

***Appendix 9***

***Derivation of Building-Specific Health-Based Screening Levels***

## **Introduction**

The draft and final COPC Committee health-based benchmarks served as a starting point for evaluation of sampling data from the Building. However, as discussed below, we have determined that the COPC Committee values were not directly applicable to the Building. In this section of our report, we have utilized generally accepted and/or published methodology to establish Building-specific health-based screening levels.

### **1. The use of risk assessment and screening levels for risk and public health evaluation.**

Risk assessment is an interpretive process whereby relevant toxicological information (particularly dose-response relationships) is assembled and evaluated in an attempt to predict the probable response in humans after chemical exposure. The risk assessment process utilizes a mathematical model to estimate the probability, or risk, that a specific adverse human health effect may occur at a specific dose of a given agent.

According to the National Research Council (NRC, 1994),

*“Human health risk assessment entails the evaluation of scientific information on the hazardous properties of environmental agents and on the extent of human exposure to those agents. The product of the evaluation is a statement regarding the probability that populations so exposed will be harmed, and to what degree. The probability may be expressed quantitatively or in relatively qualitative ways.”*

As used by regulatory and public health agencies, human health risk assessment is a scientific tool designed to help answer questions regarding when, how, and where society's resources should be spent to protect public health from environmental contamination. In order to protect public health, risk assessments are typically designed to produce conservative estimates of health risk so that risks will not be underestimated. Conservative risk assessments are designed to be sensitive, meaning they do not fail to identify a significant risk where one exists.

The evaluation discussed in this report is consistent with conservative risk assessment and with the generally accepted scientific methodology for evaluation of potential risks associated with chemical contamination in general. Methodologies for general chemical risk assessment are presented in numerous EPA publications and are

inherently conservative and protective of public health. Many of these methods have been adapted to the Building and are described in detail below.

Numerical standards or guidelines to protect public health from exposure to chemicals have been developed for hundreds of chemicals. These standards or guidelines are in many ways similar to the Building-specific health-based screening levels and are sometimes referred to as “bright lines.” As defined by the Presidential/Congressional Commission on Risk Assessment and Risk Management (Presidential/Congressional Commission, 1997),

*“Bright lines are specific exposure concentrations that are meant to provide a clear distinction between what is considered safe and what is not. Bright lines can be useful as guideposts or goals for decision-making but should not be applied inflexibly, because of the uncertainty about risks and variation in susceptibility. We support the use of sets of bright lines to protect both the general population and specific populations potentially at higher risk, such as children and pregnant women.”*

The Building-specific health-based screening levels developed for WTC Hazardous Substances are similar in their function to the bright lines described by the Presidential/Congressional Commission. In the model established by the Presidential/Congressional Commission, the health-based screening levels for WTC Hazardous Substances are similar to the Screening Risk Assessment step in the risk assessment and risk management process. Following the screening risk assessment step, the Presidential/Congressional Commission describes a “detailed risk assessment” that further refines the results of the screening risk assessment. In the same way, the health-based screening levels for WTC Hazardous Substances are not intended as absolute cleanup standards. Rather, the screening levels for WTC Hazardous Substances are for evaluation of whether existing contamination or residual contamination following remediation are present at levels that pose a potential health concern. Measured concentrations in excess of these health-based screening levels indicate that further evaluation and, perhaps, remediation may be warranted. Use of the screening levels is not meant to substitute for a complete or “final” risk assessment.

For example, the screening levels for WTC Hazardous Substances do not account for additive effects. A final decision regarding reoccupancy of the Building could only be made by performing a complete risk assessment that accounts for concurrent exposures to multiple contaminants. To address this issue in the development of Soil

Screening Levels to guide risk-based cleanup of contaminated soils, the EPA (EPA, 1996) recommends that screening levels for chemicals affecting the same organ or system be divided by the number of chemicals that affect the particular organ or system. For example, if two chemicals affect the nervous system (such as lead and mercury), the screening levels for these chemicals are divided by 2. This approach is relatively inflexible and does not account for the relative amounts of contamination of multiple substances present in various locations in the Building and the effect this may have on overall cleanup.

