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To: Pat Goddard, Director of Facilities, Town of Lexington
Paul Ash, Superintendent, Lexington Public Schools
Estabrook Advisory Committee

From: David MacIntosh

Date: October 28, 2010

RE: Air Samples Collected on October 18 and 19, 2010, Estabrook Elementary School

Environmental Health & Engineering, Inc. (EH&E) received results for the testing plan described in the October 19, 2010 memorandum titled "K-1 Wing Assessment". These data represent the complete set of results from seventh round of air samples collected at Estabrook Elementary School on October 18 - 19, 2010. All of the Round 7 results are summarized in this memo, including the results of samples that were collected on October 18, 2010 and discussed in an earlier memo.

This memo also summarizes plans for additional near-term mitigation steps that were identified during a meeting of EH&E's Director of Engineering and Lexington's facility manager and pneumatics specialist that was held at Estabrook Elementary on October 27, 2010.

Summary and Conclusions

Based on comparisons to previous sampling in the school, the Round 7 results indicate that emissions from the curtain wall are a primary source of PCBs in indoor air of the school. The results also indicate that concentrations of PCBs in indoor air of the school can be managed further by:

- sealing components of the curtain wall,
- minimizing heating of caulk on the interior of the curtain wall, and
- operating portable air cleaners with activated charcoal filters.

PCB concentrations in indoor air of occupied areas for Rooms 1 – 6 were less than 200 ng m^{-3} in Round 7. This is significant because these concentrations are within the public health levels suggested by EPA for children older than 5 years and adults and also within the most

conservative public health levels for all ages suggested by the site-specific assessment. In addition, PCB concentrations in the occupied area of Rooms 2, 3, and 5 were less than or within 10% of 100 ng m^{-3}, the public health level suggested by EPA for children less than 5 years old. Notably, these results were obtained during ventilation and heating conditions in class rooms that approximated winter conditions (room air thermostat set point of 70 degrees Fahrenheit, boiler operating, unit ventilator dampers modulating outdoor air flow based on demand for heating and cooling, average outdoor air ventilation of approximately 300 CFM).

Based in part on these results, plans made for additional near-term mitigation at the school include sealing specific components of the curtain wall, suspending use of stand-alone steam radiators (i.e., radiators that are not integral to the unit ventilators), and encapsulating transite panels below the window sills of the curtain wall.

Detailed Results

Room 1

During the testing in Room 1, the unit ventilator was isolated from the occupied space, supplemental ventilation of 300 CFM of outdoor air was provided, the *in situ* heating system was off to accommodate isolation of the unit ventilator, and supplemental heat was provided to maintain an air temperature of approximately 70 degrees Fahrenheit.

As shown in Figure 1, the PCB concentration in the occupied space was 145 ng m^{-3}. In comparison, the PCB level inside the unit ventilator was 107 ng m^{-3}. The concentration in the I-beam enclosure was 82 ng m^{-3}. The concentration in the occupied space during Round 7 was similar to the level during Round 6 (153 ng m^{-3}), despite having approximately four-fold less ventilation.

