary of Work Performed

In consultation with the USEPA, four different remedial alternatives for use in three (3) of the five (5) schools were selected for study during the first phase of the Pilot Study. The results of the first phase of the Pilot Study are presented in the June 15, 2011 Interim Remedial Investigation Report (IRIR) and its October 5, 2011 Addendum. The remedial alternatives evaluated in the first phase, which are explained in greater detail in the USEPA approved RI Plan dated July 9, 2010, were 1) Patch and repair of caulk (i.e., remove loose and deteriorating caulk and replace with new caulk); 2) Encapsulation of caulk; 3) Removal of all caulk and replacement with new caulk; and 4) Best Management Practices (i.e., use pre-remedial sampling data from each Pilot School Building to evaluate the effectiveness of current operation and maintenance practices).

During the second phase of the pilot study the initial remedial alternatives were further evaluated on a whole-school basis in the three (3) schools that were selected for the first phase of the study, and two (2) additional remedial alternatives were evaluated in two (2) additional schools. The additional remedial alternatives included PCB caulk removal associated with window frame removal and replacement and removal and replacement of light fixtures that housed PCB-containing ballasts. Note the inclusion of the light ballast evaluation was performed in accordance with the USEPA approved RI Plan modification dated November 23, 2010.

Pre- and post-remediation wipe, bulk and air sampling results were collected from the Pilot School Buildings and evaluated for comparison.

2.1.1 Overview of Remedial Investigations

The scope of the remedial investigations, which have been completed within the five (5) schools (P.S. 178X/176, 199M, 309K, 183Q and 3R), followed the sequential phasing of work as described below:

- Performed a caulk survey (including sampling, location, quantity, and condition) to inventory suspected PCB caulk installed prior to 1980 in potential Pilot Study Areas.
- Conducted pre-remedial air and wipe sampling for PCB analysis in the Pilot Study Areas. Samples were collected indoors, from primary exposure areas and transitory areas, just prior to performing remedial alternatives.
- Conducted soil sampling in unpaved areas immediately surrounding each of the Pilot School Buildings for PCB analysis.
- Evaluated various remedial alternatives in each Pilot School Building. The remedial alternatives selected, in consultation with the USEPA, for evaluation during the Pilot Study were:
  (1) Patch and repair of caulk (i.e., remove loose and deteriorating caulk and replace with new non PCB-containing caulk);
  (2) Encapsulation of caulk;

(3) Removal of all caulk and replacement with new non PCB-containing caulk;

(4) Window frame and caulk removal and replacement with new window frames and non PCB-containing caulk;

(5) Removal and replacement of all PCB light fixtures and ballasts; and,

(6) Best Management Practices (i.e., use pre-remedial sampling data from each Pilot School Building to evaluate the effectiveness of current operation and maintenance practices).

Remedial alternates (1), (2), and (3) were evaluated in three (3) schools (P.S. 178X/176, 309K, and 199M), respectively. In each of these schools, the remedial alternates were implemented in only limited Pilot Study areas in 2010, and then the remaining areas throughout the schools were remediated in 2011. Remedial alternative (4) was implemented in 2011 in all areas where windows had not been previously replaced in P.S. 183Q. Remedial alternative (6) was also evaluated in each of the five (5) schools through the evaluation of the pre-remediation sampling data. In addition, due to findings in the first three (3) schools studied during 2010, removal of light fixture PCB ballasts was evaluated in one (1) school (P.S. 3R) in 2011 pursuant to the USEPA approved RI Plan modification dated November 23, 2010.

2.1.2 Summary of Data Analysis

2.1.2.1 Applicable Comparison Criteria

Results from PCB analyses of each type of media were compared to applicable regulatory guidelines. A summary of these guidance values on a media specific basis is provided below.

- **Bulk Caulk Samples:** Any bulk caulk sample (hereafter referred to as "caulk samples") that equaled or exceeded 50 ppm of total PCBs was considered to be PCB caulk.
- **Air Samples:** Based upon USEPA's indoor air guidelines for schools and ages of building occupants (see U.S. EPA, Public Health Levels in School Indoor Air), all air sampling results were compared against the values listed in Table 2.1.

Table 2.1
USEPA's Public Health Guidance Values for PCBs in School Indoor Air (ng/m^3)

Age 3 to <6 yr (Pre-Kindergarten and Kindergarten)	Age 6 to <12 yr (Elementary School)	Age 12 to <15 yr (Middle School)	Age 15 to<19 yr (High School)	Age 19+ yr (Faculty)
100	300	450	600	450

Note: Per NYCDOH and USEPA, USEPA guidance values for air are intended to be protective of long-term exposure with an adequate margin of safety. Short-term exposures above the guidance values are unlikely to result in any adverse health effects.

- **Surface Wipe Samples:** Pre and post-remedial wipe samples were compared to USEPA's High Occupancy wipe sample criteria of 10 µg/100 cm^2 (40 CFR 761.3, 761.123 and 761.30).

- **Soil Samples:** Soil samples were compared to USEPA's clean backfill standard (40 CFR 761.125(c)(4)(v) and 40 CFR 761.125(b)(1)(ii)) and the New York State Department of Environmental Conservation (NYSDEC) CP-51/Soil Cleanup Guidance and 6 NYCRR Part 375 value of 1 ppm for PCBs.

2.1.2.2 Target Laboratory Reporting Limits

Laboratory reporting limits for each of the PCB Aroclors in the different sampling media were as follows:

- **Caulk Samples** – 1.0 milligram per kilogram (mg/kg).
- **Air Samples** – 50 nanograms per cubic meter (ng/m^3).
- **Surface Wipe Samples** – 0.1 micrograms per 100 square centimeters ($\mu g/100\ cm^2$).
- **Soil Samples** - 0.5 mg/kg.

2.1.2.3 Statistical Analyses

The PCB air sample results were evaluated to determine whether there were differences in the pre-remediation data as compared to the post-remediation data. This included a statistical analysis of the data to identify differences that were statistically significant to a 95% confidence level (indicated as "$p \leq 0.05$").

The statistical analysis method included confirmation that the data were normally distributed and comparison of typical statistical parameters (e.g., average and variance) using parametric hypothesis testing methodology and assumptions. Normality was evaluated using standard chi-square and cumulative distribution function tests. Comparison of the pre- and post-remediation mean concentrations was performed using t-distribution hypothesis tests (t-tests).

2.2 Initial Bulk Interior Caulk Sampling

Bulk caulk samples were collected in four (4) schools (P.S. 178X/176, 199M, 309K and 183Q) representing four hundred and seven (407) homogenous materials. These locations were surveyed and sampled over the course of the two phases of the RI to evaluate the interior caulk at the pilot schools to determine the presence of PCB caulk and its condition prior to implementation of various remedial alternatives. A total of one hundred fifty-two (152) locations were noted to contain PCB caulk (i.e., caulk found to contain greater than 50 ppm PCBs). Laboratory results for the caulk samples indicate that PCB concentrations ranged from non-detect (less than 0.33 mg/kg) to 440,000 mg/kg. The results of these surveys are summarized in Tables 1A, 2A, and 3A of the IRIR and Tables 1A, 2A, 3A and 4A of the RIR.

2.3 Pre-Remedial Dust Wipe and Air Sampling

During Phase I of the Interim Remedial Investigation activities both dust wipe and PCB air sampling were conducted prior to implementation of various remedial alternatives evaluated at three (3) initial pilot schools (P.S. 178X/176, 199M and 309K). In Phase II, during the supplemental work to the Interim Remedial Investigation and Remedial Investigation, additional dust wipe and PCB air sampling activities were performed prior to remedial activities at five (5) pilot schools (P.S. 178X/176, 199M, 309K, 183Q and 3R). The sampling activities described in Phase I and II are summarized below.

2.3.1 Phase I

Seventy-four (74) composite wipe samples (two samples from the same surface type) plus three (3) field blanks were collected in the three (3) initial Pilot Schools (P.S. 178X/176, 199M and 309K). The dust wipe sampling was used to establish pre-remedial surface dust conditions and to evaluate the effectiveness of cleaning methodologies described in the best management practices in controlling exposures to PCBs on surfaces. Laboratory results of the wipe samples indicate that they ranged from non-detect (less than 0.100) to 0.864 μg/100 cm^2. The results of these wipe samples are summarized in Tables 1E, 2E and 3E of the IRIR

A total of sixty-six (66) pre-remedial air samples were collected in the same three (3) initial Pilot Schools (P.S.178X/176, 199M and 309K) within a representative number of classrooms and offices. The samples consisted of thirty nine (39) area samples, four (4) ambient air samples for comparison purposes, four (4) duplicate samples, and nineteen (19) front/back samples to evaluate Apparent Collection Efficiency (ACE). In addition, eight (8) field spike samples, and six (6) field blank samples were collected for quality control purposes. Laboratory results for the air samples ranged from non-detect (less than 48.7 ng/m^3) to 4,957 ng/m^3. The results of these air samples are summarized in Tables 1C, 2C, 3B and 3C of the IRIR

2.3.2 Phase II

One hundred and forty (140) composite wipe samples (two samples from the same surface type) plus five (5) field blanks were collected in the five (5) Pilot Schools (P.S. 178X/176, 199M, 309K, 183Q and 3R). The dust wipe sampling was used to establish pre-remedial surface dust conditions and to evaluate the effectiveness of cleaning methodologies described in the best management practices in controlling exposures to PCBs on surfaces. Laboratory results for the wipe samples indicate that they ranged from non-detect (less than 0.100) to 2.10 μg/100 cm^2. The results of these wipe samples are summarized in Tables 1C, 2C, 3C, 4C and 5A of the RIR

A total of one hundred and twenty (120) pre-remedial air samples were collected in five (5) Pilot Schools (P.S. 178X/176, 199M, 309K, 183Q and 3R) within a representative number of classrooms and other school areas, such as gyms, cafeterias and hallways. The samples consisted of ninety-one (91) area samples, seven (7) ambient air samples for comparison purposes, nine (9) duplicate samples, and thirteen (13) front/back samples to evaluate Apparent Collection Efficiency (ACE). In addition, seventeen (17) field spike samples, and ten (10) field blank samples were collected for quality control purposes. Laboratory results for the air samples ranged from non-detect (less than 47.5 ng/m^3) to 1,005 ng/m^3. The results of these air samples are summarized in Tables 1D, 1E, 2D, 3D, 4D and 5B of the RIR

2.4 Exterior Sampling

Soil sampling was conducted at the five (5) Pilot Schools (P.S. 178X/176, 199M, 309K, 183Q and 3R) in accordance with Appendix G of the RI Plan. The soil sampling protocols established under the RI Plan specified that samples were collected every 20 linear feet along the building face, in three rows, located approximately 0.5 feet, three feet and eight feet away from the building. Samples were collected from zero (0) to two (2) inches below the ground surface (bgs). The results of soil sampling are summarized below. As a requirement of the RI Plan, exterior caulk samples were collected adjacent to any areas where PCB impacted soil (greater than 1 ppm PCBs) was identified.

2.4.1 Soil Sampling

A total of two hundred and ninety-nine (299) pre-remedial soil samples were collected representing the five (5) Pilot Schools (P.S. 178X/176, 199M, 309K, 183Q and 3R) from depths of zero (0) to two (2) inches and two (2) to four (4) inches (bgs). In addition, fourteen (14) duplicate soil samples and twenty-two (22) site-specific matrix spiked and matrix spiked duplicate (MS/MSD) soil samples were submitted for analysis for quality control purposes. Laboratory results for the soil samples indicate that concentrations ranged from non-detect (less than 0.5 ppm) to 36.0 ppm, with the exception of one sample (178-NORTH-SO-2A (0-2)) that had a concentration of 211 ppm. In addition, further delineation samples were taken at two of the schools (P.S. 178X/176 and 183Q). The results of these soil samples are summarized in Tables 1G, 2G and 3G of the IRIR and Tables 4G and 5E of the RIR

2.4.2 Exterior Caulk Sampling

Based on the results of soil sampling, bulk samples of exterior caulk were collected at each of five (5) Pilot Schools representing seventy-eight (78) homogenous materials. Locations containing visible caulk were surveyed and sampled to determine the presence of PCB caulk and its condition prior to implementation of various remedial alternatives. A total of forty-four (44) locations had concentrations of PCBs greater than 50 ppm and were therefore considered PCB caulk. Laboratory results for the caulk samples indicate that PCB concentrations ranged from non-detect (less than 1.00 mg/kg) to 459,000 mg/kg. The results of these surveys are summarized in Tables 1H, 2H and 3H of the IRIR and Tables 4H and 5F of the RIR.

2.5 Remedial Actions

In consultation with the USEPA, there were six (6) different remedial alternatives evaluated.

2.5.1 Remedial Alternative (1) Caulk Patch and Repair

The patch and repair of PCB caulk was evaluated at P.S. 178X/176. Patch and repair involved removing any loose or damaged and/or deteriorated caulk and replacing the removed caulk with new, non PCB-containing caulk in the Pilot Study Areas. In some cases, the amount of loose or damaged and/or deteriorated caulk was less than approximately ten percent (10%) of the total linear footage of PCB caulk identified in the study area; therefore additional "sound" PCB caulk was removed and replaced to achieve a minimum of approximately 10% by linear footage of PCB caulk subject to this remedial strategy. The list of pilot school areas remediated and the quantity of caulk that was remediated are summarized in Table 4.1 of the IRIR and/or Table 4.1 and 4.2 of the RIR

2.5.2 Remedial Alternative (2) Caulk Encapsulation

The encapsulation of PCB caulk was evaluated in P.S. 309K. The PCB caulk encapsulation involved the following three (3) different commercially available encapsulant products: Macropoxy 646 Fast Cure Epoxy and Sealant manufactured by Sherwin Williams, Series-151-1051 Elasto-Grip FC manufactured by TNEMEC and Sikagard® 550W manufactured by Sika Corporation. These products were tested as a barrier or coating to prevent dust generation and dermal contact with PCB caulk. In order to separate the effectiveness of encapsulation and patch and repair alternatives, areas of significantly deteriorated and/or loose PCB caulk were removed and replaced prior to encapsulation in accordance with procedures described above in the patch and repair remedial alternative (see Section 2.5.1). (Loose caulk does not provide a suitable foundation for encapsulation.)

Encapsulation of PCB caulk was evaluated on different homogeneous PCB caulk types in primary exposures areas (i.e., classroom areas, library, gymnasium and cafeteria) and transitory exposure areas (i.e., vestibules, corridors and stairwells). The list of Pilot School Areas remediated and the quantity of caulk that was remediated are summarized in Table 4.1 of IRIR and/or Table 4.1 and 4.3 of the RIR

2.5.3 Remedial Alternative (3) Caulk Removal and Replacement

The removal of all PCB caulk was evaluated within P.S. 199M. The locations/rooms which were identified consisted of areas considered primary exposure areas (i.e., classroom areas, auditorium, gymnasium and cafeteria) and transitory exposure areas (i.e., corridors and stairwells). All visible and accessible interior PCB caulk was removed and replaced with new, non PCB-containing caulk.

The list of pilot school areas remediated and the quantity of caulk that was remediated are summarized in Table 4.1 of the IRIR and/or Table 4.1 and 4.4 of the RIR

2.5.4 Remedial Alternative (4) Window Replacement (including Removal and Replacement of PCB caulk)

The replacement of windows in P.S. 183Q included the removal and replacement of PCB caulk with new, non-PCB-containing caulk. At P.S. 183Q, the window replacement was limited to the first floor, the stairwells and bulkheads, gymnasium and Roof C/north corridor and Roof D/south corridor on the 3^{rd} floor. All other windows in the school had previously been replaced. The project included the removal of both PCB and asbestos-containing material (ACM) caulk associated with window frames and window openings. The window frames and PCB and ACM caulk were removed using wet methods. The window openings were thoroughly cleaned using hand tools with any residual caulk waste bagged directly. The surfaces of the work area were rendered free of visible debris. Final asbestos air sampling conducted inside the work areas indicated that acceptance criteria for re-occupancy were achieved in each work area prior to removal of containment. The list of pilot school areas remediated is summarized in Table 4.1 of the IRIR and/or Table 4.1 of the RIR

2.5.5 Remedial Alternative (5) Light Fixture Ballast Removal and Replacement

The removal and replacement of all fluorescent light fixtures and ballasts was evaluated as a standalone remedial alternative in P.S. 3R. In addition, the removal of light fixtures and ballasts was also performed in three (3) schools (P.S 178X/176, P.S 199M, and P.S 309K) as a supplemental remedy. A summary of survey results of the light fixtures at the four (4) schools is provided in Table 4-9, Section 4.2.2 Light Ballast, Polychlorinated Biphenyls (PCBs) in School Buildings: Sources, Environmental Levels, and Exposures [PCBs in School Buildings]).The removal procedures included sealing rooms with polyethylene sheeting and other precautions for the removal and replacement of light fixtures and associated PCB ballasts as described in Section 7.0 of the IRIR and Section 4.5 of RIR

Four (4) non-leaking fluorescent light ballasts were sent to the laboratory and analyzed to document the concentrations of PCBs in the ballasts that were being removed. Laboratory results for the ballast samples indicated that the ballast capacitor oils contained concentrations of PCBs from 930,000 to 1,280,000 mg/kg. Results for the potting insulation material, and wire casings ranged from non-detect (less than 17.9 mg/kg) to 3,880 mg/kg. Results for discharge/impacted materials ranged from 129 to 113,000 mg/kg. Refer to Table 4C of the IRIR and Tables 5G of the RIR which provide the results of the chemical analysis of bulk samples for representative light ballast components that were sampled.

2.5.6 Remedial Alternative (6) Best Management Practices.

The City of New York has developed a Best Management Practices (BMP), that was approved by the EPA in April 2012 (see RIR, Appendix F of Appendix L Feasibility Study), which includes measures and practices that will routinely be used to protect PCB caulk from accidental damage and to identify the potential for deterioration requiring further action on an ongoing basis during school maintenance, repair and capital improvement projects.

New York City Schools are operated by the New York City Department of Education (DOE) and maintenance of the buildings is performed by the Division of Schools Facilities (DSF). Capital projects to renovate schools or construct new buildings are performed by the New York City School Construction Authority (SCA). Each of these organizations plays an important role in properly managing caulk in schools, as discussed in Section 3.0 of the BMP. Additionally, EPA will observe the implementation of BMPs through data collection and inspections, and provide feedback on the implementation activities.

The following parties have specific roles and responsibilities for observing, implementing and/or documenting various activities under the BMP at New York City Schools:

1. Custodian Engineers/Building Managers (CEs/BMs) are responsible for:

    i) Caulk inspections.

    ii) Design/implementation of caulk maintenance programs.

    iii) Operation/maintenance of Heating Ventilation and Air Conditioning (HVAC) systems, fans, ducts, registers, etc.

    iv) Record keeping.