## **2. *The COPC Committee Health-Based Benchmarks are not directly applicable to the building***

The COPC Committee reports discussed above were written in response to concerns regarding chemical contamination inside residences in Lower Manhattan. The goals were to determine the COPC based on sampling of WTC Dust and ambient air and to set health-based benchmarks for exposure to those COPC in residential environments. Though the draft version of this report was available in the early stages of the Building exposure assessment, for several reasons, the benchmarks established in this report were not directly applicable to the Building. These reasons include the following:

- The COPC Committee used a target cancer risk in their calculations that is less stringent than typically applied by relevant state and federal regulatory agencies in establishing screening levels.
- The COPC Committee discounted potential additive or synergistic effects of the multiple WTC Hazardous Substances present in the WTC Dusts.
- The health-based benchmarks were established for residential exposures, whereas the Building will be used as a commercial facility.

These limitations and inadequacies are discussed in greater detail in the following sections of the report.

a) *The COPC Committee used a target cancer risk in their calculations that is less stringent than typically applied by relevant state and federal regulatory agencies in establishing screening levels.*

The COPC Committee based their benchmark screening levels for individual carcinogens on a 1 in 10,000 ( $1 \times 10^{-4}$ ) increased cancer risk. However, both the EPA and the State of New York typically target a 1 in 1,000,000 ( $1 \times 10^{-6}$ ) acceptable increased risk goal, when establishing regulatory standards and when developing clean-up guidelines for contaminated environmental media. Thus, the COPC Committee utilized a target cancer risk that is 100 times higher than what is routinely utilized.

Derivation of  $1 \times 10^{-6}$  risk-based surface screening levels for carcinogenic WTC contaminants would be in keeping with the New York State Department of Environmental Conservation (NYSDEC) regulatory limits for carcinogens in soil and drinking water. In developing soil cleanup objectives for carcinogens, the NYSDEC states in its Technical and Administrative Guidance Memorandum (TAGM) #4046:

**Basis for Soil Cleanup Objectives:**

The following alternative bases are used to determine soil cleanup objectives:

1. Human health based levels that correspond to excess **lifetime cancer risks of one in a million for Class A<sup>1</sup> and B<sup>2</sup> carcinogens**, or one in 100,000 for Class C<sup>3</sup> carcinogens. These levels are contained in EPA's Health Effects Assessment Summary Tables (HEASTs) which are compiled and updated quarterly by the NYSDEC's Division of Hazardous Substances Regulation;  
(<http://www.dec.state.ny.us/website/der/tagms/prtg4061.html> accessed on 2/5/2004) (Emphasis added)

It should be noted that asbestos is a Class A carcinogen (i.e., known cause of human cancer) and dioxins are Class B carcinogens (i.e., probable cause of human cancer). Accordingly, a lifetime cancer risk level of  $1 \times 10^{-6}$  would be targeted for these constituents.

2. In Title 6, Part 702 of the Codes, Rules and Regulations of the State of New York states the following in describing the derivation of water quality standards and guidance values:

**§ 702.4 Procedures for deriving standards and guidance values based on oncogenic effects.**

(d) The 95 percent lower confidence limit on the dose corresponding to **an excess lifetime cancer risk of one-in-one million shall be the basis of the value.** [emphasis added].

(<http://www.dec.state.ny.us/website/regs/702.htm> accessed on 2/5/2004)

Thus, the  $1 \times 10^{-6}$  lifetime cancer risk level is the preferred target for regulatory limits and guidance designed to protect the people of New York from exposure to

carcinogens in soil and drinking water. This target risk should have been used by the COPC Committee when establishing health-based benchmarks for individual WTC-Hazardous Substances found in WTC Dusts.

For evaluating human health risk, it is well known that EPA may consider **aggregate** lifetime cancer risks (i.e., risks from simultaneous exposure to all carcinogens present at the site) of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  as acceptable. However, the identification of lifetime cancer risks above  $1 \times 10^{-6}$  is a regulatory trigger for further action. As stated by the EPA concerning the Superfund program

*“In the Superfund program, EPA must consider the need to conduct remedial action (cleanup) at a site if the theoretical risk exceeds  $1 \times 10^{-6}$ ; EPA usually requires remedial action at locations where the calculated number of excess cancer risks is greater than  $1 \times 10^{-4}$  (one excess cancer case in a population of ten thousand people could potentially occur)”. (EPA, 2000)*

The need to consider possible cleanup at lifetime cancer risk levels greater than  $1 \times 10^{-6}$  is bolstered by the practice of the EPA Regional offices. For example, EPA Regions 3, 6, and 9 have developed risk-based concentration tables for soil, drinking water, and indoor air. For carcinogens, soil, drinking water, and indoor air levels are based on the  $1 \times 10^{-6}$  lifetime cancer risk level. In no case are screening levels for individual contaminants established at the  $1 \times 10^{-4}$  or even the  $1 \times 10^{-5}$  lifetime cancer risk level.