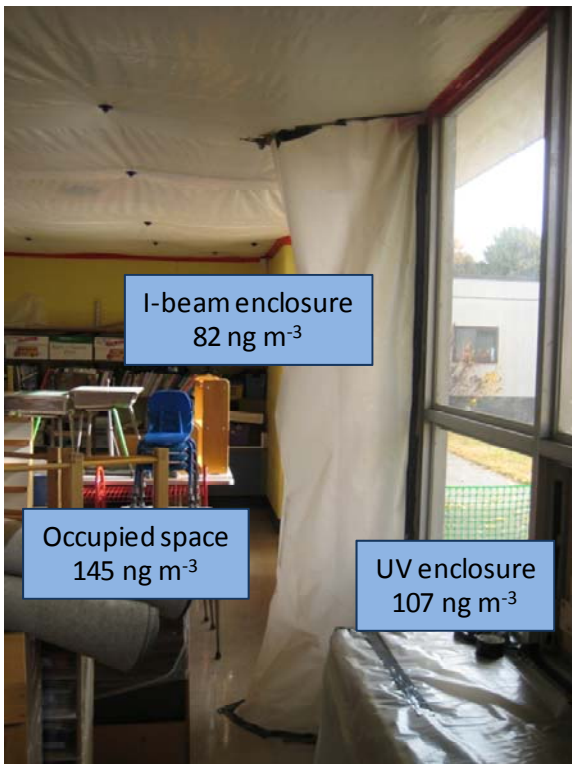

Figure 1 Photos of sampling locations and the concentration of PCBs in indoor air of Room 1.

Results of this testing indicate that isolating the curtain wall, or portions thereof (e.g., the transite panels), and suspending use of the stand-alone radiators are practical ways to control concentrations of PCBs in indoor air of the school further. These results also indicate that the unit ventilator of this room is not an important source of PCB concentrations in indoor air.

Room 2

During the testing in Room 2, the unit ventilator was operated in normal heating condition, the west-facing and south-facing curtain walls were isolated from the occupied space, and the stand-alone steam radiator was located within the south wall enclosure.

The sampling locations and PCB concentrations measured in Room 2 are shown in Figure 2. In addition to air sampling, the air exchange rate (AER) in each enclosure of Room 2 was measured. As shown in Table 1, air exchange rates within the West-wall and the South-wall enclosure were approximately 3 h^{-1} and 5.5 h^{-1}, respectively. The air exchange rate in the occupied space was estimated to be approximately 2 h^{-1} based on outdoor air ventilation of 300 CFM through the unit ventilator. Normalizing by air exchange rate, the concentration in the west wall enclosure was approximately 3 times greater than in the room. Similarly, the air exchange rate-normalized concentration in the south wall enclosure was approximately 14 times greater than in the room.

The results for Room 2 indicate that emissions from the curtain wall continue to be a source of PCBs in indoor air of the school and that heating in the vicinity of PCB-containing caulk increases PCB emission rates.

Table 1 Room 2 occupied space and curtain wall enclosure air exchange rates, PCB concentrations, and PCB concentration normalized to air exchange rate (AER) in the occupied space

Room 2	AER (h^{-1})	PCB Concentration (ng m^{-3})	Normalized to the AER in Occupied Space (ng m^{-3})
Occupied Space	2	53	53
South Wall Enclosure	5.5	274	754
West Wall Enclosure	3	97	146