2. DSF Administrators are responsible for:

    i) Evaluation of BMPs related to school-specific interior caulk inspection programs and taking corrective actions to ensure proper implementation.

    ii) DSF Environmental Health and Safety (EHS) Unit is responsible for proper management of PCB caulk in relation to existing caulk, and removal and disposal actions according to all regulatory requirements.

iii) Communication and transmission of BMPs to CEs/BMs between DSF as part of annual school opening directives.

3. SCA Construction Management is responsible for:

   i) Management of renovation and construction projects related to caulk replacement and repair associated with all requirements under the BMPs.

   ii) Soil characterization and remediation associated with PCBs from exterior caulk.

   iii) Record keeping consistent with the requirements set forth in the CAFO.

2.6 Supplemental Actions

In response to post-remedial conditions identified in each of the schools multiple supplemental actions were performed at each school, followed by a round of air sampling as described in the IRIR and RIR. This Supplemental Actions subsection presents an overview of these activities and highlights the specific actions that were evaluated and found to have materially reduced PCB air concentrations.

In response to post-remedial conditions identified, the following supplemental actions were undertaken as described in the IRIR and RIR:

- Additional removal and replacement of deteriorated caulk in one (1) school.
- Additional interior caulk encapsulation activities in one (1) school.
- Additional exterior caulk encapsulation activities at two (2) schools.
- Additional surface cleaning activities in all five (5) schools.
- Additional cleaning after window replacement/repairs to impacted finishes at one (1) school.
- Ventilation system repairs at two (2) schools (178X and 309K).
- Ventilation activities in three (3) schools.
- Ventilation system (supply and/or exhaust) cleaning in two (2) schools.
- Additional ventilation studies at two (2) schools.
- Ventilation tracer gas study at one (1) school.
- Indoor temperature and pollutant pathway studies in one (1) school.
- Additional light fixture removal activities at three (3) schools.
- Installation of granular activated carbon air filtration units in one (1) school.

Additional rounds of air samples for PCBs were collected and analyzed to gauge the relative effectiveness of measures taken in each school. The following presents a summary of the relevant results for the supplemental actions that improved the condition of the air quality at the school(s). The detailed descriptions of Supplemental Actions taken and results for all associated sample analysis can be found in the IRIR and RIR.

2.6.1 Additional Cleaning after Window Replacement/Repairs to Impacted Finishes

At P.S. 183Q, subsequent to installation of replacement windows and repair of impacted finishes, additional detailed and fine cleaning activities were conducted. These are as follows: HEPA vacuuming and wet wiping of non-porous horizontal surfaces including, but not limited to, floors, desks, shelves, cabinets, radiator coverings, and window sills. These activities were conducted in the following areas:

- Rooms 103, 105, 107, 109, 151, and the SW and NE stairwells were re-cleaned on August 30, 2011, followed by a 24-hour ventilation period with windows opened, building ventilation on, and the doors to the stairwells and bulkheads opened. The exterior ground floor stairwell entrance door was opened during day-time hours only.
- The Gym was re-cleaned utilizing the same methods described above on August 31, 2011.

The additional detailed cleaning of physical spaces subject to window replacement by a qualified environmental contractor resulted in the improvement of subsequent PCB air sampling to levels within USEPA acceptance criteria in these Pilot Study Areas.

2.6.2 Ventilation System Repairs

Ventilation system repairs were completed at two (2) schools (P.S. 178X/176 and 309K) to address preliminary investigations completed in the Pilot Study. At P.S. 178X/176, repairs were made to the HVAC mechanical systems, including manually overriding the unresponsive fresh and spill air dampers to maximize fresh air intake and exhaust of return air, and replacement of a fan belt on the unit serving Rooms 356 and 357. At P.S. 309K, repairs were made to the ventilation mechanical systems, which included repair of exhaust fan motor and belts, by securing the fans to the duct risers, sealing duct penetrations, and replacing the belts on each of the fan motors. At P.S. 178X air quality was improved and at P.S. 309K the ventilation improved.

2.6.3 Additional Light Fixture Removal Activities

The removal and replacement of the PCB light ballasts and associated fixtures improved conditions in observed PCB air concentrations in the three (3) schools. At P.S. 199M, P.S. 178X/176 and P.S. 309K, lighting ballasts removal was demonstrated as a significant source of PCBs to the indoor air, as well as, residues that remain on lighting fixtures after PCB containing ballasts and capacitors have been removed (see Section 3.3.2.1).

2.6.4 Installation of Granular Activated Carbon Air Filtration Units

In August 2011, activated carbon air filtration units were installed in two (2) classrooms and air testing was performed in those rooms at P.S. 199M. Based on the marked improvement in air concentrations in these two (2) rooms, activated carbon air filtration units were subsequently installed in all normally occupied rooms throughout the building. Filtration units continue to operate to date.

Carbon filtration has been effective at reducing airborne PCB concentrations, as the mean PCB concentration measured in air within the Primary Exposure Areas decreased significantly after implementing the on-going carbon filtration for approximately one (1) month. After two (2) months of operation, the mean PCB concentration in air was lower than the one-month results, but the difference was not statistically significant. In the case of both rounds of measurements, the mean PCB concentration was less than the guidance value for elementary-age rooms, with certain individual measurements exceeding guidance values.

2.7 Post-Remedial Sampling

As discussed in the IRIR and the RIR, post-remedial sampling was conducted following the implementation of remedial alternatives at each of the Pilot Schools. This included post-remedial dust wipe and air samples which were collected in the same target areas as the pre-remedial wipe and air samples for comparison of the results. In addition, long term monitoring via bulk and wipe sampling was conducted in the three initial phase Pilot Schools (P.S. 178X/176, 199M and 309K) to evaluate the effectiveness of the remedial methodology selected for that school.

2.7.1 Post-Remedial Dust Wipe Sampling

Two hundred and fourteen (214) composite (two samples from the same surface type) post-remediation dust wipe samples were collected in the five (5) Pilot Schools (P.S. 178X/176, 199M, 309K, 183Q and 3R). Results from the post-remediation wipe sampling in remediated areas were consistent with the pre-remedial wipe sampling data as all results were below the comparison criteria of 10 µg/100 cm^2 (refer to Tables 1F, 2F and 3F of the IRIR and 1F, 2E, 3E, 4E and 5C of the RIR for sample results).

Based upon these results, the presence of PCBs on surfaces is not thought to represent a significant source of potential PCB exposures in the study areas. The current cleaning methodologies described in the Best Management Practices (as supported by the favorable pre-remedial wipe sample analytical results) were deemed effective in controlling exposures to PCBs on surfaces. In addition, to the extent that the PCB caulk within the study areas may have contributed to the presence of PCBs on surfaces, the dust control and cleaning methodologies utilized as a part of the PCB caulk remedial activities were also deemed appropriate to control exposure to PCBs on surfaces, as evidenced by the post-remedial wipe sample results.

2.7.2 Post-Remedial Air Sampling for Caulk Patch and Repair

2.7.2.1 P.S. 178X/176 – July 28, 2010

A total of eleven (11) post-remedial air samples were collected on July 28, 2010 in the locations described in the RI Plan. Laboratory results for the air samples indicated that concentrations ranged from non-detect (less than 49.5 ng/m^3) to 328 ng/m^3. Refer to Table 1D of the IRIR for a summary of the sample results. A comparison of pre- and post-remediation data found post-remediation air sample results to be generally higher than the pre-remediation samples, although concentrations were still relatively low.

In response to these results, which were above the USEPA guidance value of 100 ng/m3 for kindergarten and pre-kindergarten classrooms, additional investigations and remedial measures were taken (refer to IRIR Section 7.0) ultimately resulting in concentrations less than EPA guidance values. Of note was the finding that HVAC repairs had a marked positive impact on air concentrations found.

2.7.2.2 P.S. 178X/176 – August 11, 2011

A total of nineteen (19) post-remedial air samples were collected on August 10, 2011. Samples were collected from the same locations used during the pre-remediation event. Laboratory results for the air samples indicate that concentrations ranged from non-detect (less than 48.5 ng/m3) to 55.2 ng/m3. Refer to Table 1G of the RIR for a summary of the sample results. A comparison of pre- and post-remediation data, found post-remediation air sample results to be generally equal to or lower than the pre-remediation samples.

2.7.3 Post-Remedial Air Sampling for Caulk Removal

2.7.3.1 P.S. 199M – August 7, 2010

A total of nineteen (19) post-remedial air samples (including one ambient sample), two ACE samples, one duplicate sample, two field spiked samples, and one field blank were collected on August 7, 2010 in the locations described in the RI Plan. Laboratory results for the air samples indicate that air concentrations ranged from non-detect (less than 49.6 ng/m^3) to 934 ng/m^3. Refer to IRIR Table 2D for a summary of those results. A comparison of pre and post-remediation data, found the post-remediation air sample results to be generally lower than the pre-remediation samples.

In response to these results, many of which were above the USEPA guidance of 300 ng/m^3 for elementary school aged children, additional investigations and remedial measures were taken, including extensive cleaning and ventilation of the school and removal and replacement of light fixture ballasts as described in IRIR Section 7.0.

2.7.3.2 P.S. 199M – October 11/17, 2010

Additional air samples were collected in P.S. 199M on October 11 and 17, 2010. A total of seventeen (17) air samples were collected on October 11, 2010 and an additional six (6) air samples were collected on October 17, 2010. Laboratory results of the air samples indicated that concentrations ranged from non-detect (less than 49.4 ng/m^3) to 231 ng/m^3. Results showed improvement in all locations as compared to previous post-encapsulation air sample results; however, kindergarten classrooms still exhibited concentrations above the 100 ng/m^3 USEPA guidance value.

2.7.3.3 P.S. 199M – November 26, 2010

An additional nineteen (19) air samples were collected on November 26, 2010 during the heating season with the windows closed so as to be representative of normal winter conditions. Laboratory results indicated that concentrations ranged from non-detect (less than 48.6 ng/m^3) to 221 ng/m^3.

Only two (2) of the samples, those collected in Rooms 114 and 118, exceeded the 100 ng/m^3 USEPA guidance value for kindergarten classrooms. These results show improvement over the previous October 11 and 17, 2010 round of air samples, where all eight (8) kindergarten classroom air samples exceeded the 100 ng/m^3 USEPA guidance value.

2.7.3.4 P.S. 199M – February 22, 2011

An additional nineteen (19) air samples were collected on February 22, 2011 during the February Recess. Laboratory results of the air samples ranged from less than 48.6 nanograms per cubic meter of air (ng/m^3) to 177.6 ng/m^3 with a mean indoor air concentration of 83.7 ng/m^3. None of the results for the classrooms sampled exceeded the applicable USEPA guidance values.

2.7.3.5 P.S. 199M – August 6, 2011

A total of twenty-three (23) post-remedial air samples were collected on August 6, 2011. Laboratory results for the air samples indicated that air concentrations ranged from non-detect (less than 48.7 ng/m^3) to 821 ng/m^3. Refer to RIR Table 2F for a summary of those results. A comparison of pre- and post-remediation data found the results to be similar and the differences between pre-remediation and post-remediation data sets to be statistically insignificant (see Section 2.1.2.3).

In response to these results, many of which were above the USEPA guidance values (100 ng/m^3 for kindergarten and pre-kindergarten classrooms and 300 ng/m^3 for elementary school aged children), additional investigations and remedial measures were taken, including installation of carbon air-filtration devices, and additional air sampling. Results of post-carbon filtration samples showed a significant decrease in air concentrations as compared to pre- and post-remediation results. The mean airborne PCB concentrations in primary areas were reduced by more than 45%, from 289.8 ng/m^3 measured in June 2011 and 288.5 ng/m^3 measured in August 2011, to 157.8 ng/m^3 measured in September 2011 following installation of the carbon air filtration units.

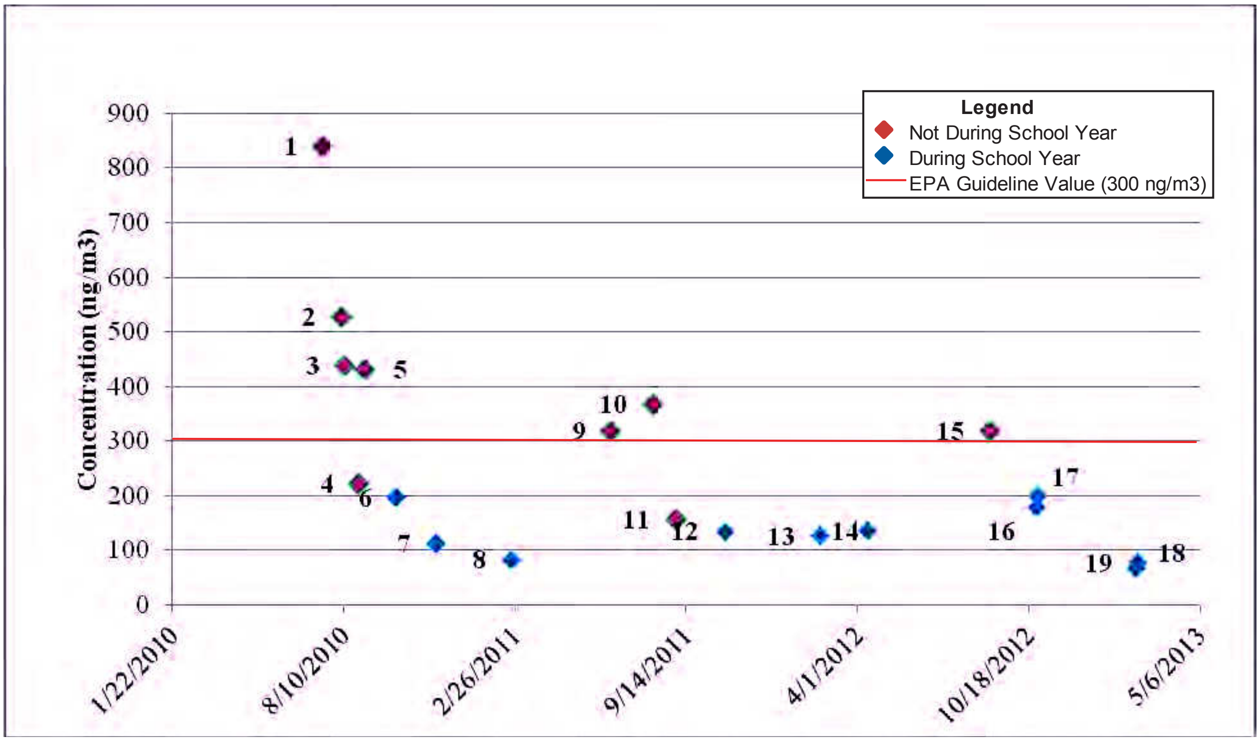
2.7.3.6 P.S. 199M – February 21/22, 2013

A total of 29 air samples were collected on February 21, 2013 under normal winter conditions (classroom doors open). An additional 29 air samples were collected on February 22, 2012 under similar conditions with the exception that classroom doors were closed for comparison purposes. Laboratory results for the indoor air samples on February 21, 2013 ranged from less than 47.6 ng/m3 to 419 ng/m3 and the results from February 22, 2013 ranged from less than 47.6 ng/m3 to 459 ng/m3. The samples which were found to exceed the EPA's indoor air guidelines for elementary schools (U.S. EPA 2009) were also analyzed by congener specific method (CQCS). The EPA has demonstrated that the CQCS is a more extensive test method representative of air quality. Although Method 8082 (Aroclor pattern matching) is conservative for PCB testing, the CQCS analysis is being performed in certain cases. The three (3) samples that were further analyzed by CQCS were found to be lower than the result from USEPA Method 8082 with five peak match; however, the sample results by CQCS still exceeded the EPA's indoor air guidelines.

2.7.3.7 P.S. 199M Airborne PCB Concentrations Over Time

Between August 23, 2008, and February 22, 2013, twenty-five (25) rounds of wide-scale testing were performed in P.S. 199M. Four (4) of these rounds were performed prior to the initiation of the Pilot Study, and the other twenty-one (21) rounds were performed as part of the Pilot Study. Eight (8) rounds of sampling were performed in the month of August, five (5) rounds in October, four rounds in February, two (2) rounds in September, and one (1) round each in January, April, June, July and November. Building-wide monthly PCB averages ranged from a high of 839.67 ng/m^3, measured in July 2010, to a low of 67.24 ng/m^3, in February 2013 Refer to Figure 2.1 below for a graphical representation of the building-wide airborne PCB average concentration trend since the beginning of the Pilot Study in June 2010. The same trend has also been noted in P.S. 309K, as detailed in Supplemental Report #1 located in Appendix M of the RIR.

Figure 2.1 – P.S. 199M Building Average Concentration Over Time



Key to Air Sampling Events:

1 – June 17, 2010 pre-remedial sampling
2 – August 7, 2010 post-remedial sampling
3 – August 11, 2010 post-remedial resampling
4 – August 27, 2010 post-light fixture replacement sampling
5 – September 3, 2010 post-encapsulation sampling
6 – October 11, 2010 post-ventilation sampling
7 – November 26, 2010 winter conditions sampling
8 – February 22, 2011 winter conditions sampling
9 – June 18, 2011 pre-remedial sampling
10 – August 6, 2011 post-remedial sampling
11 – September 2, 2011 post-carbon filtration sampling

12 – October 30, 2011 post-carbon filtration sampling
13 – February 17, 2012 winter conditions sampling
14 – April 12, 2012 spring conditions sampling
15 –September 2, 2012 summer conditions sampling
16 – October 26 and 27, 2012 fall conditions sampling
17 – October 28, 2012 fall conditions sampling
18 – February 21, 2013 winter conditions sampling
19 – February 22, 2013 winter conditions sampling

These data indicate that school wide averages were generally highest over the summer months and at the beginning and end of the school year and lowest during the school year winter months. As indicated by the data, average building-wide airborne PCB concentrations at P.S. 199M have tended to decrease with time and following implementation of the remedial and post-pilot activities. The same trend has also been noted in P.S. 309K, as detailed in Supplemental Report #1 located in Appendix M of the RIR.

2.7.3.8 P.S. 183Q (Window Removal) – August 21, 2011

A total of sixteen (16) post-remedial air samples were collected on August 21, 2011. Samples were collected from the same pre-remediation locations described previously. The laboratory results for the air samples indicate that concentrations ranged from non-detect (less than 49.2 ng/m^3) to 785 ng/m^3. A comparison of pre- and post-remediation data found no statistical difference (see Section 2.1.2.3) between the pre- and post-remediation Primary Exposure Area air sample results.

In response to the results which were above the USEPA guidance values (100 ng/m^3 for kindergarten and pre-kindergarten classrooms and 300 ng/m^3 for elementary school aged children), additional investigations and remedial measures were undertaken as described in RIR Section 7.0 Post-Pilot Study Investigation and Remediation. Results of the September 2011 round of air samples collected in Primary Exposure Areas showed a statistically significant decrease in air concentrations as compared to pre- and post-remediation air sample results (see Section 2.1.2.3). Furthermore, all Primary Exposure Area results were non-detected and less than applicable USEPA guideline concentrations. The mean airborne PCB concentrations in primary areas were reduced by more than 60%, from 124.9 ng/m^3 measured in June 2011 and 156.9 ng/m^3 measured in August 2011, to 48.8 ng/m^3 measured in September 2011.