The rationale behind this approach is the general assumption that if clean-up guidelines for individual chemicals are established at the  $1 \times 10^{-6}$  level, then it is unlikely that concomitant exposure to multiple carcinogens would result in an aggregate risk in excess of the maximum aggregate lifetime cancer risk level of  $1 \times 10^{-4}$ . For example, for four carcinogenic WTC Hazardous Substances (asbestos, dioxins, PCBs, PAHs), use of  $1 \times 10^{-4}$  risk-based screening levels for each individual contaminant would allow aggregate lifetime cancer risks that are unacceptably high (i.e.,  $4 \times 10^{-4}$ ).

In summary,  $1 \times 10^{-6}$  lifetime cancer risk-based surface levels for carcinogenic WTC Hazardous Substances are in keeping with State of New York regulations and guidance and EPA practice. They are also in keeping with the findings of the EPA Inspector General’s report of August 2003 regarding health-based benchmarks to be applied in evaluation of WTC contamination. Like the soil, drinking water, and indoor air screening levels described above, application of these levels to determine the need

for further action (remediation, building modifications, institutional controls, etc.) is exactly in keeping with the spirit of the intended use of these risk-based surface levels.

b) *The COPC Committee discounted potential additive or synergistic effects of the multiple WTC Hazardous Substances present in WTC Dusts.*

In deriving their health-based benchmarks, the COPC Committee explicitly ignored the generally accepted practice of considering additive carcinogenic risks for carcinogens (as discussed above), and additive non-carcinogenic effects for chemicals with the same target organ. The COPC Committee noted:

*“Mixture toxicology was not factored into the derivation process because little or no quantitative dose-response data exist regarding specific interactions across the WTC COPC...”*

This stance is justified by the authors by pointing out that the derived benchmarks are well-below observed effect levels and that interactions between COPC are less likely if they do not behave in a toxicologically similar manner. They conclude that exposure to combinations of COPC, each at or below benchmark levels, would be unlikely to produce effects. This statement is not supported by any referenced documentation nor is the reasoning behind this conclusion explained. This approach ignores accepted risk assessment methodology.

As demonstrated in Appendix 8, numerous peer-reviewed studies have measured synergistic or additive effects between several WTC COPC in a variety of experimental systems. At the very least, the EPA should have considered these studies as evidence of potential interactions between COPC. Though the authors mentioned this in final version Section 4.0-Uncertainties and Limitations, they dismiss the possibility of COPC interactions as unlikely without hard evidence to support this opinion, stating,

*“Presumably, exposures to one or multiple substances below or near the NOAEL will not result in adverse effects...”*

and,

*“Exposures to COPC at or below benchmark concentrations - which are set at levels significantly lower than observable effect levels - would be unlikely to produce effects individually or in combination.”*

As presented elsewhere, peer-reviewed studies have shown possible synergistic and additive effects between COPC in the Building exposure assessment that bring into question whether these statements in the EPA’s report are justified and suggest that further examination of this issue should have been carried out by the authors. This is further supported by the comments of the EPA Inspector General’s report of August 2003.

*c) The health-based benchmarks were established for residential exposures, whereas the Building will be used as a commercial facility*

As discussed previously, the COPC Committee derived health-based benchmarks designed to protect occupants of residential facilities in lower Manhattan. To accomplish this, certain assumptions were made regarding potentially exposed populations (e.g., children), duration of exposure (30 years), and frequency of exposure (365 days per year). In general, in a commercial/industrial facility these assumptions are not applicable. Overall, when conventional assumptions regarding potential exposures of adult workers in a commercial facility are used, the “allowable” surface concentrations of chemicals will be higher than those calculated for residential exposure settings.