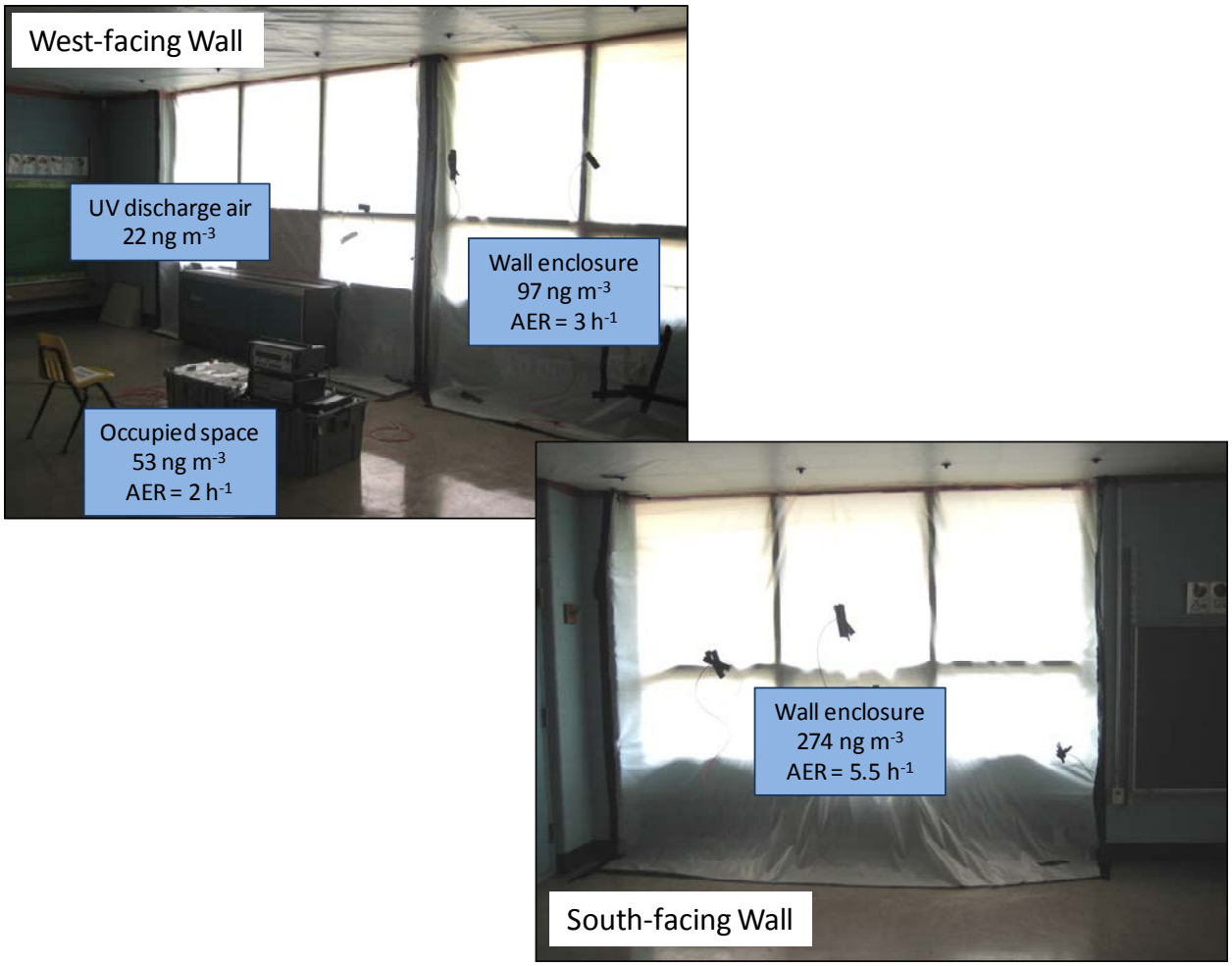

Figure 2 Photos of sampling locations and air exchange measurement equipment in Room 2, with the corresponding concentrations of PCBs in indoor air.

Room 3

During the testing in Room 3, the I-beam chase was enclosed and specific areas related to the curtain were sealed with silicone caulk or foam insulation. Those areas included the base of the curtain wall, metal-to-metal joints of aluminum framing, and original caulking at the intersection of horizontal and vertical aluminum frames. The unit ventilator was operated in normal heating condition. Two portable air cleaners, each operating at high fan speed of 400 CFM were located adjacent to the unit ventilator. Based on the room volume, the nominal recirculation rate attained by the air cleaners was 5.6 per hour.

As shown in Figure 3, the PCB concentration in the occupied space was 111 ng m^{-3}. In comparison, the PCB level of discharge air of unit ventilator was 54 ng m^{-3}. The concentration in the I-beam enclosure was 67 ng m^{-3}. The concentration in the occupied space during Round 7 was three fold less than the level during Round 6 (364 ng m^{-3}), with approximately the same ventilation, but the addition of the air cleaners.