2.7.4 Post Air Sampling for Caulk Encapsulation

2.7.4.1 P.S. 309K – August 1, 2010

A total of fifteen (15) post-remedial samples were collected on August 1, 2010 in the locations described in the RI Plan. The laboratory results for the air samples indicated that concentrations ranged from non-detect (less than 49.5 ng/m^3) to 1,815 ng/m^3. A comparison of pre- and post-remediation data found the post-remediation air sample results to be generally lower than the pre-remediation sample results.

In response to these results, many of which were above the USEPA guidance value of 300 ng/m^3 for elementary school aged children, additional investigations and remedial measures were performed as described in IRIR Section 7.0 Post-Pilot Study Investigation and Remediation

2.7.4.2 P.S. 309K – August 7, 2011

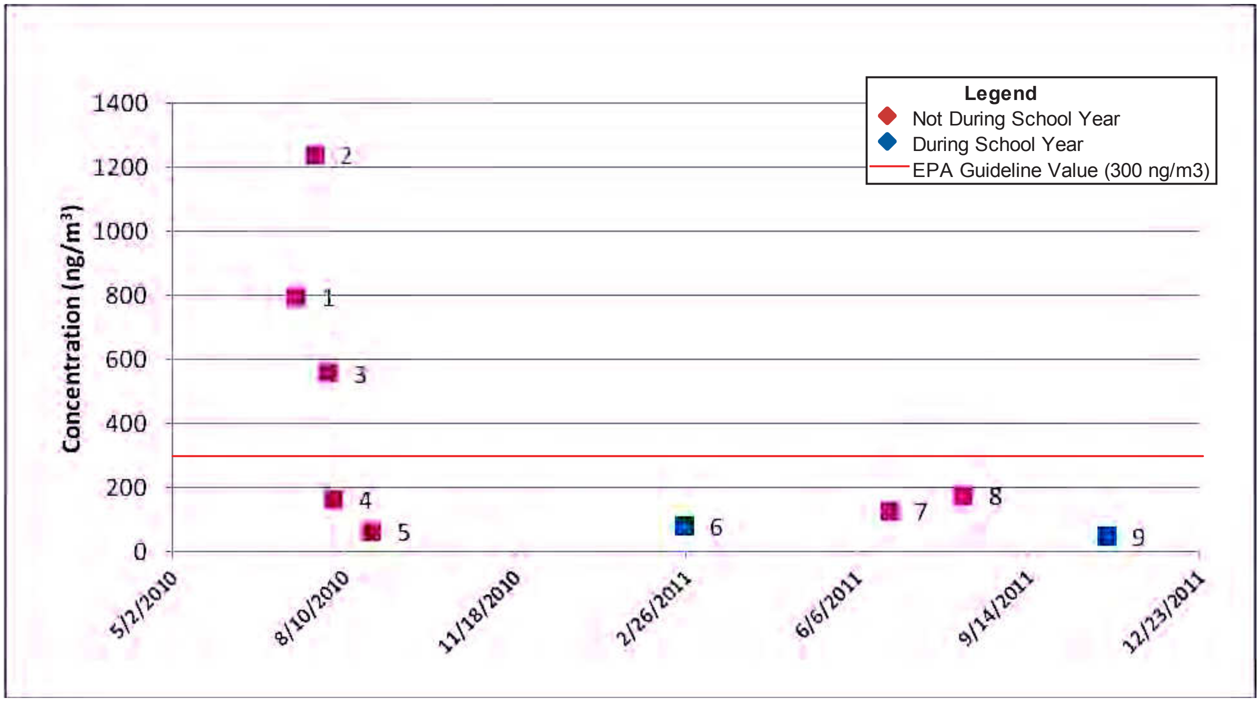
A total of nineteen (19) post-remedial air samples were collected on August 7, 2011. Samples were collected at the Pre-Remediation locations described previously. The laboratory results for the air samples indicate that concentrations ranged from non-detect (less than 49.7 ng/m^3) to 409 ng/m^3. A comparison of pre- and post-remediation data found the post-remediation air sample results in Primary Exposure Areas to be statistically higher on average (see Section 2.1.2.3) than the pre-remediation sample results. Pre-remedial transitory area data, representing areas where encapsulation actually occurred, were not significantly different (see Section 2.1.2.3) from the mean of the post-remedial Transitory Area data.

In response to these results, some of which were above the USEPA guidance values (100 ng/m^3 for kindergarten and pre-kindergarten classrooms and 300 ng/m^3 for elementary school aged children), additional investigations and building cleaning were performed as described in RIR Section 7.0. Results of the October 2011 round of air samples collected in Primary Exposure Areas showed a statistically significant decrease (see Section 2.1.2.3) in air concentrations as compared to pre- and post-remediation air sample results. Furthermore, all results were less than applicable USEPA guideline concentrations. The mean airborne PCB concentrations in primary areas were reduced by more than 45%, from 90.7 ng/m^3 measured in June 2011 and 168.8 ng/m^3 measured in August 2011, to 49.6 ng/m^3 measured in October 2011.

2.7.4.3 P.S. 309K Airborne PCB Concentrations Over Time

Nine rounds of wide-scale testing were performed in P.S. 309K from July 2010 to October 30, 2011. Six rounds of sampling were performed in August, two rounds in July, and one round each in February, June and October. Building-wide monthly PCB averages ranged from a high of 1,240 ng/m^3, measured in July 2010, to a low of 49.8 ng/m^3, measured in October 2011. See Figure 2.2 for a graphical representation of the building-wide airborne PCB average concentration trend since the beginning of the Pilot Study in July 2010.

Figure 2.2- P.S. 309K Building Average Airborne PCB Concentration Over Time



Key to Air Sampling Events:
1 – July 13, 2010 pre-remedial sampling
2 – July 24, 2010 pre-remedial sampling
3 – August 1, 2010 post-remedial resampling
4 – August 4, 2010 post-ventilation
5 – August 26, 2010 post-light fixture replacement sampling
6 – February 25, 2011 winter conditions sampling
7 – June 25, 2011 pre-remedial sampling
8 – August 7, 2011 post-remedial sampling
9 – October 30, 2011 fall conditions sampling

2.7.4.4 P.S. 199M – September 3, 2010

Encapsulation of PCB caulk was conducted utilizing a layer of clear silicone caulk applied over existing caulking. Ventilation of rooms to be sampled occurred during and subsequent to encapsulation operations utilizing 2,000 cfm HEPA filtered AFD units so as to provide approximately four (4) air changes per hour for approximately eight (8) hours.

A total of seventeen (17) post-encapsulation air samples were collected on September 3, 2010. Laboratory results indicated concentrations that ranged from non-detect (less than 49.3 ng/m^3) to 599 ng/m^3. In light of all the activities performed in the summer of 2010, a month was allotted to allow the building to achieve a stable condition and an additional set of air samples was collected on October 11 and 17, 2010 (see Section 2.7.3).

2.7.4.5 P.S. 3R – September 2, 2011

Following completion of repair and encapsulation activities, PCB air sampling was conducted in the First Floor East Stairwell on September 2, 2011. This was in the same location used for post-remediation air sampling. As presented in the RIR, the First Floor East Stairwell air sample result of 277 ng/m^3 was below the post-remedial air sample result of 675 ng/m^3. The co-located duplicate sample was found to be 322 ng/m^3. The average of these two results is 299.5 ng/m^3, which is below the USEPA guidance value.

2.7.5 Post Air Sampling for Area Ventilation

2.7.5.1 P.S. 178X/176 – August 9, 2010

Following ventilation of the kindergarten and pre-kindergarten classrooms, as described above, post-ventilation air samples were collected. A total of twenty-two (22) post-ventilation air samples were collected on August 9, 2010 in all pre-kindergarten and kindergarten classrooms. Laboratory results of the air samples indicated concentrations that ranged from non-detect (less than 48.4 ng/m^3) to 382 ng/m^3. In response to these results, supplemental remedial actions and additional samples were taken as described in this Section.

2.7.5.2 P.S. 199M – August 11, 2010

Post-ventilation air samples were collected following ventilation of the entire building. A total of nineteen (19) post-ventilation air samples were collected on August 11, 2010 in the locations described in the RI Plan. Laboratory results of the air samples indicated concentrations that ranged from non-detect (less than 48.9 ng/m^3) to 554 ng/m^3. In response to these results, supplemental remedial actions and additional samples were taken as described in this Section.

2.7.5.3 P.S. 309K – August 4, 2010

Post-ventilation air samples were collected following ventilation of the entire building at P.S. 309K as described above. A total of twenty-one (21) post-ventilation air samples were collected on August 4, 2010. Sample locations for the post-ventilation air samples were identical to pre- and post-remedial locations. Laboratory results of the air samples indicated concentrations that ranged from non-detect (less than 49.2 ng/m^3) to 230 ng/m^3. In response to these results, supplemental remedial actions and additional samples were taken as described in this Section.

2.7.6 Post Air Sampling for Light Fixture Removal

2.7.6.1 P.S. 178X/176 – August 25, 2010

Air samples were collected following replacement of light ballasts and fixtures in the kindergarten and pre-kindergarten classrooms at P.S. 178X/176. Only kindergarten and pre-kindergarten classrooms were sampled, as these were the only areas where prior air sampling results exceeded the applicable comparison criteria of 100 ng/m^3. Ventilation was accomplished with windows open utilizing HEPA filtered AFD units exhausted to the exterior of the building, for a period of at least 24 hours followed by a period of at least 24 hours with the building ventilation systems operational, windows closed and without supplemental AFD units.

A total of twenty-three (23) post-light fixture replacement air samples were collected on August 25, 2010. Laboratory results indicated concentrations that ranged from non-detect (less than 47.5 ng/m^3) to 227.0 ng/m^3. In response to these results, the HVAC system was repaired and an additional round of samples collected (see Section 2.7.7).

2.7.6.2 P.S. 199M – August 27, 2010

Post-light fixture replacement air samples were collected following HVAC system and building cleaning, replacement of fluorescent light fixtures throughout the school and ventilation of the entire building. Ventilation was accomplished utilizing multiple 2,000 cfm HEPA filtered AFD units installed throughout the building to provide approximately four (4) air changes per hour for a minimum 24-hour period. A total of seventy-five (75) post-light fixture replacement air samples were collected on August 27, 2010. Laboratory results indicated concentrations that ranged from non-detect (less than 48.1 ng/m^3) to 362 ng/m^3. These results indicated that the Gym and Room 314 were elevated over the respective USEPA guidance values (300 ng/m^3 for elementary school aged children and 100 ng/m^3 for kindergarten and pre-kindergarten classrooms). As a result, supplemental remedial actions were taken and additional rounds of samples were collected.

2.7.6.3 P.S. 309K – August 26, 2010

Post-light fixture replacement air samples were collected following ventilation and building cleaning, replacement of fluorescent light fixtures throughout the school and ventilation of the entire building at P.S. 309K. Ventilation was accomplished utilizing multiple 2,000 cfm HEPA filtered AFD units installed in the building so as to provide approximately four (4) air changes per hour for a minimum 24-hour period. A total of eighty-eight (88) post-light fixture replacement air samples were collected on August 26, 2010. Laboratory results indicated concentrations that ranged from non-detect (less than 42.7 ng/m^3) to 333.1 ng/m^3. All results were below applicable USEPA guidance values (the 333.1 ng/m^3 result was in an office area).

2.7.6.4 P.S. 3R – August 24, 2011

A total of thirteen (13) post-remedial air samples were collected on August 24, 2011. Samples were collected at the pre-remediation locations described previously. The laboratory results for the air samples indicate that concentrations ranged from non-detect (less than 48.3 ng/m^3) to 675 ng/m^3. A comparison of pre- and post-remediation data found the post-remediation air sample results to be generally, but not statistically significantly (see Section 2.1.2.3), lower than the pre-remediation samples.

In response to one (1) result in the East Stairwell, which was above the USEPA guidance value of 300 ng/m^3 for elementary school aged children, additional investigations and remedial measures were taken as described in RIR Section 7.0 Post-Pilot Study Investigation and Remediation. Results of the September 2011 round of air samples collected in the East Stairwell were less than applicable USEPA guideline concentrations.

2.7.7 Post HVAC Repair Air Sampling P.S. 178X/176 – September 5, 2010

Post-HVAC repair air samples were collected in P.S. 178X/176 in Classrooms 178, 356 and 357 following repairs to the HVAC system. A total of nine (9) post-HVAC repair air samples were collected on September 5, 2010. Laboratory results of the post-HVAC repair air samples were all non-detect (less than 47.1 ng/m^3 to less than 50.2 ng/m^3).

2.7.8 Post Surface Cleaning Air Sampling

2.7.8.1 P.S. 178X/176 – August 31, 2010

Post-supplemental cleaning air samples were collected in P.S. 178X/176 following supplemental cleaning in classrooms 139, 178, 182, 356 and 357. A total of eleven (11) post-supplemental cleaning air samples were collected on August 31, 2010. Laboratory results indicated concentrations that ranged from non-detect (less than 49.5 ng/m^3) to 429 ng/m^3. In response to these results, supplemental remedial actions and additional samples were taken as described in this Section.

2.7.8.2 P.S. 309K – August 17, 2011

Following cleaning activities a total of five (5) air samples were collected on August 17, 2011. Laboratory results for the area air samples ranged from 267 to 312 ng/m^3. On August 23, 2011, one (1) additional area air sample was collected in Room 309. Laboratory results of the area air sample indicated the concentration in the room was 192.8 ng/m^3. The results represented an improvement, as compared to previous post-remediation air sample results; however, two (2) locations, including one kindergarten classroom, still exhibited concentrations above applicable USEPA guidance values.

2.7.8.3 P.S. 309K – October 30, 2011

A total of eleven (11) air samples were collected from kindergarten rooms only on October 30, 2011. Laboratory results for the area air samples ranged from less than 47.2 ng/m^3 to 63.2 ng/m^3. All of the air samples were below the 100 ng/m^3 USEPA guidance value for kindergarten classrooms.

2.7.8.4 P.S. 183Q – September 1, 2011

Following completion of re-cleaning activities, PCB air sampling was conducted in Rooms 103, 105, 107, 151, and the SW and NE stairwells in the same locations as the post-remediation air sample locations. Laboratory results for five (5) of the seven (7) air samples indicated that concentrations were below the analytical detection limit (non-detected). The third floor NE stairwell sample location had a concentration of 106 ng/m^3 and the second floor SW stairwell sample location had a concentration of 480 ng/m^3. In response to these findings, an inspection of representative fixtures in those areas was conducted that identified fixtures with non-PCB ballasts; however, there was evidence of possible historic ballast staining/discharge within the fixtures. Therefore, it is recommended that P.S. 183Q be included in the ongoing light fixture replacement program.

2.7.9 Post Air Sampling for Carbon Filtration

2.7.9.1 P.S. 199M – September 2, 2011

Prior to the start of the school year, and after approximately six (6) days of carbon air filtration, air samples were collected in P.S. 199M in all occupied rooms. A total of fifty-six (56) area air samples were collected on September 2, 2011. Laboratory results indicated concentrations that ranged from non-detect (less than 47.8 ng/m^3) to 355 ng/m^3, with a mean concentration of 157.8 ng/m^3 . These data represent an average reduction of approximately 45% in PCB concentrations from the previous round of sampling. The results showed a statistically significant decrease (see Section 2.1.2.3) as compared to the previous post-remediation air sampling event (comparison of mean PCB air concentrations). Only six (6) of the fifty-six (56) locations exhibited concentrations above applicable USEPA guidance values.

2.7.9.2 P.S. 199M – October 29/30, 2011

A total of fifty-six (56) area air samples were collected in P.S. 199M in all occupied rooms on October 29 - 30, 2011 (see Section 2.6.4). . Laboratory results indicated concentrations that ranged from non-detect (less than 46.3 ng/m^3) to 414 ng/m^3, with a mean concentration of 138.67 ng/m^3 The mean airborne PCB concentration from this additional round of post-carbon air filtration sampling was statistically consistent with the mean concentration of the September sampling event and continued to show, on average, a statistically significant improvement (see Section 2.1.2.3) as compared to post-remediation air sample results; however, seven (7) locations, including one (1) kindergarten classroom, exhibited concentrations above applicable USEPA guidance values.

2.7.9.3 P.S. 199M – April 12, 2012 (Carbon Filter Replacement)

Air sampling was performed on April 12, 2012, approximately two (2) days after carbon filters throughout the building had been replaced. Samples were collected under typical occupancy conditions in each primary exposure area where one or more air sample results had exceeded applicable EPA guideline values within the past year. Indoor samples were collected in Classrooms 110, 116, 118, 216, 306, 308, 310, 312, 314, 322, 332 and 336, the gymnasium and the library. The results for the indoor air samples indicated that total PCB concentrations ranged from non-detect (less than 47.3 ng/m^3) to 469 ng/m^3.

2.7.10 Long Term Monitoring - Bulk Caulk Sampling

Long Term Monitoring bulk samples were collected of non-PCB replacement caulk that was installed in two (2) schools (P.S. 178X and P.S. 199M) in 2010 and 2011. The results indicated that, in several instances, the replacement caulk had become contaminated with PCBs. The source of this contamination is believed to be the underlying substrate. This substrate was in contract previously with PCB caulk and these PCBs have, in turn, contaminated the replacement caulk.

2.7.10.1 Bulk Sampling of 2010 Replacement Caulk

Post-remediation bulk samples were collected in two (2) schools (P.S. 178X/176 and 199M) consisting of a total of thirty (30) composite samples (each consisting of three sub-samples). Samples were collected from locations where PCB caulk material had been identified, removed and replaced with non-PCB caulk (DAP Dynaflex 230 - manufactured by DAP Products) during the 2010 Pilot Study rooms. The replacement caulk used in the two (2) schools was sampled and analyzed prior to installation and found not to contain PCBs (see Appendix A of the RIR for a copy of the analytical results).

Laboratory results from the post-remedial bulk sampling indicated that the sample concentrations ranged from non-detect (less than 1.00 milligrams per kilogram [mg/kg]) to 70,000 mg/kg. Thirteen (13) of the thirty (30) caulk samples equaled or exceeded 50 mg/kg of total PCBs, which is the level at which the USEPA considers caulk to be PCB caulk. Refer to Tables 2.2 and 2.3 in Appendix N of the RIR for the description and location of the original PCB caulk material, the original PCB content of the materials that were removed, and the results of the initial long term monitoring of the replacement caulk.

2.7.10.2 Bulk Sampling of 2011 Replacement Caulk

Post-remediation bulk samples were collected in two (2) schools (P.S. 178X/176 and 199M) consisting of a total of nine (9) composite samples (each consisting of three sub-samples). Samples were collected from locations where PCB caulk material had been identified, removed and replaced with non-PCB caulk (at P.S. 178X/176 Sikasil-C995 manufactured by Sika and at P.S. 199M Pecora 890 manufactured by Pecora Corporation) in the 2011 Pilot Study rooms.