### **3. Derivation of likely applicable Health-Based Screening Levels for the Building.**

As mentioned previously in Section 1, the Health Group did not, and could not at this time, conduct a formal risk assessment for the Building. Instead, we derived Building-specific health-based screening levels for a select group of four WTC Hazardous Substances: asbestos, lead, mercury, and dioxins/furans. The Building-specific health-based screening levels for WTC Hazardous Substances reflect a step in the risk assessment process described as a “screening risk assessment” described in Section 1 of this appendix. In deriving these screening levels, we have applied generally accepted methodology and corrected for the deficiencies and inadequacies of the screening level derivation by the COPC Committee described previously. Specific details of these screening level derivations are presented below on a chemical by chemical basis.

a) *Asbestos:*

As noted previously, risk-based settled dust and risk-based air concentrations of asbestos were presented by the COPC Committee in their September 2002 draft report. The methods used to calculate risk-based concentrations of asbestos were revised in the May 2003 report. In their 2002 report, the COPC Committee adopted a tiered procedure for conducting cleanup of indoor surfaces. This tiered approach included three tiers of progressively more stringent cleanup levels. The Tier I level, that is the level where “aggressive clean-up action should be taken”, was set at 30,000 f/cm<sup>2</sup>. The Tier III or “negligible” risk level was set at “background.”<sup>1</sup> However, the risk-based settled dust concentration for asbestos was removed in the COPC Committee 2003 Report on the basis that the approach used to calculate the settled dust asbestos level was too uncertain. However, the lack of a settled dust benchmark in the COPC Committee 2003 Report should not be interpreted as

Unfortunately, the COPC Committee 2002 Report was insufficiently detailed to determine actual inputs used to determine the settled dust level of >30,000 f/cm<sup>2</sup>. However, from the text of the report, it is clear that the Tier I level was set by assuming 365 days of exposure for a single year. For carcinogens such as asbestos, the lifetime cancer risk level for this one-year exposure was set at  $1 \times 10^{-4}$ . However, if the settled dust benchmark for asbestos was set at the typical EPA target lifetime cancer risk level of  $1 \times 10^{-6}$ , the level of asbestos in settled dust would be calculated as 300 f/cm<sup>2</sup>, or 1/100<sup>th</sup> that of the  $1 \times 10^{-4}$  based level.

A risk-based settled dust level for asbestos is not available for commercial/industrial areas. However, health-based surface and air screening levels for asbestos were derived by a method based on RE, or K-factors specifically calculated for WTC Dust. RE for PCME (Phase-contrast microscopy ) asbestos fibers, based on surface concentrations of total TEM (Transmission Electron Microscope) structures (or all structures >0.5 μm in length), were calculated from data obtained from the Chatfield and Kominsky, 2001 study of apartments contaminated with WTC Dust. The RE were derived from both “high exposure” and “low exposure” locations, and were utilized to calculate surface concentrations of total TEM structures that would result in airborne

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<sup>1</sup> The background asbestos surface concentration for hard surfaces in residential locations in upper Manhattan was reported by the EPA Region 2 was 6,192 s/cm<sup>2</sup>. This was defined as the upper 95% confidence limit of the mean value obtained in the background study (EPA, 2003). The 95-95 UTL for the Building, serving as an upper limit of background, i.e., Maximum Appropriate Level, for this Class A office facility was found to be 801 s/cm<sup>2</sup> (CTEH, 2003).

concentrations of PCME fibers that result in a  $1 \times 10^{-6}$  cancer risk in potential future occupants of the Building.

RE calculations based on Chatfield and Kominsky, 2001, high exposure and low exposure location data are presented in Tables 1 and 2, using geometric mean calculations, and in Tables 3 and 4, using arithmetic mean calculations. The source of the data from the Chatfield and Kominsky (2001) paper are indicated in the tables, based on personal communications with John Kominsky.

**Table 1 - Asbestos Resuspension Efficiencies Calculated from Chatfield and Kominsky, 2001 - High Exposure Location (250 South End)  
Geometric Mean Calculations**

TEM Structures >0.5 micron	Tables 14 & 15 <sup>3</sup>	Tables 20 & 21 <sup>3</sup>	TEM Structures >5 micron 250 South End - High Exposure	Table 15	Table 16	Table 21
250 South End - High Exposure	Air (s/cc)	Surface (s/cm2)		Air (s/cc)	Air-PCME (s/cc)	Surface (s/cm2)
	3.96	321,000		0.22	0.063	21,000
	3.24	289,000		0.23	0.06	19,000
	2.72	368,000		0.16	0.048	18,000
	2.74	668,000		0.29	0.075	28,000
	3.33			0.28	0.081	
Geomean	<b>3.167</b>	<b>388,604</b>	Geomean	<b>0.23</b>	<b>0.064</b>	<b>21,176</b>
Resuspension Efficiency <sup>1</sup>	<b>8E-06</b>		Resuspension Efficiency <sup>2</sup>	<b>6E-07</b>	<b>2E-07</b>	