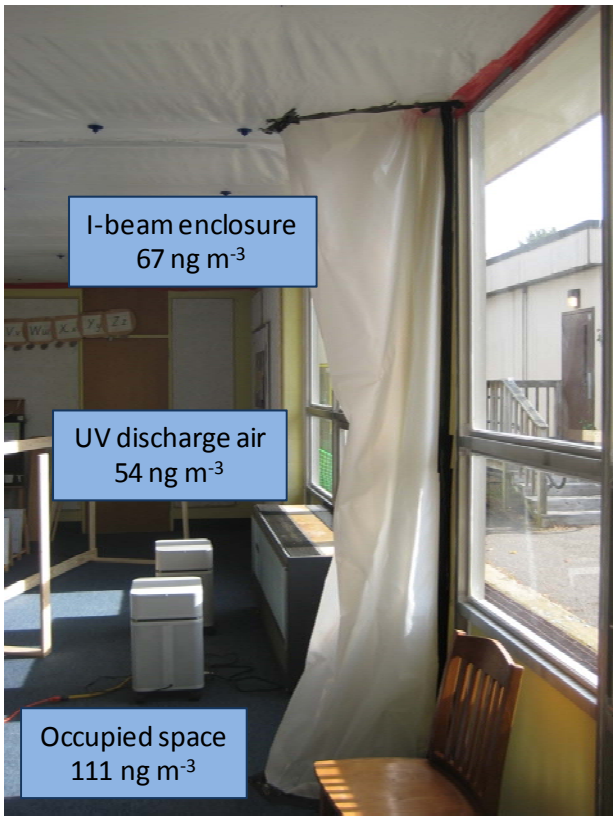

Figure 3 Photos of sampling locations and the concentration of PCBs in indoor air of Room 3.

Room 4

During the testing in Room 4, the unit ventilator was isolated from the occupied space, supplemental ventilation of 300 CFM outdoor air was provided, the *in situ* heating system was off to accommodate isolation of the unit ventilator, and supplemental heat was provided to maintain an air temperature of approximately 70 degrees Fahrenheit.

As shown in Figure 4, the PCB concentration in the occupied space was 126 ng m^{-3}. In comparison, the PCB level inside the unit ventilator was 118 ng m^{-3}. The concentration in the occupied space during Round 7 was 3 fold less than the level during Round 6 (344 ng m^{-3}), with approximately the same ventilation.

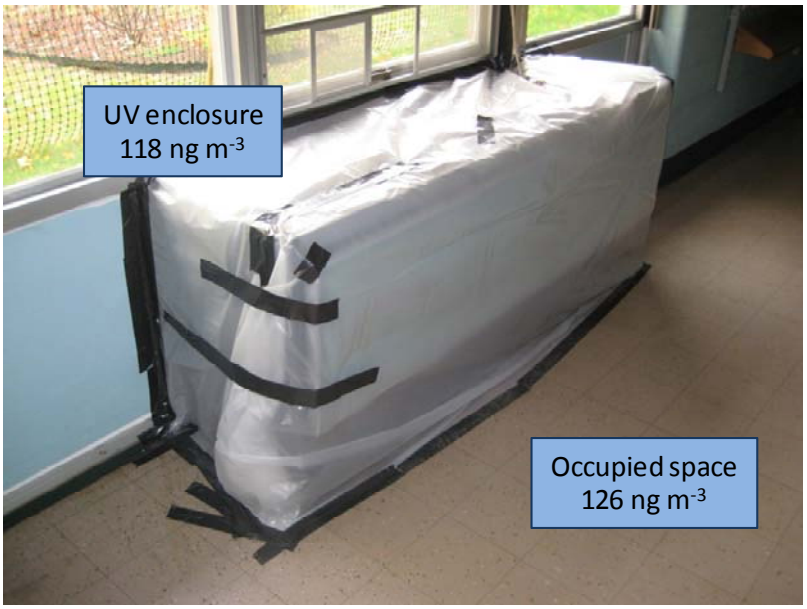

Figure 4 Photos of sampling locations and the concentration of PCBs in indoor air of Room 4.

The results for Room 4 indicate that the unit ventilator is not an important source of PCB concentrations observed in indoor air of the room.

Room 5

During the testing in Room 5, the unit ventilator was operated in normal heating condition. Two portable air cleaners, each operating at high fan speed of 400 CFM were located adjacent to the unit ventilator. Based on the room volume, the nominal recirculation rate attained by the air cleaners was 6 per hour.