Laboratory results from the post-remedial bulk sampling indicated that the sample concentrations ranged from 651 to 3,820 mg/kg. All nine (9) of the caulk samples exceeded 50 mg/kg of total PCBs and are, therefore, considered to be PCB caulk. Refer to Tables 2.7 and 2.8 in Appendix N of the RIR for the description and location of the original PCB caulk material, the original PCB content of the materials that were removed, and the results of the initial long term monitoring of the replacement caulk.

2.7.11 Long Term Monitoring - Encapsulated Caulk Wipe Sampling

Long-term monitoring encapsulation wipe samples were collected in P.S. 309K representing a total of eight (8) samples from the surfaces of encapsulated PCB caulk. These long-term monitoring wipe samples were collected to measure the concentration of PCBs on the surface of the encapsulated PCB caulk in order to evaluate the overall effectiveness of the encapsulation methodology selected. The results of the post-remediation encapsulation wipe sampling should not be used to measure the overall effectiveness of surface cleaning methodologies described in the Best Management Practices in controlling exposures to PCBs on surfaces.

Long-term monitoring encapsulation wipe samples were collected from surfaces of PCB caulk that were encapsulated, using Macropoxy 646 manufactured by Sherwin Williams. The laboratory results indicated that the sample concentrations ranged from 36.24 to 1,362 micrograms per 100 square centimeters (ug/100 cm^2). All (8) eight wipe samples exceeded the USEPA's High Occupancy wipe sample criteria of 10 µg/100 cm^2 (40 CFR 761.3, 761.123 and 761.30). Refer to Table 2.1 in Appendix O of the RIR for the description and location of encapsulated caulk materials that were sampled, the PCB content of the encapsulated materials, and the result of the recent wipe sample analysis of the encapsulated materials. These results suggest that some of the PCBs from the caulk have migrated through the encapsulant to the exposed surface. See Appendices A and B of the RIR for results of the analyses and the sample locations, respectively.

2.7.12 Post Remedial Bulk Sampling of Secondary Source Materials

During the post remedial phase secondary source materials were investigated as a potential source for PCBs. Secondary source materials were identified and numerous bulk samples were collected for PCBs at two (2) schools (P.S. 199M and 309K). Post-remedial bulk sample results confirmed that varying amounts of PCBs existed in several of these secondary source materials. USEPA's research determined that these secondary source materials are likely contaminated due to absorption from direct contact with primary sources for PCBs such as caulk, or through absorption of PCBs in the indoor air that were emitted by primary sources such as caulk and light ballasts. Materials such as paints, floor and ceiling tiles, and mastics can become secondary sources for PCB emissions in turn, after years of exposure to

PCBs emitted from primary sources. Alternately, these secondary source materials could have had PCBs added during manufacture. USEPA's laboratory research has also confirmed that secondary source materials are also PCB emission sources depending on composition and concentration of PCB congeners present.

2.7.12.1 Relative Source Strength (RSS) of PCBs in Secondary Sources

A Relative Source Strength (RSS) approach was developed for the Pilot Study in order to determine whether there is a correlation between the observed PCB concentrations in air and bulk concentration of PCBs in other materials besides PCB caulk and PCB Ballasts. Since PCB caulk and PCB ballasts are considered primary source materials, these other materials (i.e., paint, varnish, mastics, etc.) are considered to be secondary source materials for PCBs in buildings.

The largest RSS values in these two (2) schools were typically for those materials which had the largest surface area (i.e., wall paint), even though those materials, for the most part, were found to contain less than 50 ppm. Other materials which tended to have relatively high RSS values included higher concentration orange and blue door paint.

Total RSS was calculated for the major surface area materials in select classrooms on the first, second and third floors at both P.S. 199M and P.S. 309K, and the results were then normalized for room volume and air exchange rate. . As there was a greater number of sampling events and materials sampled at P.S. 199M due to more persistent PCB air concentrations, only those major surface area materials which were present and sampled for in the classrooms at both buildings (i.e., floor tiles, wall paint, radiator paint, etc.) were included in the calculations to allow for a representative comparison. In general, the rooms in both schools are of comparable construction and size. Both schools are three-story brick buildings constructed in 1962 and 1963. Each of the selected rooms has vinyl composition floor tiles (9" x 9" or 12" x 12"), painted plaster walls, and painted plaster or concrete ceilings. Bulk sample analysis of the different materials, as discussed in greater detail elsewhere in the RI, indicated that, in general, materials in P.S. 199M contained more PCBs than did similar bulk materials in P.S. 309K. The calculations indicated that, for the select rooms at P.S. 199M, the total normalized RSS ranged from 0.373 to 1.385, with an average of 1.107, while the total normalized RSS for the select classrooms at P.S. 309K ranged from 0.199 to 0.621, with an average of 0.419. This evaluation shows that average normalized RSS of major surface area materials at P.S. 199M was more than double the average normalized RSS of major surface area materials at P.S. 309K. Although analysis of the data did not identify any direct relationship between total relative source strengths and airborne PCB concentrations within individual rooms, the higher normalized RSS in P.S. 199M as compared to P.S 309K, which is similar to P.S. 199M in both construction type and date, as well as ventilation configuration, suggests that the other interior PCB-containing materials may be contributing to the higher mean airborne PCB concentration associated with post-remediation samples at P.S. 199M. Refer to Tables 2I and 3I in Appendix A of the RIR for details on the rooms studied and the total RSS calculations.

2.8 Summary of Overall Findings

Based on the results of the pilot activities to date, the following is a summary of the overall findings:

2.8.1 General Findings

- Despite the relative ineffectiveness of the various caulk remedial alternatives, as evidenced by the long-term monitoring results, the majority of post–remediation air sampling results were found to be below the applicable guidance criteria. Comparison of differences in airborne PCB concentrations between pre- and post-caulk remediation results in those locations where interior PCB caulk remediation was performed were found not to be statistically significant. This finding is based upon caulk remedial activities performed in each of four (4) pilot schools in 2011. Since the various PCB caulk remedial alternatives did not result in corresponding significant reductions in PCB concentrations in room air it is likely that caulking does not represent the only significant source at those locations where remediation took place. USEPA analyses of data from these same four (4) schools concluded that room air PCB concentrations in two (2) of the schools were higher than the maximum estimated air concentrations attributable to emissions from caulk sources alone (see Section 3.3.1 and Figure 2 in Appendix C). Both SCA/TRC and USEPA data suggest that other non-caulk PCB containing materials represent significant emissions sources of PCBs in a number of the pilot schools examined.
- Airborne PCB concentrations within individual classrooms were typically variable from one sampling event to another. Airborne PCB concentrations also varied between Pilot Study areas during the same sample event. These results are consistent with the temporal and spatial variations associated with the behavior of air in building interiors.
- Airborne PCB concentrations were found to be elevated in several spaces prior to and after removal and replacement of all identified PCB caulk during the summer, 2011. This suggests one or more other contributing sources of PCBs are likely present P.S.199M. These may include secondary sources, such as painted surfaces, that remain after the primary sources have been removed (see Section 3.3.1, Section 3.5 and Figure 2 in Appendix C).
- At P.S. 309K, there was a statistically significant increase in airborne PCB concentrations between the 2011 pre and post-remediation samples in the primary exposure areas. However, no remedial activities were performed in those locations. Rather, the increases are believed to be attributable to temporal and spatial variations typical of airborne PCB concentrations, as well as variability associated with the sampling and analytical methodologies
- Aroclor 1254 was, by far, the most common contributor to the reported total PCB concentrations in air and wipe samples, with a much smaller portion being attributed to Aroclor 1248. No other Aroclors were identified in any of the air or wipe samples collected in the Pilot School Buildings. USEPA analyses of the SCA/TRC data base corroborate the predominance of Aroclor 1254 in the air and wipe samples collected during the six (6) school study (see Section 3.4 and Figure 1 in Appendix C).
- An evaluation of the total normalized Relative Source Strength (RSS) of PCB-containing materials for select classrooms at P.S. 199M indicated that the average RSS was more than two

times higher than the average RSS for comparable select classrooms at P.S. 309K. Although no correlation between the RSS and airborne PCB concentrations in either school was identified, the higher normalized RSS in P.S. 199M as compared to P.S 309K, suggests that interior PCB-containing materials other than caulk, may be contributing to the higher mean airborne PCB concentrations associated with post-remediation samples at P.S. 199M. Both schools were built at the same time and are similar in the type of construction and configuration of building ventilation.

2.8.2 Caulk Removal

- Bulk samples collected from replacement non-PCB caulk nine (9) and nineteen (19) months after the caulk was installed indicate that PCBs from the original caulk appear to have contaminated the underlying substrates, and those PCBs have, in turn, penetrated and contaminated the replacement caulk. These results suggest that removal and replacement of PCB caulk, without additional remedial measures to isolate and/or treat (e.g., chemically) the underlying substrate prior to installing the new caulk, is of limited benefit.

2.8.3 Caulk Encapsulation

- Long-term monitoring results consisting of wipe samples from surfaces of PCB caulk that were encapsulated at P.S. 309K indicate that PCBs from the caulk have migrated through the encapsulant layer to the surface over time. These results indicate that the coatings used and methods employed in the pilot study do not represent an effective remedial measure for encapsulation of PCB caulk. USEPA ORD laboratory tests performed with ten (10) commercially available coatings indicated that encapsulation was not effective when high concentrations of PCBs were present in the caulk. None of the ten (10) encapsulants evaluated represented a long term remedial measure for PCB caulk concentrations greater than 4,300 ppm if wipe test results < $10\ \mu g/100\ cm^2$ are desired. Furthermore, none of the ten (10) encapsulants were found to be truly impenetrable to PCBs. As a result, encapsulation of PCB caulk may only represent a short term or interim control measure and not a long term or permanent remedial measure, especially when high concentrations of PCBs are present (see Section 3.6.1 and Figures 3 to 6 in Appendix C).

2.8.4 Lighting Ballast Removal

- Removal and replacement of the PCB light ballasts and associated fixtures had a pronounced effect in terms of lowering PCB levels in air in the three Pilot School Buildings in which more than one remedy was implemented (i.e., P.S. 199M, P.S. 178X/176 and P.S. 309K). An important source of airborne PCB in these schools appears to have been leaking light fixture ballasts, rather than caulk. Based on the apparent success of this additional remedy, the CAFO Pilot Study Remedial Investigation Work Plan was modified to include PCB light ballast removal as the sole remedy at P.S. 3R. USEPA regards lighting ballasts as a primary source of PCBs present in NYC schools. Leaking and failed ballasts represent significant sources of PCBs to the indoor air, as well as residues that remain on lighting fixtures after PCB containing ballasts and capacitors have been removed (see Section 3.3.2.1).
- Mean airborne PCB concentrations at P.S. 199M were significantly reduced after light ballast removal and replacement.

- In P.S. 3R, concentrations in air were on average lower in Primary Exposure Areas following light fixture removal; however the difference was not statistically significant.

2.8.5 Cleaning

- In all five (5) Pilot School Buildings (P.S. 178X/176, 199M, 309K, 183Q and 3R), despite the significant variability in the quantity and concentration of PCB caulk concentrations in the study areas, pre- and post-remediation wipe samples were consistently below the USEPA guidance value of 10 µg/100 cm^2. Based on these results, surface exposure through ingestion or dermal contact with PCB-laden dust has not been identified as a concern and current housekeeping/cleaning methods employed by the schools adequately address this issue.
- At P.S. 183Q, an additional, detailed, and fine cleaning of the physical spaces subject to the window removal and replacement work by a qualified environmental contractor resulted in subsequent air sampling results meeting the applicable acceptance criteria.

2.8.6 Ventilation

- Mean airborne PCB concentrations in Transitory Areas appeared greater than in Primary Exposure Areas within P.S. 199M, P.S. 3R, and P.S. 183Q for the 2011 Pilot Study, which may be due to the general absence of exhaust ventilation in hallways and stairwells. USEPA regards building ventilation as an important factor in the reduction of PCB concentrations found in school buildings (see Section 3.6).
- Based on the results of the tracer gas study performed in PS 199M, it is suspected that ‘short circuiting’ of the fresh ventilation air may be occurring in the classrooms, particularly when the windows are closed. Make-up air coming from the hallways, through the room entrance, may be extracted from the room before it has thoroughly mixed with or displaced stale air in the middle of the room. This may be occurring because of the proximity of the exhaust vents to the doorway and to each other.
- An evaluation of the ventilation systems at P.S. 199M and P.S. 309K indicated that designed and measured exhaust ventilation rates were variable between classrooms. With one or two windows partially opened, measured air exhaust rates in select classrooms at P.S. 199M increased by an average of 68%, and air exchange rates increased by an average of 76%. Similarly, at P.S. 309K measured air exhaust rates in select classrooms increased by an average of approximately 45% when one or two windows were opened slightly versus when they were closed.
- Based on air sample results at P.S. 178X, which is the only Pilot School with a Heating Ventilation and Air Conditioning (HVAC) system, an increase in the amount of fresh air introduced into the building via the ventilation system helped reduce indoor air PCB concentrations. USEPA corroborates this finding as they found that a linear relationship exists between room air concentrations (predicted using PCB emission rates from caulk) and room air exchange rates (AER) (see Section 3.3.1).
- Conversely, based on a simple trend analysis of the air sample results from P.S. 199M, which has a mechanical exhaust system that relies on operable windows for make-up air, there was no

correlation between air exhaust rates and indoor air PCB concentrations (refer to Section 9.7 of the RIR).

- The pollutant pathway study at P.S. 199M revealed that, when the classroom windows were closed, a majority of the tracer gas was removed from the room via the exhaust ventilation system, and when the windows were slightly opened, a majority of the tracer gas migrated to the adjacent hallway. Only trace amounts of tracer gas migrated from the 1st floor classroom to the upper floor classrooms, most likely via the pipe risers for the perimeter radiators.

2.8.7 Temperature

- Evaluation of multiple rounds of wide-scale testing data at P.S. 199M and P.S. 309K suggests a positive relationship between indoor air PCB concentration and outdoor temperature. In addition, school-wide mean airborne PCB concentrations at both buildings are higher in the warmer summer months, when school is generally not in session, and lower in cooler fall and winter months, when school is in session.

2.8.8 Carbon Filtration

- Results for PS199M indicate that, on average, airborne Aroclor 1248 concentrations in the classrooms decreased by approximately 36% and Aroclor 1254 concentrations decreased by approximately 52% after installation of the carbon air filtration units. These results suggest that the addition of carbon filtration was effective in reducing airborne concentrations of PCBs present in the classrooms. (See Final Remedial Investigation Report Supplemental Report #3, Section 4.5 page 11 and 12). (see Appendix O of the RIR, Section 4.5 of the Supplemental Report #3).
- Carbon filtration has been effective at reducing airborne PCB concentrations, as the mean PCB concentration measured in air within the Primary Exposure Areas decreased significantly after implementing the on-going carbon filtration for approximately one (1) month. After two (2) months of operation, the mean PCB concentration in air was lower than the one-month results, but the difference was not statistically significant. In the case of both rounds of measurements, the mean PCB concentration was less than the guidance value for elementary-age students.

2.8.9 Exterior Sources

- Based on a review of the results of soil sampling efforts in 2010 and 2011, varying areas of soil contamination were identified at all five Pilot School Buildings studied. The distance from the building face to which soil contamination extended was typically limited to eight feet. Soil contamination encountered at P.S. 199M, P.S. 178X/176 and P.S. 309K was successfully mitigated through the process of delineation, excavation, and off-site disposal. Soil contamination at P.S. 3R and P.S. 183Q has been isolated pending implementation of soil excavation and disposal.
- With the exception of P.S. 309K, PCB caulk was identified on the building exterior of each of the Pilot School Buildings. Survey inspections indicated that the existing PCB caulk was most often not deteriorated or damaged; therefore, it is unclear as to the extent existing PCB caulk has

contributed to PCBs present in surface soils. PCB caulk contributions from historical construction projects (prior to the use of current PCB caulk containment and removal procedures) is thought to be the main source of the PCBs encountered in surface soils rather than releases from existing PCB caulk. Analyses of results by USEPA for soil samples collected at P.S. 178/176 indicate that greater concentrations were found at depth (5-10 cm) than were found in surface soil samples (0-5 cm) at locations closest to the school building exterior (Reference 15 page 59). These data support the likely contributions associated with historical construction activities and previously contaminated exterior caulking.

2.9 Analysis of Practices for Investigatory Protocols

The analysis of the practices for investigatory protocols used for the selection of the proposed Pilot Preferred Remedy, as supported by the results of the RIR:

- The Pilot Study evaluated six (6) remedial alternatives with respect to interior caulk: (1) Patch and repair of caulk at P.S. 178X/176; (2) Encapsulation of caulk at P.S. 309K; (3) Removal of all caulk and replacement with new non PCB-containing caulk at P.S. 199M; (4) Window frame and caulk removal and replacement with new window frames and non PCB-containing caulk at P.S. 183Q; (5) Light fixture ballast removal and replacement at P.S. 3R and (6) Best Management Practices at all Pilot Study School buildings. Based on the current data, with the exception of the Best Management Practices, each of these alternative remedial approaches, as designed and implemented in this Pilot Study, have been shown to be relatively ineffective over the long term as sole remedies. Best Management Practices have been shown to be effective at reducing surface dust levels below USEPA criteria. Long-term monitoring results, however, suggest that removal and replacement of PCB caulk, without additional actions to isolate the underlying substrate prior to installing the new caulk, is of limited benefit as a remedial alternative over the long term. Additionally, results suggest that encapsulation of PCB caulk, using the various coatings and methodology employed in the Pilot Study, is also of limited benefit as a remedial alternative to isolate PCB caulk over the long term.
- The Pilot Study determined that the replacement of PCB light ballasts and associated fixtures is a successful remedial measure for lowering PCB levels in indoor air where concentrations exceed the USEPA air guidance values. Light fixture replacements were implemented at P.S. 309K, P.S. 178X/176, and P.S. 199M as supplemental remedial measures, and at P.S. 3R as the primary remedial measure. Light fixture replacement is effective where a supplemental remedy is necessary, and also as a primary remedial measure. Accordingly, the Pilot Preferred Remedy includes light fixture replacement at the Pilot School Buildings. Light fixture replacement should be implemented at (at all applicable schools) in accordance with the City's ongoing program.
- PCB contamination of soil encountered in Outside Exposure Areas at P.S. 199M, P.S. 178X/176 and P.S. 309K was successfully mitigated through the process of delineation, excavation, and off-site disposal. The PCB contaminated soil identified in the Outdoor Exposure Areas at P.S. 183Q and P.S. 3R should be excavated and disposed utilizing these same protocols. A Soil Remediation Plan should be created for USEPA approval and soils above 1 ppm should be remediated by excavation and off-site disposal, and confirmatory post-excavation soil results should be obtained. In addition, the soil should be backfilled with clean fill and surface features

should be reestablished. Exterior caulk at the Pilot Study Schools should be periodically inspected and be repaired to the extent it becomes damaged or deteriorated.