1 - Resuspension efficiency for total fibers greater than 0.5 microns in length

2 - Resuspension efficiency for fibers greater than 5 microns in length, based on total TEM surface structures

3 - Data from the indicated tables in Chatfield and Kominsky (2001) were added together to obtain the air or surface concentrations in these columns.

**Table 2 - Asbestos Resuspension Efficiencies Calculated from Chatfield and Kominsky, 2001 - Low Exposure Location (45 Warren)  
Geometric Mean Calculations**

<b>TEM Structures &gt;0.5 micron</b>	<b>Tables 6 &amp; 7<sup>3</sup></b>	<b>Tables 18 &amp; 19<sup>3</sup></b>	<b>TEM Structures &gt;0.5 micron</b>	<b>Tables 10 &amp; 11<sup>3</sup></b>	<b>Tables 18 &amp; 19<sup>3</sup></b>	
<b>45 Warren - Low Exposure</b>	<b>Air</b>	<b>Surface</b>	<b>45 Warren - Low Exposure</b>	<b>Air</b>	<b>Surface</b>	
<b>2nd Floor</b>	<b>(s/cc)</b>	<b>(s/cm2)</b>	<b>5th Floor</b>	<b>(s/cc)</b>	<b>(s/cm2)</b>	
	0.11	31,300		0.054	539,000	
	0.131	530,000		0.059	132,000	
	0.103			0.059		
<b>Geomean</b>	<b>0.11</b>	<b>128,798</b>	<b>Geomean</b>	<b>0.057</b>	<b>266,736</b>	
<b>Resuspension Efficiency<sup>1</sup></b>	<b>9E-07</b>		<b>Resuspension Efficiency<sup>1</sup></b>	<b>2E-07</b>		
<b>TEM Structures &gt;5 micron</b>	<b>Table 7</b>	<b>Table 8</b>	<b>TEM Structures &gt;5 micron</b>	<b>Table 11</b>	<b>Table 19</b>	
<b>45 Warren - Low Exposure</b>	<b>Air</b>	<b>Air-PCME</b>	<b>45 Warren - Low Exposure</b>	<b>Air</b>	<b>Air-PCME</b>	<b>Surface</b>
<b>2nd Floor</b>	<b>(s/cc)</b>	<b>(s/cc)</b>	<b>5th Floor</b>	<b>(s/cc)</b>	<b>(s/cc)</b>	<b>(s/cm2)</b>
	0.01	0.01		0.008	NSS	79,000
	0.011			0.013	NSS	22,000
	0.018			0.008	ND	
<b>Geomean</b>	<b>0.013</b>	<b>0.010</b>	<b>Geomean</b>	<b>0.01</b>	<b>-</b>	<b>41,689</b>
<b>Resuspension Efficiency<sup>2</sup></b>	<b>1E-07</b>	<b>8E-08</b>	<b>Resuspension Efficiency<sup>2</sup></b>	<b>2E-07</b>	<b>-</b>	

1 - Resuspension efficiency for total fibers greater than 0.5 microns in length

2 - Resuspension efficiency for fibers greater than 5 microns in length, based on total TEM surface structures

3 - Data from the indicated tables in Chatfield and Kominsky (2001) were added together to obtain the air or surface concentrations in these columns.