As shown in Figure 5, the PCB concentration in the occupied space ranged between 67 - 90 ng m^{-3} and the PCB level in discharge air of the unit ventilator was 65 ng m^{-3}.

The concentration in the occupied space during Round 7 was three fold less than the level during Round 6 (209 ng m^{-3}), with approximately the same ventilation and operation of the air cleaners.

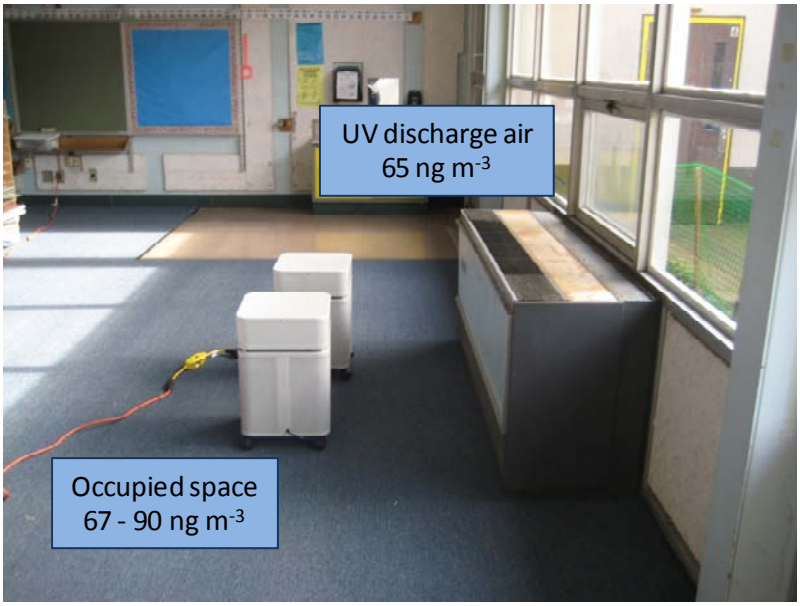

Figure 5 Photos of sampling locations and the concentration of PCBs in indoor air of Room 5.

The results for Room 5 in comparison to previous sampling and Round 7 results for other rooms suggest that the portable air cleaners were effective at controlling concentrations of PCBs in indoor air of the class room.

Room 6

During the testing in Room 6, the I-beam chase was enclosed and specific areas related to the curtain wall were sealed with silicone caulk or foam insulation. Those areas included the base of the curtain wall, metal-to-metal joints of aluminum framing, and original caulking at the intersection of horizontal and vertical aluminum frames. The convective heaters were operated in normal heating condition. The outdoor air ventilation rate was measured and found to be 470 CFM. Each thermostat was set to 70 degrees Fahrenheit.

Figure 6 Photos of penetration sealed in Room 6.

The PCB concentration in the occupied space was 182 ng m^{-3}, approximately one-half the level observed in Round 6 prior to sealing of the curtain wall.

The results of this testing indicate that sealing of penetrations on the curtain wall is a practical way to further control concentrations of PCBs in indoor air of the school.

Summary of Results for Occupied Spaces

The full set of results available at this time for PCB concentrations in indoor air of occupied spaces, as well as a crawlspace and ceiling plenums, is provided in Table 2. Concentrations observed in Round 7 were generally below the levels measured in previous rounds of testing.

PCB concentrations in indoor air of occupied areas for Rooms 1 – 6 were less than 200 ng m^{-3} in Round 7. This is significant because these concentrations are within the public health levels suggested by EPA for children older than 5 years and adults and also within the most conservative public health levels for all ages suggested by the site-specific assessment. In addition, PCB concentrations in the occupied area of Rooms 2, 3, and 5 were less than or within 10% of 100 ng m^{-3}, the public health level suggested by EPA for children less than 5 years old.