This proposed Pilot Preferred Remedy – based on a detailed assessment of currently available remedial strategies and technologies – offers a reasoned approach to efficiently manage PCB caulk, PCB light ballasts and associated fixtures, and contaminated surface soils in Outside Exposure Areas, at the Pilot School Buildings. This proposed Pilot Preferred Remedy is subject to USEPA review and possible modification prior to approval.

2.10 Conclusions on Effectiveness of Pilot Process

The findings of RI along with USEPA's report (EPA/600/R-12/051/September 30, 2012), entitled Polychlorinated Biphenyls (PCBs) in School Buildings: Sources, Environmental Levels, and Exposures (PCBs in School Buildings), among other things, incorporates the results of the investigations of the Pilot Study and evaluation of five (5) remedial alternatives with respect to interior caulk: (1) Patch and repair of caulk at P.S. 178X/176; (2) Encapsulation of caulk at P.S. 309K; (3) Removal of all caulk and replacement with new non PCB-containing caulk at P.S. 199M; (4) Window frame and caulk removal and replacement with new window frames and non PCB-containing caulk at P.S. 183Q; and (5) Best Management Practices at all Pilot School Buildings. Based on the current data, with the exception of the Best Management Practices, each of these alternative remedial approaches, as designed and implemented in this Pilot Study, have been shown to be relatively ineffective over the long term as sole remedies.

The USEPA has also demonstrated that there are numerous source(s) of PCBs in and around school buildings which have been investigated and that a Best Management Practice remediation approach has been demonstrated as the most effective approach for an overall exposure reduction strategy. USEPA in fact concluded that the multiple remedial measures implemented (caulk remediation, light fixture and ballast removal, cleaning, ventilation, etc.) in the NYC schools were "successful in substantially reducing the indoor air concentrations and exposures to PCBs" (see PCBs in School Buildings).

The PCB source assessments at School Buildings are difficult because multiple primary sources may exist, and transport of the semi-volatile congeners through air can contaminate dust and soil and create secondary sources of other materials in a building. Information from six (6) school buildings examined by USEPA has shown why it is difficult to characterize and to understand the relative potential of various PCB sources. Important uncertainties and limitations remain in the information presented in both the RIR and USEPA's latest research data published in September 2012 (PCBs in School Buildings).

Pre-remediation PCB concentrations in indoor air were found to exceed EPA's 2009 public health guidance levels (ranging from 70 to 600 ng/m^3 depending on age) in many of the rooms at the schools that were evaluated. According to USEPA, inhalation was estimated to be responsible for over 70% of the exposure that could occur in buildings with environmental levels of PCBs that were found in these schools. Mitigation efforts that focus on reducing indoor air PCB concentrations are likely to have the greatest impact on reducing exposures, although cleaning to reduce dust levels will also have an impact.

Although the concentrated effort to develop a preferred remedy at the five (5) Pilot Study Schools to eliminate PCB emissions from PCB caulk and PCB lighting fixture to the relatively low air levels (ng/m^3)

(air levels which approach laboratory detection limits), it appears that mitigation efforts have been reasonably successful in reducing indoor air concentrations and exposures to PCBs. Therefore, the Summary Report and Preferred Citywide Remedy (SR/PCR) includes recommendations for further study. Since the PCB levels in the air of the pilot schools has been shown to still exceed EPA guidance values in some instances after application of the Pilot and post-Pilot Study remedial alternatives for PCB caulk and PCB Lighting Fixtures, we propose to perform additional studies to mitigate and reduce indoor air concentrations and exposures to PCBs at New York City Schools.

3.0 USEPA REVIEW OF PCBS IN SCHOOL BUILDINGS

3.1 Introduction and Background

The USEPA identified a series of research studies that were needed to fill information gaps and improve upon our understanding of exposure to PCBs in our nation's schools. Data from these research programs were needed to support USEPA's guidance issued in September 2009 regarding management of PCB containing caulk present in our nation's schools. Research was needed to identify primary and secondary sources of PCBs, transport and fate of PCBs within indoor environments, routes and magnitude of exposure, as well as identification of remedial measures to minimize or mitigate these exposures. As a result a series of laboratory research programs were designed and executed by the USEPA Office of Air and Radiation. These are described in a four (4) volume set of reports (see Laboratory Study of Polychlorinated Biphenyl (PCB) Contamination and Mitigation in Buildings [Laboratory Study], Parts 1 to 4). In addition an NERL sponsored program was designed and executed to gain a better understanding of caulk and other building materials as a source of exposure within the nation's schools. The latter program would make use of actual measurement data representing real-world school settings. The data base used for the NERL study was comprised of results from the SCA NYC pilot school study (P.S. 178X/176, 199M, 309K, 183Q and 3R) with the addition of data collected by NERL at a sixth school (School 6). Each of these five (5) reports was reviewed and provided the basis for the discussion to follow in this section. Particular emphasis was placed on those findings and conclusions deemed most relevant to the SCA/TRC pilot study goals and objectives including the Preferred Citywide Remedy presented in Section 4.0.

The EPA NERL report makes use of SCA/TRC data collected in five (5) schools (P.S. 178X/176, 199M, 309K, 183Q and 3R) that participated in the Pilot Study.. The report states. "Because the NYC SCA data were collected in a systematic fashion using strategies and methods similar to the NERL EPA research plan, SCA/TRC results could be used to address Region 2 interests and to meet many of the NERL objectives for source and environmental characterization and exposure modeling" (see Section 2.2, Polychlorinated Biphenyls (PCBs) in School Buildings: Sources, Environmental Levels, and Exposures [PCBs in School Buildings]).

3.2 Methodology

The approach including sampling and analyses methods used by SCA/TRC and EPA were similar. All samples were analyzed for total Aroclor PCBs using SW 846 Method 8082. All air samples collected by USEPA in School 6 and a subset of other sample types were also analyzed for PCB congeners (NEA CQCS). PCB results generated using Method 8082 (Aroclor pattern matching) were found to overstate concentrations found in all media analyzed. Method 8082 data for all media were 14-46 % higher than data reported using the congener specific method (NEA CQCS). Results for air samples on average were 21% higher than results reported using the congener method. This is based upon analyses of seven (7) air samples collected in School 6 by EPA using both the Aroclor and congener methods. This result or bias if applied to the SCA/TRC data collected in the five (5) schools (P.S. 178X/176, 199M, 309K, 183Q and

3R) that participated in the SCA pilot study suggest that the SCA/TRC data represent overstated or conservative concentrations of PCBs present in all of the media types examined (see page 65 and Table 4-27, PCBs in School Buildings).

3.3 Primary Sources of PCBs in Schools

3.3.1 PCBs in Caulk

- The majority of the interior caulk samples (82% of the 427 samples collected) representing the six (6) participant schools contained PCBs less than 50 ppm PCBs. Only 6% of the samples contained greater than 100,000 ppm PCBs. Conversely only 37% of the exterior caulk samples collected contained PCBs less than 50 ppm PCBs, while 41% contained greater than 10,000 ppm PCBs (see Table 4-6, PCBs in School Buildings).

- Caulk emission rates were calculated and used to estimate room air concentrations as a function of AER. A linear relationship was found to exist between PCB concentrations predicted in room air and the AER. Concentrations increased as AER decreased. Predicted concentrations were compared to actual TRC/SCA measured concentrations in room air (see Table 4-8, PCBs in School Buildings). These data serve to emphasize the importance of adequate building forced air ventilation in reducing PCB concentrations indoors.

- Data in Table 4-8 (see PCBs in School Buildings) suggests that measured room air PCBs concentrations in two (2) of the four (4) schools could be accounted for if attributable only to in room caulk emissions. In two (2) of four (4) locations in room measured air PCB concentrations were higher than the maximum estimated concentrations attributable to caulk alone. These data suggest that other sources and not caulk alone are contributing to room air PCBs. Refer to Figure 2 in Appendix C for a comparison of emission rate estimates for caulking and other sources at one of these four (4) locations (P.S. 199M). These more likely represent real world conditions present in the NYC school systems. More specifically elimination/removal of caulk will likely not remedy the PCB problem.

- The majority of the interior caulk samples had total concentrations less than 100 ppm PCBs (see Table 4-4, PCBs in School Buildings). The median concentration for these samples was 6.9 ppm and comparable to levels found in many other materials in these NYC schools. This body of data suggests that many of these caulks may represent secondary sources and may have accumulated PCBs over time that had been emitted from non-caulk primary sources. These caulk data can be contrasted to wall and ceiling PCB data from these same schools. (wall paints n = 36 median PCBs 29.1 ppm and ceiling paints n = 28 median PCBs 30.5 ppm) (see Page 43, PCBs in School Buildings) The majority of the caulk samples tested contained an Aroclor 1254 type pattern.

- A linear correlation was shown to exist between PCB concentrations present in caulk and the corresponding emission factor. Equation 4.4 (see Section 4.1.5, Laboratory Study of Polychlorinated Biphenyl (PCB) Contamination and Mitigation in Buildings – Part 1 [Laboratory Study – Part 1]) can be used to estimate emissions once the PCB Aroclor or congener concentration in the caulk is known. These emissions factors derived in the EPA/ORD research study were used by EPA in the derivation of estimated emission rates for PCBs in caulk and other building materials found in the NYC pilot study schools.

- An excellent correlation was shown to exist between normalized emission factors and the vapor pressure of the PCBs present in a solid material (see Equation 4.5 in Section 4.1.6, Laboratory Study – Part 1).

3.3.2 Lighting Ballasts

3.3.2.1 EPA Analysis of SCA/TRC Pilot School Data (PCBs in School Buildings)

- SCA/TRC analysis of light ballast capacitor oil confirmed the presence of Aroclor 1242 in ballasts tested in three (3) NYC schools (one ballast per school). A ballast sample taken in a fourth NYC school confirmed the presence of Aroclor 1254.
- Light ballast survey results from the five (5) pilot study schools indicated that the percentage of lighting ballasts likely to contain PCBs ranged from a low of 24% at one of the five (5) schools to a high value of 95% at another of the five (5) schools (see Executive Summary, PCBs in School Buildings).
- PCB-containing lighting ballasts remain in use in older buildings within the NYC school population. These lighting ballasts serve as a primary source of PCBs. Higher PCB emissions are associated with leaking or failed capacitors and ballasts. PCB residues that remain on lighting fixtures that previously housed PCB containing ballasts and/or capacitors also serve as a source (see Executive Summary, PCBs in School Buildings).

3.4 Dusts as a Source of PCBs

Some relevant findings regarding dusts as a source of PCBs, their transport within indoor environments, and dust removal as a remedial measure based upon USEPA analyses of SCA/TRC Pilot School data, School 6 data and EPA ORD laboratory studies (References 15-19) are as follows:

- Modest, yet statistically significant correlations were found in comparison of the data sets representing indoor air PCB concentrations and high contact surface wipe samples within the six (6) schools evaluated by USEPA (see PCBs in School Buildings). These findings are supported by high and statistically significant Pearson correlations in comparison of indoor air and dusts ($r = 0.805$), as well as in comparison of surface wipe samples ($r = 0.840$) collected in School 6. The latter data set includes seven (7) sets of wipe samples from both high contact and low contact surfaces within School 6. These samples were collected at the same time and location as the seven (7) air samples (see Table 4-26, PCBs in School Buildings).

- Examination of homologue profiles indicated that surface wipes and dusts displayed very similar profiles. These data suggest that surface wipes have a dust component. Examination of the indoor air homologue profiles indicate contributions from airborne particulate and not vapor phase PCBs alone. This particulate matter likely includes a dust component (see Figures 4-13 and 4-17, PCBs in School Buildings). Figure 1 in Appendix C shows a comparison of PCB homologue profile data for surface wipes and indoor dusts (adapted from Figure 4-17, PCBs in School Buildings).

As shown the homologue profiles are nearly identical suggesting common sources or origins. PCB homologue patterns present in surface wipes, dusts, caulks and other types of building materials were found to be similar to Aroclor 1254.

- The SCA/TRC field data confirm that dust removal represents a significant remedial measure for the mitigation of PCBs present in indoor environments. These remedial measures should include removal of both bulk and surface dusts. Dusts represent an important exposure pathway that includes inhalation, non-dietary ingestion and dermal contact. Cleaning of schools will reduce dust levels and in turn reduce exposures to PCBs found in indoor air and on dust laden surfaces (see Section 5.2, PCBs in School Buildings).

- The transport of PCBs from indoor air to settled or surface dusts is primarily influenced by sorption capacity of the solid. As a result, the transport of the higher molecular weight and less volatile PCB congeners is favored (see Page 80, Laboratory Study, Part 2).

- Dust to source and source to dust partitioning is a more important transport mechanism for PCBs that partitioning that occurs between indoor air and dusts (see Page 85, Laboratory Study, Part 2).

3.5 PCBs Transport and Behavior-Indoor Environments and the Role of Secondary Sources

Some relevant findings related to the behavior of PCBs in indoor environments and their transport from primary sources within buildings including the role played by secondary sources are as follows:

- PCB emissions from secondary sources (in combination) can be significant even after all primary sources have been removed or mitigated (see Page 44, PCBs in School Buildings). For example emission rates estimated for paints (500 µg/hr) in gymnasium (P.S. 199M) were found to be comparable to caulk emission rates (620 µg/hr) (see Table 4-8, PCBs in School Buildings). Paints and varnishes combined resulted in an emission rate of 850 µg/hr in the same gymnasium location (see Table 4-14, PCBs in School Buildings). Refer to Figure 2 in Appendix C for a comparison of estimated PCB emission rates for a number of the gymnasium primary and secondary sources.

- NYC schools data (see Table 4-12, PCBs in School Buildings) supports the fact that paints may be amongst the most important of all secondary sources. This is attributable to the relatively high concentrations of PCBs found in paints in NYC schools (median 39.1 ppm; 143 samples) and large areas represented by painted surfaces.

- Wall and ceiling paints had lower median concentrations than paints found on metal surfaces, doors and trims. The latter are likely oil based products and have thicker films when applied than latex based wall and ceiling products. Paints with higher organic content tend to adsorb more PCBs (see Page 43, PCBs in School Buildings).

- Secondary sources represent a reservoir of PCBs that may need to be considered as part of building remedial measures to reduce concentrations to acceptable levels (page 51 Reference 15).

- Sink materials will adsorb PCBs emitted into indoor air. Some of the strongest sink materials include petroleum based and latex based paints, and certain types of carpet. Conversely, some of the weakest sinks include solvent-free epoxy coatings, brick masonry and some types of flooring. After the primary sources have been removed (ballasts and caulking for example) the sink materials may become secondary sources and re-emit sorbed PCBs. This phenomenon may help explain higher than expected post remediation air concentrations that have been observed in some of the NYC schools that participated in the Pilot Study (see Sections 7 and 6.3.6, Laboratory Study, Part 2).

- It was observed that the PCB homologue patterns present in sink materials often were similar to the homologue patterns present in the primary sources (light ballast and caulking). These findings prohibit identification of sources contributing to indoor air concentrations based solely on PCB patterns. These observations are attributable to the behavior of PCBs within indoor environments. More specifically, emissions from primary sources are comprised primarily of the more volatile PCB congeners (lower molecular weight and higher vapor pressures). Sorption by sink sources is comprised primarily of the less volatile PCB congeners (higher molecular weight and lower vapor pressures). These two (2) competitive processes result in the presence of very similar, but not identical, homologue patterns in both primary and sink sources (see Section 7.5 Laboratory Study, Part 2).

- Test chamber results and mass transfer model estimates demonstrate that the PCB sorption concentration in a sink increases as a function of time, while the actual rate of sorption decreases as a function of time. The sink sources adsorb PCBs present in room air and continue to do so while the primary sources remain in place. Once the primary sources are removed the sink sources now may serve as re-emitting PCB sources (see Section 8, Laboratory Study, Part 2).

3.6 Mitigation/Abatement and Remediation of PCBs

Some observations made by USEPA relative to the SCA/TRC pilot program data and remedial measures employed by SCA/TRC in the participant schools are as follows:

- Building ventilation using outdoor air represents an important factor in the reduction of indoor PCB concentrations (see Executive Summary, PCBs in School Buildings).

- NYC remedial investigation demonstrated that measures taken could substantially reduce indoor air PCB concentrations in schools with elevated pre remedial levels. A considerable part of the reduction occurred after school cleaning (e.g. remove dusts) and removal of PCB containing light fixtures (see Page 51, PCBs in School Buildings). The multiple remedial measures implemented (caulk remediation, light fixture and ballast removal, cleaning, ventilation, etc.) in the NYC schools were "successful in substantially reducing the indoor air concentrations and exposures to PCBs" (see Section 5.2, PCBs in School Buildings).

- Indoor air PCB data from the five (5) NYC Schools (P.S. 178X/176, 199M, 309K, 183Q and 3R) indicated that median concentrations had decreased 72% in comparison of pre and post remedial levels. Average or mean concentrations indicated a decrease of 74% subsequent to the multiple remedial measures implemented (caulk remediation, light fixture and ballast removal, cleaning, ventilation, etc.). These data suggest that the multiple remedial measures employed effected significant reductions in PCB concentrations present in indoor air within the five (5) pilot schools that were evaluated (see Page 60 and Table 4-24, PCBs in School Buildings).

- Secondary sources represent a reservoir of PCBs that may need to be considered as part of building remedial measures to reduce concentrations to acceptable levels (see Page 51 PCBs in School Buildings).

3.6.1 Encapsulation as a Remedial Measure for Reducing Emissions of PCBs from Building Materials

USEPA's Office of Research and Development (ORD) conducted a series of laboratory chamber tests to evaluate the performance of a number of commercially available coatings for encapsulating PCBs present in a variety of building materials. In summary, the EPA ORD study endeavored to develop a basic understanding of encapsulation for reducing PCB emissions to indoor air from a select number of source materials. The EPA ORD research program is described in more detail elsewhere (Laboratory Study, Part 3). The discussion to follow summarizes some of the key findings of the laboratory research viewed to be directly relevant to remediation and mitigation of PCBs present in NYC Schools. These are as follows:

- Encapsulation was not effective in laboratory tests in reduction of PCB concentrations in indoor air and on encapsulated caulking surfaces when high concentrations of PCBs were present in the caulk itself. For example, for a particular source containing 13,000 ppm (µg/g) of PCBs wipe tests of encapsulated panels resulted in surface concentrations of PCBs ranging from 10.1 to 584 µg/100 cm^2 (see Executive Summary and Section 6.1, Laboratory Study, Part 3).

- The maximum allowable concentration of PCBs in a source was estimated at 430 ppm based upon a surface wipe test result of 1 µg/100 cm^2 in combination with use of the best performing epoxy-no solvent (see Table 2 in Appendix B).

- Epoxy based coatings were found to have a significantly greater ability to encapsulate PCBs than the acrylate based coatings that were tested (see Section 4.1.2, Laboratory Study, Part 3). Epoxy coatings resulted in lower concentrations of PCBs at the exposed surface of the encapsulant, as well as in room air. Acrylic based coatings resulted in the highest concentrations of PCBs at the exposed surface of the encapsulant, as well as in room air. Table 1 in Appendix B ranks the ten (10) encapsulants that were examined as part of the EPA ORD laboratory study based upon percent reduction of the PCB concentration measured at the exposed surface (adapted from Table 5.6, Laboratory Study, Part 3).

- Test results demonstrated that multiple coatings of the encapsulant when applied to the source or substrate were more effective than a single coating. These findings were based upon PCB concentrations found in wipe samples taken at the surface of the encapsulant. PCB concentrations decreased as the thickness of the encapsulant layer increased (see Section 4.2.6, Laboratory Study, Part 3) Figures 5 and 6 in Appendix C display estimated concentrations of PCBs in room air as a function of encapsulant film thickness.

- Source properties may influence encapsulant performance. For example certain types of encapsulants may actually mix with the PCB containing substrate or source. Tests performed with polyurethane based encapsulants and caulks, for example, "suggested that the encapsulant had actually penetrated into the caulk" (see Section 4.2.6.2, Laboratory Study, Part 3).

- "PCB concentrations on the exposed surface of the encapsulant is an important parameter for evaluating the performance of the encapsulant because the concentration found at the surface is linked to dermal exposure and to the contribution of the encapsulated source to the PCB concentration in the air." PCB concentrations present on the exposed surface of the encapsulant are always less than the average concentration found in the encapsulant layer (see Page 56, Laboratory Study, Part 3). A good encapsulant, therefore, reduces PCB concentrations found on the exposed surface and ultimately emissions to the room air. The latter should result in lower concentrations of PCBs in room air attributable to the encapsulated media (see Figures 5.22 and 5.23, Laboratory Study, Part 3). As shown here the epoxy based coating products performed best based upon PCB concentrations present on the exposed surface of the encapsulant and in the room air. A good encapsulant will likely not reduce the average concentration of PCBs found in the encapsulant layer itself, however.

- Table 2 in Appendix B ranks the ten (10) encapsulants evaluated in the EPA/ORD tests based upon maximum allowable PCB source concentrations. Maximum allowable source concentrations are calculated based upon wipe test result goals of 1 ug/100 cm2 and 10 ug/100 cm2. As shown, there is a linear relationship between the source strength or concentration and the PCB concentration present at the surface of the source material. The latter concentration is represented by the wipe test results (refer to Laboratory Study, Part 3). These data provide further evidence that encapsulation does not represent a viable long term remedial measure for sources containing PCBs in excess of 4300 ppm if the remedial goal is wipe test results < 10 ug/100 cm2.

EPA ORD test results indicated that none of the ten (10) encapsulants evaluated were *truly impenetrable to PCBs*. Use of encapsulants for caulk sources containing high concentrations of PCBs, as a result, may only represent a short-term or interim control measure and not a long term or permanent remedial measure (see Sections 6.5 and 7, Laboratory Study, Part 3).

4.0 PREFERRED CITYWIDE REMEDY

4.1 Introduction

This section presents the City of New York and School Construction Authority's Preferred Citywide Remedy to address PCB exposures in the school environment. The Preferred Citywide Remedy appearing below is subject to modification on the basis of the input of the EPA, the independent peer review committee, and the public as described in the CAFO.

After the finalization of the Preferred Citywide Remedy, the City of New York and School Construction Authority and the EPA will meet to negotiate a Citywide PCB Management Plan. While the specific details of the Citywide PCB Management Plan will be addressed during the negotiations, pursuant to the CAFO, the parties have agreed to the following principles and requirements to guide the negotiations:

1. PCB caulk is a national issue and EPA will consider any national or regional policies in developing and accepting a plan for New York City;
2. Given the large number of Relevant Schools, EPA agrees that any Citywide PCB Management Plan shall be structured in a phased manner, prioritizing work based on factors including, but not limited to: (i) the condition of caulking; (ii) the potential for exposure; (iii) the concentrations of PCBs contained in caulking; (iv) the ages of the children within a school building; or (v) any other such factors that the parties may agree are appropriate for prioritizing work.

The parties also agree that the Citywide PCB Management Plan shall include:

1. A schedule for remedial action that maximizes health protection consistent with City resources and avoidance of disruption of school activities.
2. An initial focus on schools with the highest potential exposure risks.
3. Cost-effective strategies to reduce PCB exposures.
4. Reasonable testing or other methods of evaluation to characterize PCBs in Relevant Schools to help set priorities for remediation.
5. Reduce potential PCB exposures through BMPs, encapsulation or removal of caulk.
6. Where necessary for risk reduction, investigation of potential significant non-caulk sources and appropriate remedial action.
7. A Citizens Participation Plan containing steps to inform and obtain input from the public concerning the Citywide PCB Management Plan and its implementation.

With these agreements in mind, the proposed Preferred Citywide Remedy offers a reasoned approach to efficiently manage PCBs in the Relevant Schools by addressing PCB ballasts and associated light fixtures, Best Management Practices, PCB caulk, and contaminated surface soils in Outside Exposure

Areas. Additional studies are recommended, however, since each of the alternative PCB caulk pilot remedial approaches were shown to be relatively ineffective over the long term as sole remedies. It is anticipated that any Citywide PCB Management Plan will be subject to change based on on-going data collection and data evaluation.

The specific elements of the proposed Preferred Citywide Remedy are presented in the subsections below.

4.2 PCB Ballast and Associated Light Fixture Management and Replacement

The Pilot Study determined that the replacement of PCB light ballasts and associated fixtures is a successful remedial measure for lowering PCB levels in indoor air where concentrations exceed the USEPA air guidance values. PCB light ballast replacement is effective where a supplemental remedy is necessary, and also as a primary remedial measure. Accordingly, the proposed Preferred Citywide Remedy includes PCB light ballasts and associated fixtures replacement at the Relevant School Buildings. PCB light ballasts and associated fixtures replacement will be implemented as part of the City's ongoing program. All light fixture replacements projects will be completed by December 31, 2016.

4.2.1 Identified Buildings and Light Fixture Removal Schedule

In April 2012, 738 buildings were identified with T12 lighting fixtures that may contain PCBs. Since that time, three buildings (K884, K868, X825) were removed from the list due to lease terminations, and four buildings (K396, K721, M207, M208) were added that are tandem buildings to buildings already on the list (K327, K128, M149, M185 respectively). Tandem buildings are two separate classroom buildings with separate entrances which are joined by a central core containing a shared gymnasium, auditorium and cafeteria. Accounting for these changes, the total of buildings with T12 lighting fixtures was revised to 739 (see Survey of School Buildings with Older T-12 Fluorescent Lighting Fixtures).

As of May 21, 2013, 645 buildings still have T12 lighting fixtures. All light fixture replacements projects will be completed by December 31, 2016.

It should be noted that many Department of Education (DOE) buildings contain multiple schools and the type of schools within will determine when the projects will be completed. For example, a building that houses an elementary school and a secondary school would be prioritized before a building that only houses a secondary school.

The City will prioritize schools constructed in the 1950s and the early 1960s because the ballasts in these schools are older and thus the PCB capacitors within the ballasts are more likely to leak. The City will also prioritize work in pre-kindergarten, kindergarten, and elementary schools based on EPA's September 2009 guidance document "Public Health Levels in School Indoor Air" which indicates lower recommended indoor air concentrations for these younger children as compared to older children and adults.

Replacement of all the lighting fixtures in these buildings will be given higher priority than other schools in the comprehensive plan where no visible leaks have been found;

4.2.1.1 Methodology

The following presents an overview of the fluorescent light fixture and PCB ballast removal methodology. Note additional protocols are required if the wiring is found to be an asbestos-containing material.

The furniture and all other movable items will be removed from each room or moved to the side. The contractor will then install three (3) polyethylene sheeting flaps on each doorway and seal all openings/penetrations in the work area including exhaust and supply ventilation system vents. Electrical power to the light fixtures will be de-energized. The fixed objects within the work area will be enclosed with a minimum of one layer of 6-mil polyethylene sheeting sealed airtight with tape. The contractor then will install six-mil polyethylene sheeting on the floor directly beneath the light fixture(s) and extending approximately five (5) feet in all directions. Non-movable objects within this five foot area will be covered with one layer of sheeting.

The contractor workers, wearing PPE, then remove the lamp cover or grille from each light fixture exposing the fluorescent lamps. The fluorescent lamps will be removed and the ballast enclosure cover will then be removed exposing the ballasts. The exterior of the ballast and the interior exposed section of the light fixture including housing (with ballast removed), cover and wires are visually inspected for evidence of any leakage or staining.

If leaking or staining is identified on the ballast and/or light fixture, the ballast is removed and placed directly in the authorized waste container (leaking PCB ballast drum), and the light fixture is wrapped in two layers of clear six-mil, polyethylene sheeting, placed in waste container and disposed of as PCB remediation waste.

If no leaking or staining is identified on the ballast or light fixture, the ballast is removed and placed directly in the authorized waste container (non-leaking PCB ballast drum), and the light fixture is recycled.

Work will take place outside of school hours as required by asbestos abatement protocols and to minimize the disruption to students and staff.

4.2.2 Response to Potentially Leaking Ballasts at the Schools

In addition to the on-going PCB light ballast and associated fixture replacement program described above, the DSF will continue to implement a program whereby T12 lighting fixtures are inspected on a regular basis by custodial staff for evidence of brownish black residue on any of the following: light diffuser (lens), light housing, or any area directly below lighting fixtures (furniture or floor). This inspection includes all fixtures in the facility, including external observations of fixtures in classrooms, offices, corridors, stairwells, labs, cafeterias, resource rooms, maintenance areas, and storage areas.

If residue or other evidence of a leak is found, the Custodial Engineer submits a high priority work order to the Division of School Facilities' (DSF) Environmental Health and Safety Unit (EHS). Upon receipt of the work request, EHS dispatches DSF's environmental consultant to visit the school and inspect the reported condition within 48 hours.

The environmental consultant and an electrician open the fixture and check to see if there is a "non-PCB" label identifying the ballast as not containing PCBs. Absent that label or stamp, the ballast is assumed to contain PCBs. The fixture is also inspected for signs of old stains or residue, and if found, the fixture is removed (even if the ballast is labeled non-PCB). The environmental consultant checks for any leakage from the ballast or residue on the fixture and safeguards the area around the work area by placing double layers of plastic directly below the fixture(s).

If leaks are observed, the fixture and the intact ballast or the ballast alone (if only the ballast has PCBs and there are no stains on the fixture) is removed by the electrician. If the consultant sees that the stain does not emanate from the fixture, then they report the incident as a non-PCB leak. (New ballasts and/or fixtures are installed at a later date by the Division of School Facilities.)

Fixtures are wrapped in 6 mil poly sheathing and labeled and manifested as per US DOT and US EPA. Ballasts are placed in US DOT rated 5-gallon drums. All ballasts and fixture equipment removed from fixtures with unlabeled ballasts are presumed to contain PCBs.

Refer to the applicable New York City Department of Education, Division of School Facilities, Office of Building Services Circular No. 4, T-12 Ballast Inspection Protocol, April 11, 2011 for custodial engineers and building managers.

4.2.2.1 Response to Ballast Fluid Leakage Outside the Fixture or Visible Smoke Emissions From Ballasts at the Schools

The following procedures are in place and will continue to be implemented for the limited cases when T-12 ballast leakage occurs outside the fixture (housing or diffuser) or when smoke is emitted from ballasts.

Upon notification, the Custodial Engineer (CE) or Building Manager (BM) immediately reports to the location to inspect, and the following measures will be taken:

- shut off the power to the fixture; and
- call the incident in to Division of School Facilities (DSF).

DSF will notify the EPA within 24 hours and dispatch an environmental response contractor within 48 hours of the CE/BM's reporting of the leak or the smoke condition. Also, within 48 hours, DSF will inspect the reported location and the T-12 fixtures in the rest of the building. DOE will provide the Principal with a letter to backpack to parents, generally within 24 to 48 hours of the CE/BM reporting the condition.

The environmental contractor will remove the ballasts and/or fixtures and any additional impacted items will be cleaned or removed and disposed. As part of the corrective action, the environmental contractor will aggressively ventilate the space to ensure 20 complete air exchanges in the room.

An environmental consultant will take wipe samples at the conclusion of the remediation process. When results are below the regulatory standards, the EPA and school administration will be notified that the space can be reoccupied. In instances where the wipe samples are positive, DSF will re-clean and resample until acceptable results are achieved.

Following the identification of a ballast leak or smoke condition at a school, that school will be placed in priority Category 1 for ballast replacement. Also following the identification of a leak or smoke condition, DSF will comply with notice and reporting requirements set forth in applicable local laws (Int 0563-2011, Int 0566-2011).

Refer to the applicable NYC Department of Education, Re-occupancy Protocol for Ballast Fluid Leakage Outside the Fixture or Visible Smoke Emissions From Ballasts, submitted to EPA on April 23, 2013.

4.3 Best Management Practices

The City of New York has developed a Best Management Practices (BMP) that was approved by the EPA in April 2012. This includes employing strategies for managing PCB caulk and ensuring safe and proper operation of all heating, air conditioning, ventilating and similar equipment (collectively "HVAC"). The BMPs are a set of protocols that, when implemented, help to mitigate exposure to PCB caulk through the use of regular inspections, stringent cleaning methods, and maintaining essential building systems (e.g., HVAC systems. The BMPs also include measures and practices to be used to protect interior and exterior PCB caulk from accidental damage and to identify the potential for deterioration requiring further action on an ongoing basis during school maintenance, repair and renovation. Finally, the BMPs reference remediation of deteriorated PCB caulk by removal and replacement, patch and repair, or encapsulation. The EPA-approved Best Management Practices will be implemented in all relevant schools on an ongoing basis.

4.3.1 PCB Caulk Management

Measures and practices will be used to protect PCB caulk from accidental damage and identify the potential for deterioration requiring further action on an ongoing basis during school maintenance; repair and capital improvement projects (see RIR, Appendix F of Appendix L Feasibility Study).

New York City Schools are operated by the New York City Department of Education (DOE) and maintenance of the buildings is performed by the Division of School Facilities (DSF). DSF performs quarterly visual inspections of interior caulk to determine if there is any exposed caulk that is flaking, cracking, or otherwise exhibiting visual signs of significant deterioration. No sampling and analysis for PCBs in caulk is specifically required; deteriorated caulk is presumed to be PCB caulk. If deteriorated caulk is identified, corrective actions are then implemented by DSF's Environmental Health and Safety Unit (EHS). These corrective actions could include patching and repairing the deteriorated caulk, under EPA's supervision, or removing and disposing of the deteriorated caulk. The Director of DSF's EHS will determine and implement the best available remedy and shall first consult with EPA should patch and repair or encapsulation be selected as the preferred remedy.

Inspection and management of exterior PCB caulk will be addressed in the BMP Plan, and specifically require that exterior caulk be periodically inspected and be repaired to the extent it becomes damaged or deteriorated. After completion of renovation or demolition that involves the disturbance of exterior PCB caulk, soil adjacent to the school building will be sampled by a qualified environmental professional to test for the presence of PCBs and remediated if required in accordance with Section 4.5 below.

4.3.2 Heating Ventilating and Air Conditioning Maintenance

DSF has full responsibility for the condition, and safe and proper operation of all heating, air conditioning, ventilating and similar equipment (collectively "HVAC") and shall clean, adjust and , maintain and repair such equipment in accordance with the requirements of the Department. The DSF will ensure that building air exchange rates are maintained per design, by ensuring that the HVAC and general ventilation systems are operating properly in accordance with the requirements contained in Appendix F of the Collective Bargaining Agreement. In order to optimize ventilation and air circulation, HVAC and general ventilation supply and exhaust fans will be operated while schools are occupied. Heating stacks, where designed primarily for ventilation rather than heating, shall be used to provide tempered fresh air while buildings are occupied. The DSF will maintain, adjust and make minor repairs as needed. If there are problems identified that are beyond the ability of the DSF to directly rectify, a work request will be submitted through Passport as a Priority 4, which is an expedited priority of a time sensitive nature, with an email notification to the respective Deputy Director of Facilities.

To help ensure the building air exchange rates are maintained as per design, the DSF will:

- Operate, regulate and maintain HVAC plants;
- Inspect, overhaul and repair HVAC systems;
- Inspect and change filters, as necessary;
- Inspect, maintain and clean cooling systems;
- Inspect, keep free from objects that obstruct air flow and clean registers;
- Inspect and clean accessible ducts, as necessary;
- Adjust fresh air inlet dampers on supply fans or heating stacks;
- Inspect HVAC systems annually, including circuit breakers and belts;
- Fan Motors shall be inspected, lubricated and kept clean. Univents shall be cleaned on the outside and inside, as necessary. (This includes cleaning and oiling motor bearings, cleaning motor fans, water pans and dampers.)

4.4 Removal, Replacement and Encapsulation of Caulk

As presented in Section 3.5 of the BMP, capital projects to renovate schools are performed by the New York City School Construction Authority (SCA). The SCA construction specifications have been developed to properly manage and dispose of PCB caulk when it is disturbed during renovation activities. These protocols require rigorous dust control measures during the work, followed by cleaning and inspection at the conclusion of every work shift to minimize the potential exposure to PCB-containing dust during construction. In addition, window replacement project procedures will be modified to incorporate a detailed and fine cleaning of the physical spaces subject to the window removal and replacement work by a qualified environmental contractor following the replacement work and prior to re-occupancy.

4.5 Soil Evaluation, Excavation and Replacement

SCA will evaluate the presence of PCBs in the surface soil within outside exposure areas (i.e., soil within ten feet of the building face), following the completion of construction projects that disturb exterior PCB caulk. SCA will first create and implement a Soil Sampling Plan consistent with the SCA's Phase II Surface Soil Investigation Outline. Any surface soil within ten feet of the building found to contain PCBs at a concentration of greater than the 1 ppm guidance value will be the subject of remediation.

In accordance with 40 CFR 761.61 and the SCA IEH PCB Soil Remediation Requirement Service Contract, Contractor General Scope of Work/Protocol and Unit Pricing, the permanent remedy to address soil exposure will consist of soil excavation in all areas where PCB concentrations are greater than 1 ppm in the surface soil. A Soil Remediation Plan will be created for USEPA approval and soils above 1 ppm will be remediated by excavation and off-site disposal. Confirmatory post-excavation soil results will be obtained. After removing contaminated soil, the excavation will be backfilled using clean fill. Following completion of remediation, SCA will generate a PCB Soil Remediation Report (see a sample report in Appendix J of the RIR).

4.6 Recommended Studies

The proposed Preferred Citywide Remedy offers a reasonable approach to manage PCBs efficiently in the Relevant Schools by addressing PCB ballasts and associated light fixtures, Best Management Practices, PCB caulk, and contaminated surface soils in Outside Exposure Areas. Additional studies are recommended, however, since none of the alternative PCB caulk pilot remedial approaches were shown to be effective over the long term as sole remedies. Listed below are areas that warrant further evaluation to address some of the knowledge gaps. Information derived from pilot-scale studies conducted either by EPA or other research entities could then be incorporated into the existing citywide remedy.