Near-Term Mitigation Plans

Plans for additional near-term mitigation at the school as established by EH&E and Lexington Department of Facilities are as follows:

1. Seams along I-beam chases, at upper and lower edges of the cove base, and butt joint ends of the aluminum framing members of the curtain wall system will be sealed with latex silicone caulk.

2. Use of fin tube radiators and convective heaters will be suspended where employed. All heating will be provided by unit ventilators or supplemental heating devices.

4. Transite panels will be covered by 5/8" thick drywall. To minimize the void space behind the drywall a closed cell foam board will be installed behind the drywall.

5. All materials choices will be reviewed by a contract architect that the school uses to manage building projects. This person will not stamp, but will review and advise to avoid safety, flame and smoke spread rating issues for the materials selected.

6. Additional items to be addressed were identified and put on the agenda for a subsequent meeting.

Table 2 Air Sample Results for Polychlorinated Biphenyls as Total Homologs, Estabrook Elementary School, 117 Grove Street, Lexington, Massachusetts, July 22, 2010 – October 19, 2010*

Sample Location	PCBs in Air as Total Homologs (ng/m^3)						
	Round 1[a]	Round 2[b]	Round 3[c]	Round 4[d]	Round 5[e]	Round 6[f]	Round 7[g]
Room 1	299	426	118‡	63‡	76‡	153‡	145
Room 2	–	775	455	189	166	253†	53
Room 3	–	–	–	–	–	364†	111
Room 4	–	–	–	–	–	344†	126
Room 5	459	736	320	196	149	209†	67 - 90
Room 6	1,800	764	483	171	213	383	182
Room 7A	–	–	5.19	–	–	–	–
Room 13	319	340	184	155†	–	–	–
Room 21A	–	–	410	193	–	–	–
Room 24	680	601	226	173†	–	–	–
Room 26	–	–	–	79	–	–	–
Room 31A	562	575	444	–	–	282	–
Room 39B	–	419	–	–	–	–	–
Room 39C	342	495	245	100	–	–	–
Library	–	469	196	–	–	–	–
Art Room	–	–	194	–	–	–	–
Teacher Work Room	–	–	138	–	–	–	–
Basement	–	–	227	–	–	–	–
Ceiling plenum (39C)	–	–	562	–	–	–	–
Psychologist Office	–	–	–	–	–	253	–
Outdoors	<3.79	<5.00	<4.20	<4.46	<4.32	<4.44	<5.54
Air Sample Obtained Between False Ceiling and Drop Ceiling – Round 5 Only							
Room 1	–	–	–	–	265	–	–
Room 2	–	–	–	–	287	–	–
Room 5	–	–	–	–	571	–	–
Room 6	–	–	–	–	526	–	–

PCB polychlorinated biphenyl
ng/m^3 nanograms per cubic meter
– air sample not collected at that location

[a] Round 1 samples collected July 22, 2010, during summer conditions.
[b] Round 2 samples collected on August 25, 26 or 27, 2010, following removal of caulk around exterior window frame.
[c] Round 3 samples collected on September 6, 2010, following initial optimization of outdoor air delivery and central exhaust, unless otherwise noted.
[d] Round 4 samples collected on September 19, 2010 with optimization of outdoor air delivery and central exhaust, and indoor caulk encapsulation, unless otherwise noted.
[e] Round 5 samples collected on September 27, 2010 with optimization of outdoor air delivery and central exhaust, partial indoor caulk encapsulation, and isolation of ceiling tiles.
[f] Round 6 samples collected on September 28 or 29, 2010 with ventilation as noted, central exhaust, full indoor caulk encapsulation, and isolation of ceiling tiles.
[g] Round 7 samples collected on October 18 or 19, 2010 with room conditions as described in this memo.
† Samples collected with reduced outdoor air delivery.
‡ Sample collected with supplemental air outdoor air (1200 CFM).
* PCB concentration analysis performed by Alpha Analytical Inc., using U.S. Environmental Protection Agency (EPA) Method 10A (GC/MS-SIM).