4.6.1 Long Term Monitoring

Long-term monitoring programs will continue according to USEPA approved plans to evaluate the effects of remedial measures implemented during the Pilot Study. The current program of long term monitoring consists of bulk and wipe sampling at four (4) schools (P.S. 178X, P.S. 183Q, P.S. 199M and P.S. 309K). Sampling will target locations where 2010 replacement caulk was found to contain less than 50 ppm of PCBs and new locations where 2011 replacement or encapsulated caulk has not been sampled. Sampling of 2011 exterior encapsulated caulk at P.S. 178X and P.S. 199M, and 2011 replacement caulk for new windows installed at P.S. 183Q will also be included.

Long term air samples will be collected at one (1) School (P.S. 199M) on a quarterly (spring, summer, fall and winter) basis at locations where PCB caulk and PCB lighting fixtures were replaced. The samples will consist of area samples, along with recommended quality control samples. Additional long term air sampling will occur at a second school (P.S. 3R) semi-annually (once during the heating season (February) and once in non-heating season (September/October) where PCB lighting fixtures were replaced. The samples will consist of area samples, along with recommended quality control samples.

4.6.2 Encapsulation of Caulk

- Field testing of coatings other than those used during the pilot study should be conducted to identify an effective encapsulant for caulk containing low or manageable concentrations of PCBs. USEPA ORD research concluded that epoxy-based coatings performed best as encapsulants for PCBs present in caulk. Silicone based coatings were also identified as a candidate although these were not evaluated in the EPA laboratory tests (TWO Teknik). A list of candidate coatings should be developed based upon EPA ORD findings, review of chemical composition data for commercially available products and performance data from other school and building case studies. The most promising coatings should be selected for evaluation in a school setting.

- Multiple coatings of encapsulant should be evaluated as a means of reducing surface concentrations of PCBs after application to PCB caulk. EPA/ORD research (see Section 3.0) has demonstrated that reductions in PCB concentrations on the encapsulant surface layer are effected after application of multiple layers of the coating. Use of different types of coatings applied in layers should also be examined. For example, application of a primer or other top coat over the encapsulant layer.

- Non liquid products should be evaluated under field conditions in an actual school setting. These products include solid films such as metallic tapes. If it can be shown that solid films are impenetrable to PCBs these materials may serve as a viable remedial measure for encapsulation of caulk containing high concentrations of PCBs. TRC/SCA data collected during this Pilot Study, as well as, EPA/ORD laboratory based research have both demonstrated that liquid coatings are not effective for encapsulation of PCB caulk especially when high concentrations are present.

4.6.3 Secondary Sources-Encapsulation

- Secondary sources are likely contributing to PCBs concentrations found in indoor air in NYC schools. Emissions from these sources may become more significant after primary sources have been removed. These sources include surfaces coated with paints and varnishes. EPA ORD research findings indicate that encapsulation may represent an effective means of reducing PCB emissions from surfaces coated with paints and/or varnishes. TRC identified secondary source materials (i.e., wall paint, door paint, shelf laminate, etc.) containing PCBs greater than 50 ppm in two classrooms at P.S. 199M. Post-remedial air and wipe sampling was conducted following encapsulation of the two classrooms. Comparison of the air and wipe sample results with those of non-encapsulated classrooms was not shown to be effective or ineffective based on this study.

  A series of pilot tests should be designed and conducted within a NYC study school to evaluate the effectiveness of selected coatings as encapsulants for secondary PCB sources such as painted surfaces. Application of an epoxy based (or performance equivalent) product should be considered. The gymnasium located in P.S.199M should be considered as one of the test locations. PCB air concentrations should be measured prior to application of the encapsulant and at predetermined times after application. Surface wipe tests should also be performed concurrent with the collection of all room air samples.

4.6.4 Treatment of Underlying Substrate

- Pilot school study results have shown that newly installed caulking may become contaminated with PCBs that remain in the underlying building substrate over time. The substrate contains PCBs released from PCB caulk that has been removed previously. Methods for the isolation or removal of the PCBs present in the substrate are therefore needed. Evaluation of chemical degradation methods, for example, is warranted for mitigation of PCBs present in underlying substrates. An effective measure is needed to prevent recontamination of newly applied PCB free caulk. A list of candidate products and methods/techniques should be developed based upon EPA ORD findings, review of manufacturers' data for commercially available products and performance data from other school and building case studies. The most promising products should be selected for application to representative substrates (masonry/concrete) and evaluation in a school setting.

- Commercially available caulks typically are comprised of organic polymers /or contain organic compounds that may serve to enhance migration of PCBs from the underlying substrate to the newly applied/installed caulk. (Higher organic content promotes adsorption/solubilizing of PCBs.) A survey of commercially available caulks should be conducted so as to identify caulks with little or no organic content. If suitable candidate caulk products can be identified (e.g., water-based) several of these should be selected for use in pilot test in a school setting.

4.6.5 Carbon Filtration

Carbon filtration has been shown to be an effective means of reducing concentrations of PCBs present in room air at P.S. 199M. Use of carbon beds should continue at this school and use should be expanded to include other classrooms where indoor PCB concentrations remain above acceptable USEPA Guidance values. In all instances PCB concentrations present in the room air should be measured as a function of time so as to evaluate the effect of the carbon bed in reduction of room air levels. Representative samples of each carbon bed should also be analyzed for PCBs so as to identify the Aroclor found and the approximate mass of PCBs removed from room air during the duration of each event. The latter data can be used for mass balance calculations.

4.6.6 Ventilation Upgrades

Pilot study data for P.S. 178X, which has a central heating ventilation and air-conditioning (HVAC) system, indicates that indoor PCB concentrations are directly affected by room and building ventilation, whereby increasing fresh air supply into the system decreases airborne PCB concentrations. Analyses performed by the USEPA predicted that airborne PCB concentrations in classrooms are directly proportional (linear relationship) to ventilation air exchange rates when there is complete room air mixing and PCBs in the make-up air is zero. The typical NYC school does not have a central HVAC system, but rather classrooms are ventilated via exhaust-only ventilation systems, which were designed to draw in fresh air supply from perimeter windows. Since windows are not always open and have become more energy efficient over time, the make-up air for these classroom exhaust systems can come from within the building, and therefore room air mixing is incomplete and PCBs in the make-up air is not zero. Pilot study data for P.S. 199M, which has an exhaust-only ventilation system, indicates that the relationship between PCB air concentrations and exhaust ventilation rates will not follow a predicted linear relationship.

Ventilation rates measured in two (2) schools with exhaust-only ventilation systems (P.S. 199M and P.S. 309K) were found to be low and inadequate and hence do not serve as a mitigation measure for reducing room air PCB levels. Strategies for ventilation improvement, with particular focus on improvement in fresh air supply need to be evaluated further and should include window design, passive and active fresh air supply to spaces. As this is a complicated issue, an architect and/or engineer may be needed to make recommendations for improvements to building ventilation, and additional air monitoring will be needed to establish a direct relationship between ventilation rates and airborne PCB concentrations after recommended improvements have been implemented. The positive impacts of improved ventilation strategies on indoor PCB concentrations need to be documented to understand their effectiveness.

Currently, the SCA is in the process of conducting additional ventilation studies at two (2) Pilot schools (P.S. 199M and 309K). Ventilation systems at these schools will repaired and upgraded, and will be further evaluated through additional post remedial PCB air monitoring. The information gathered from these Pilot Study schools may be used to help improve the current strategy for overall ventilation system management at NYC Schools.

5.0 REFERENCES

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APPENDIX A

ATTACHMENTS

ATTACHMENT 1

LOCAL LAWS 68

LOCAL LAWS
OF
THE CITY OF NEW YORK
FOR THE YEAR 2011

No. 68

Introduced by Council Members Ignizio, Levin, Greenfield, Arroyo, Brewer, Cabrera, Chin, Dickens, Dromm, Ferreras, Fidler, Gentile, Koslowitz, Lander, Mendez, Palma, Rose, Sanders Jr., Seabrook, Van Bramer, Vann, Williams, Vallone, Nelson, Foster, Vacca, Mark-Viverito, Garodnick, James, Barron, Jackson, Rodriguez, Eugene, Lappin, Halloran, Koo, Oddo, Ulrich, Weprin, Crowley and Gennaro. Passed under a Message of Necessity from the Mayor.

A LOCAL LAW

To amend the New York city charter, in relation to the notification of information related to polychlorinated biphenyls (PCBs) in schools.

Be it enacted by the Council as follows:

Section 1. Chapter 20 of the New York city charter is amended by adding a new section 530-d to read as follows:

§530-d Notification requirements, PCBs. a. For the purposes of this section, the following terms shall have the following meanings:

1. "Department" shall mean the New York city department of education.

2. "PCBs" shall mean polychlorinated biphenyls.

3. "PCB light ballast" shall mean a device that electrically controls fluorescent light fixtures and that includes a PCB small capacitor containing dielectric.

4. "PCB lighting removal plan" shall mean the department's comprehensive plan to remove, replace or remediate light fixtures that have used or are using PCB light ballasts or are presumed to have used or to be using PCB light ballasts.

5. "Reportable PCB levels" shall mean written test results of light fixtures including, *but not limited to, air, wipe or bulk sample analysis, performed by or at the request of the department, the New York city school construction authority or the United States environmental protection agency that show concentrations of PCBs which exceed the amount allowable pursuant to the applicable regulations promulgated by the United States environmental protection agency, and shall also mean the inspection results of light fixtures that are leaking and presumed to have used or to be using PCB light ballasts.*

6. "Public school" shall mean any school in a building owned or leased by the department, including charter schools, that contains any combination of grades from kindergarten through grade twelve.

b. The department shall notify the parents of students and the employees in any public school that has been inspected or tested for reportable PCB levels of the results of such inspection or testing, and whether the results of such inspection or testing were negative or positive, within seven days of receiving such results; provided that if such results are received during a scheduled school vacation period exceeding five days and the area where such inspection or testing occurred is not being used by students during such period, such notification shall occur no later than seven days following the end of such period. The department shall also post such results on the department's website within seven days of receiving such results.

c. The notification required pursuant to subdivision b of this section shall include information setting forth the steps the department has taken and will take to address such reportable PCB levels, including the timeframe during which such reportable PCB levels were or will be addressed. If such steps are not completed within such timeframe then the department shall notify such parents and employees of the new timeframe for such steps. The department shall also notify such parents and employees within seven days of the date such steps to address reportable

PCB levels are completed.

d. Not later than the fifteenth day of April of the year 2012 and annually thereafter not later than the fifteenth day of November, the department shall notify the parents of students and the employees in any public school identified as part of the department's PCB lighting removal plan that such school has been identified as part of such plan and shall provide in such annual notice an explanation regarding the department's PCB lighting removal plan including, but not limited to, the reasons for removal, replacement, or remediation, the fact that certain light fixtures are presumed to contain PCBs, and the schedule for such removal, replacement or remediation.

§ 2. This local law shall take effect sixty days after its enactment into law.

THE CITY OF NEW YORK, OFFICE OF THE CITY CLERK, s.s:

I hereby certify that the foregoing is a true copy of a local law of The City of New York, passed by the Council on ……December 19, 2011………… and approved by the Mayor on ……December 27, 2011…………

MICHAEL M. McSWEENEY, City Clerk Clerk of the Council.

CERTIFICATION PURSUANT TO MUNICIPAL HOME RULE §27

Pursuant to the provisions of Municipal Home Rule Law §27, I hereby certify that the enclosed Local Law (Local Law 68 of 2011, Council Int. No. 563-A) contains the correct text and was passed by the New York City Council on December 19, 2011 approved by the Mayor on December 27, 2011 and returned to the City Clerk on December 27, 2011.

JEFFREY D. FRIEDLANDER, Acting Corporation Counsel.

ATTACHMENT 2

LOCAL LAWS 69

LOCAL LAWS
OF
THE CITY OF NEW YORK
FOR THE YEAR 2011

No. 69

Introduced by Council Members Levin, Ignizio, Arroyo, Brewer, Dickens, Dromm, Ferreras, Fidler, Lander, Mendez, Palma, Rose, Seabrook, Van Bramer, Vann, Williams, Vallone, Vacca, Wills, Chin, Nelson, Garodnick, Jackson, Rodriguez, Eugene, Lappin, Halloran, Koo, Ulrich, Weprin, Barron, Crowley, Gennaro, Greenfield and Oddo. Passed under a Message of Necessity from the Mayor.

A LOCAL LAW

To amend the New York city charter, in relation to requiring the reporting of information related to polychlorinated biphenyls (PCBs).

Be it enacted by the Council as follows:

Section 1. Chapter 20 of the New York city charter is amended by adding a new section 530-e to read as follows:

§530-e PCB reporting data. a. For the purposes of this section, the following terms shall have the following meanings:

1. "Department" shall mean the New York city department of education.

2. "PCBs" shall mean polychlorinated biphenyls.

3. "PCB light ballast" shall mean a device that electrically controls fluorescent light fixtures and that includes a PCB small capacitor containing dielectric.

4. "PCB lighting removal plan" shall mean the department's comprehensive plan to remove, replace or remediate light fixtures that have used or are using PCB light ballasts or are presumed to have used or to be using PCB light ballasts.

5. "Reportable PCB levels" shall mean written test results of light fixtures *including, but not limited to, air, wipe or bulk sample analysis, performed by or at the request of the department, the New York city school construction authority or the United States environmental protection agency that show concentrations of PCBs which exceed the amount allowable pursuant to the applicable regulations promulgated by the United States environmental protection agency, and shall also mean the inspection results of light fixtures that are leaking and presumed to have used or to be using PCB light ballasts.*

6. "Public school" shall mean any school in a building owned or leased by the department, including charter schools, that contains any combination of grades from kindergarten through grade twelve.

b. Not later than the fifteenth day of April of the year 2012 the department shall submit to the council a preliminary report, and annually thereafter not later than the fifteenth day of November the department shall submit to the council a report, regarding the progress of the department's PCB lighting removal plan and the department's efforts to address caulk in public schools and shall post such report on the department's website. The report shall include, but not be limited to: information regarding the overall progress on such plan including, but not limited to, an updated list of public schools identified as part of such plan, the steps that will be taken to address reportable PCB levels at such schools, and the schedule for addressing such reportable PCB levels at such schools; a list of schools where reportable PCB levels have been addressed, the steps taken to address such reportable PCB levels including, but not limited to, information regarding whether light fixtures and floor tiles were removed, replaced or remediated, and the timeframe during which such reportable PCB levels were addressed; a list of schools for which notification was sent to parents and employees pursuant to subdivision b of section 530-d *of this chapter, the steps taken to address the presence and removal, replacement or remediation of PCB light ballasts at such schools, including the number of light fixtures and floor tiles that were removed, replaced or remediated and the reasons for which inspection or testing for reportable PCB levels occurred including, but not limited to, routine inspection and discovery of a leaking ballast or pursuant to a consent order or any existing agreement with the United States environmental protection agency; a summary of the test results for any routine testing for PCBs in caulk performed by or at the direction of the department or the New York city school construction authority including, but not limited to, which schools were tested and for what reason, and information pertaining to the steps the department has taken and will take to address the presence and removal of PCBs in caulking including, but not limited to, the test results of any pilot study conducted pursuant to a consent order or any existing agreement with the United States environmental protection agency, an update on the status of such pilot study, and in the event that the department and New York City school construction authority reach agreement with the United States environmental protection agency at some future date on a final citywide PCB management plan, as described in and pursuant to all terms and conditions of the existing agreement with EPA, a description and update on PCB management activities, including the management of PCBs in caulking, implemented under such a final plan. All information required by this subdivision shall be aggregated citywide, as well as disaggregated by community school district, council district and borough.*

c. The report shall include a link to information posted on the website of the department of health and mental hygiene that provides answers to frequently asked *questions regarding PCBs.*

d. The requirements of this section shall no longer be in effect following the department's submission to the council of a report documenting that the removal of all light fixtures pursuant to the department's PCB lighting removal plan has been completed.

§ 2. This local law shall take effect sixty days after its enactment into law.

THE CITY OF NEW YORK, OFFICE OF THE CITY CLERK, s.s:

I hereby certify that the foregoing is a true copy of a local law of The City of New York, passed by the Council on ……December 19, 2011…………. and approved by the Mayor on ……December 27, 2011…………

MICHAEL M. McSWEENEY, City Clerk Clerk of the Council.

CERTIFICATION PURSUANT TO MUNICIPAL HOME RULE §27
Pursuant to the provisions of Municipal Home Rule Law §27, I hereby certify that the enclosed Local Law (Local Law 69 of 2011, Council Int. No. 566-A) contains the correct text and was passed by the New York City Council on December 19, 2011 approved by the Mayor on December 27, 2011 and returned to the City Clerk on December 27, 2011.

JEFFREY D. FRIEDLANDER, Acting Corporation Counsel.

APPENDIX B

TABLES

Table 1. Ranking the encapsulants by percent reduction of the concentration at the exposed Surface. (*For congener #110; initial concentration in source = µ/g;t = 500 days)* *(Ref: EPA/600/R-11/156B, April 2012; Adapted from Table 5.6).*

Encapsulant	% Reduction	Rank
Epoxy-no solvent	96.1%	1
Epoxy-waterborne	84.5%	2
Epoxy-low VOC	55.2%	3
Polyurea elastomer	28.2%	4
Polyurethane	0.0%	5
Oil enamel	-12.1%	6
Lacquer primer	-15.4%	7
Acrylate-waterborne	-17.1%	8
Acrylic-solvent	-33.3%	9
Acrylic-latex enamel	-79.2%	10

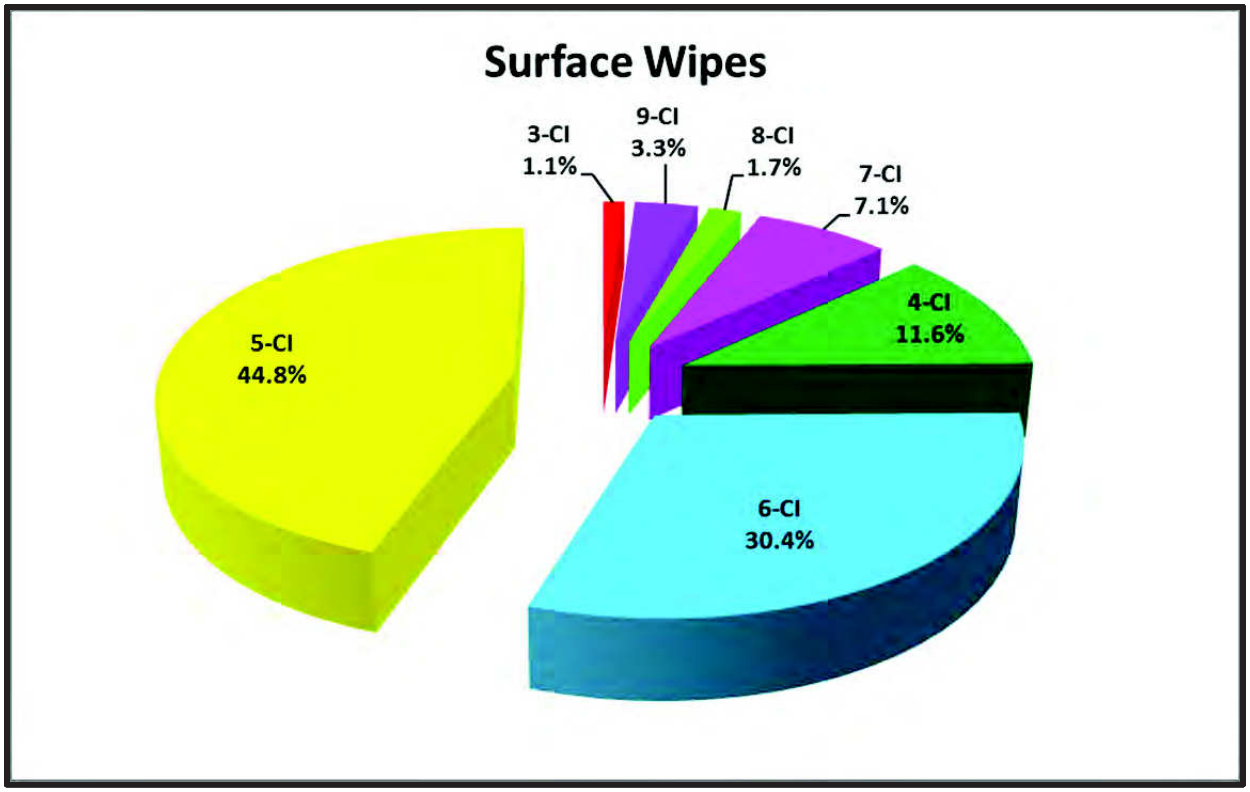
Table 2. Calculated maximum allowable concentrations in the source for effective encapsulation with two mitigation goals based on the PCB concentration in wipe samples (W_{max}). *(Adapted from Table 6.1 – EPA/600/R-11/156b, April 2012).*

Encapsulant	Maximum Allowable PCB Concentration In the Source, $C_{max,}$ (µ/g) |[a]|	
	For W_{max} = 1µg/100 cm^2	For W_{max} = 10 µg/100 cm^2
Lacquer primer	7.4	74
Acrylic-latex enamel	8.8	88
Oil enamel	14	140
Polyurethane	18	180
Acrylic-solvent	19	190
Acrylate-waterborne	19	190
Epoxy-waterbone	34	340
Polyurea clastomer	69	690
Epoxy-low VOC	120	1200
Epoxy-no solvent	430	4300

[(a)] *Results rounded to two (2) significant figures.*

APPENDIX C

FIGURES



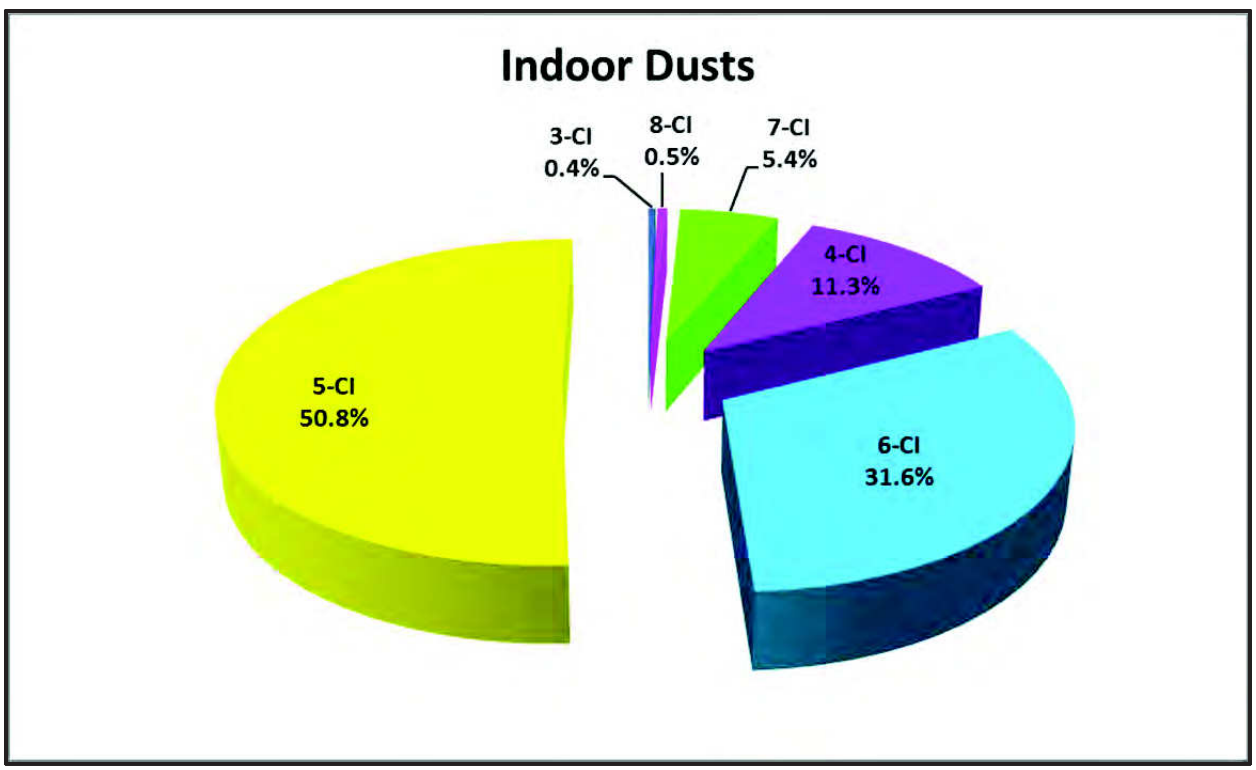


Figure 1. Comparisons of PCB Homologue Profiles – Surface Wipes and Indoor Dusts

(Adapted from Figure 4-17; Reference 1, EPA/600/R-12/051, September 2012)

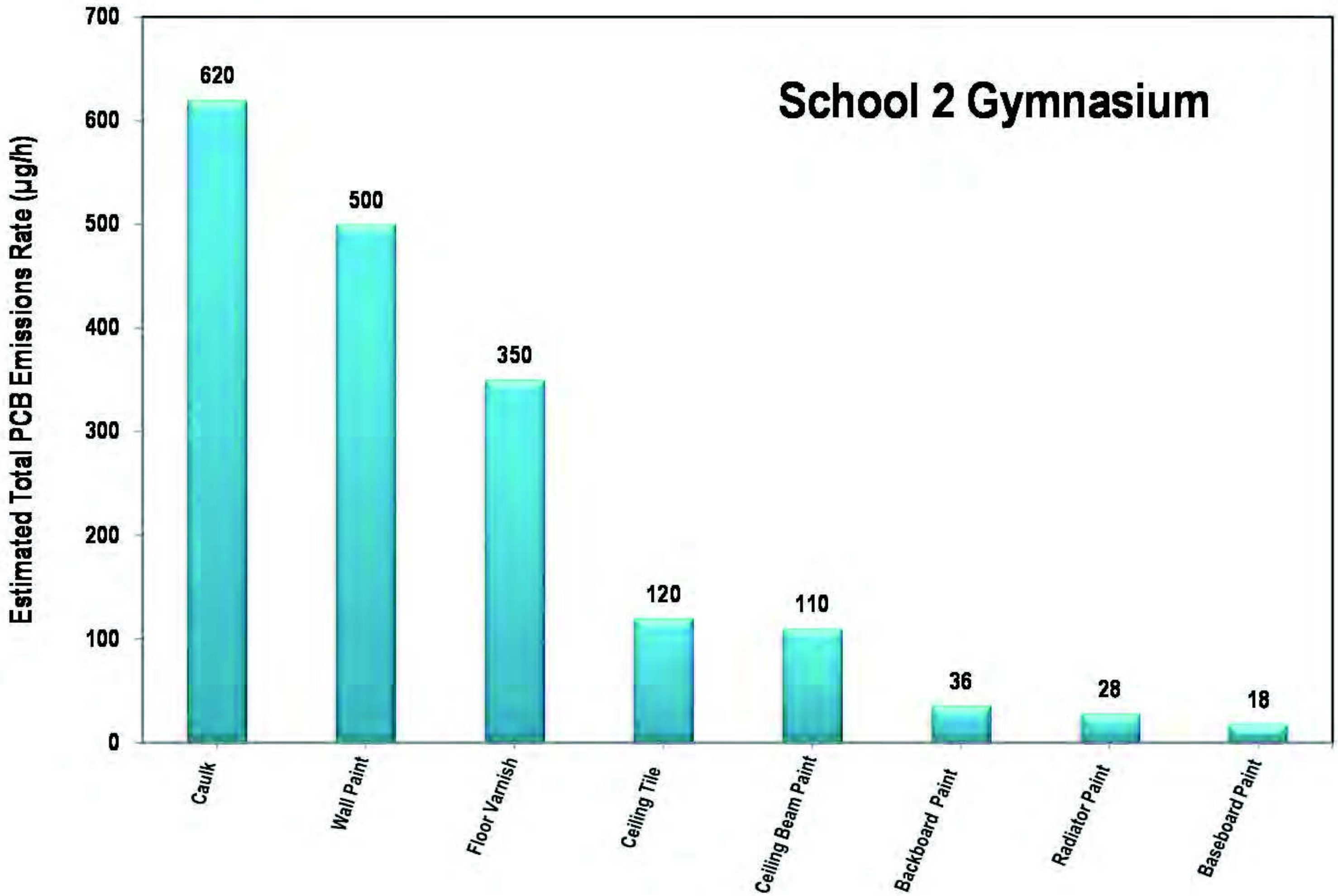


Figure 2. Estimated Total PCB Emission Rates – Comparison of Primary and Selected Secondary Sources – School 2 Gymnasium (Adapted from Figure 4-5, EPA/600/R-12/051 September 2012).

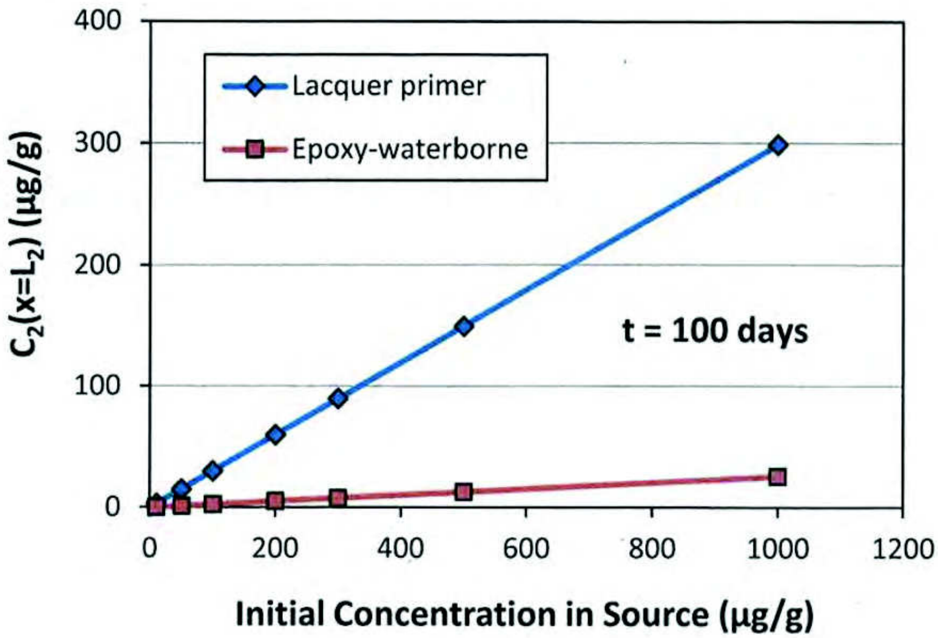


Figure 3. Concentration of congener #110 at the exposed surface of the encapsulant layer [$C_2(x = L_2]$ as a function of initial concentration in the source (t = 100 days).

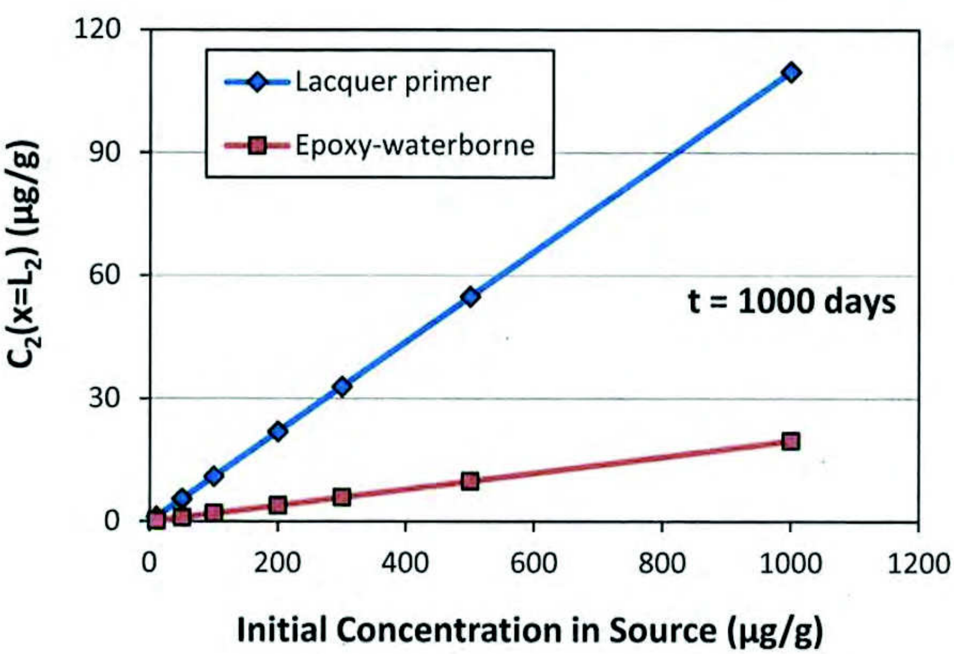


Figure 4. Concentration of congener #110 at the exposed surface of the encapsulant layer [$C_2(x = L_2]$ as a function of initial concentration in the source (t = 1000 days).

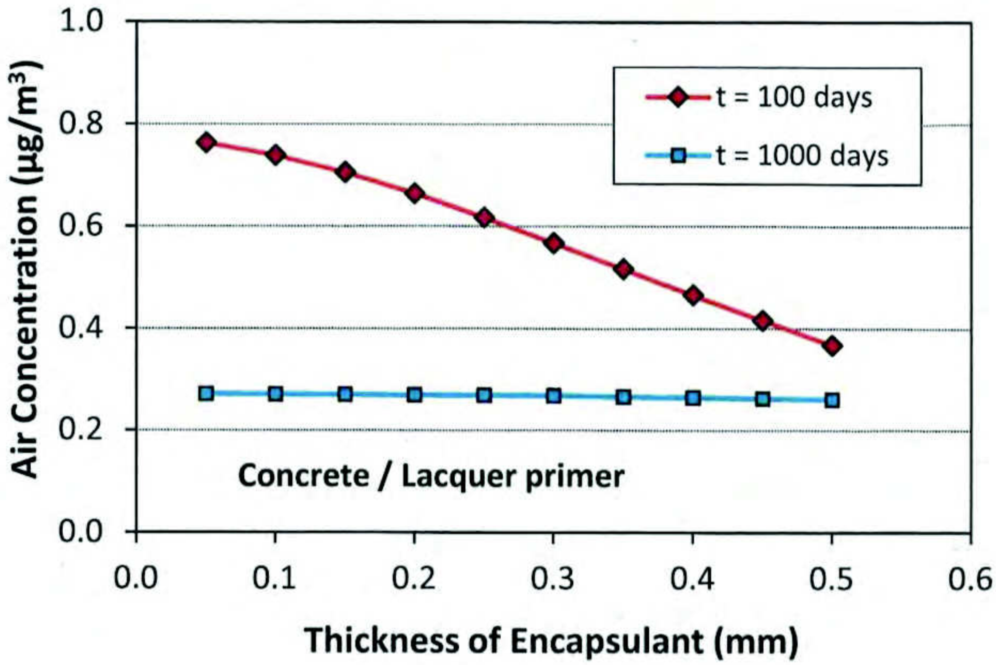


Figure 5. Effect of encapsulant thickness on the concentration of congener #110 in room air due to emissions from the encapsulated source – Case 1: Laquer-primer

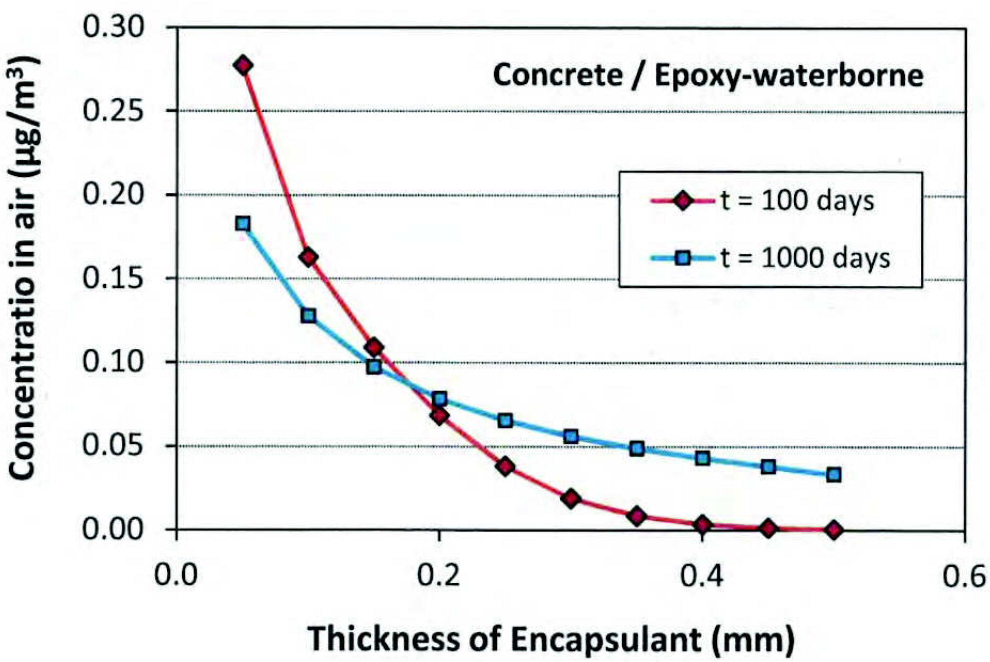


Figure 6. Effect of encapsulant thickness on the concentration of congener #110 in room air due to emissions from the encapsulated source – Case 2: Epoxy-waterborne

APPENDIX D

CERTIFICATION