**Table 3 - Asbestos Resuspension Efficiencies Calculated from Chatfield and Kominsky, 2001 High Exposure Location (250 South End)  
Arithmetic Mean Calculations**

<b>TEM Structures &gt;0.5 micron</b>	<b>Tables 14 &amp; 15<sup>3</sup></b>	<b>Tables 20 &amp; 21<sup>3</sup></b>	<b>TEM Structures &gt;5 micron</b>	<b>Table 15</b>	<b>Table 16</b>	<b>Table 21</b>
<b>250 South End - High Exposure</b>	<b>Air</b>	<b>Surface</b>	<b>250 South End - High Exposure</b>	<b>Air</b>	<b>Air-PCME</b>	<b>Surface</b>
	<b>(s/cc)</b>	<b>(s/cm2)</b>		<b>(s/cc)</b>	<b>(s/cc)</b>	<b>(s/cm2)</b>
	3.96	321,000		0.22	0.063	21,000
	3.24	289,000		0.23	0.06	19,000
	2.72	368,000		0.16	0.048	18,000
	2.74	668,000		0.29	0.075	28,000
	3.33			0.28	0.081	
<b>Mean</b>	<b>3.198</b>	<b>411,500</b>	<b>Mean</b>	<b>0.24</b>	<b>0.065</b>	<b>21,500</b>
<b>Resuspension Efficiency<sup>1</sup></b>	<b>8E-06</b>		<b>Resuspension Efficiency<sup>2</sup></b>	<b>6E-07</b>	<b>2E-07</b>	

1 - Resuspension efficiency for total fibers greater than 0.5 microns in length

2 - Resuspension efficiency for fibers greater than 5 microns in length, based on total TEM surface structures

3 - Data from the indicated tables in Chatfield and Kominsky (2001) were added together to obtain the air or surface concentrations in these columns.

**Table 4 - Asbestos Resuspension Efficiencies Calculated from Chatfield and Kominsky, 2001 Low Exposure Location (45 Warren)  
Arithmetic Mean Calculations**

<b>TEM Structures &gt;0.5 micron</b>	<b>Tables 6 &amp; 7<sup>3</sup></b>	<b>Tables 18 &amp; 19<sup>3</sup></b>	<b>TEM Structures &gt;0.5 micron</b>	<b>Tables 10 &amp; 11</b>	<b>Tables 18 &amp; 19</b>	
<b>45 Warren - Low Exposure 2nd Floor</b>	<b>Air (s/cc)</b>	<b>Surface (s/cm2)</b>	<b>45 Warren - Low Exposure 5th Floor</b>	<b>Air (s/cc)</b>	<b>Surface (s/cm2)</b>	
	0.11	31,300		0.054	539,000	
	0.131	530,000		0.059	132,000	
	0.103			0.059		
<b>Mean</b>	<b>0.11</b>	<b>280,650</b>	<b>Mean</b>	<b>0.057</b>	<b>335,500</b>	
<b>Resuspension Efficiency<sup>1</sup></b>	<b>4E-07</b>		<b>Resuspension Efficiency<sup>1</sup></b>	<b>2E-07</b>		
<b>TEM Structures &gt;5 micron</b>	<b>Table 7</b>	<b>Table 8</b>	<b>TEM Structures &gt;5 micron</b>	<b>Table 11</b>	<b>Table 19</b>	
<b>45 Warren - Low Exposure 2nd Floor</b>	<b>Air (s/cc)</b>	<b>Air-PCME (s/cc)</b>	<b>45 Warren - Low Exposure 5th Floor</b>	<b>Air (s/cc)</b>	<b>Air-PCME (s/cc)</b>	<b>Surface (s/cm2)</b>
	0.01	0.01		0.008	NSS	79,000
	0.011			0.013	NSS	22,000
	0.018			0.008	ND	
<b>Mean</b>	<b>0.013</b>	<b>0.010</b>	<b>Mean</b>	<b>0.01</b>	<b>-</b>	<b>50,500</b>
<b>Resuspension Efficiency<sup>2</sup></b>	<b>5E-08</b>	<b>4E-08</b>	<b>Resuspension Efficiency<sup>2</sup></b>	<b>2E-07</b>	<b>-</b>	

1 - Resuspension efficiency for total fibers greater than 0.5 microns in length

2 - Resuspension efficiency for fibers greater than 5 microns in length, based on total TEM surface structures

3 - Data from the indicated tables in Chatfield and Kominsky (2001) were added together to obtain the air or surface concentrations in these columns.

The calculated RE, based on total TEM structures on the surface are as follows, using geometric mean and arithmetic mean calculations for concentrations:

**Resuspension Efficiencies (cm<sup>-1</sup>) for Chatfield & Kominsky (2001)  
High and Low Exposure Locations – Use of Geometric Mean Calculations**

Resuspension Efficiency	Structures >0.5 µm	PCME Fibers
High Exposure Location	8 x 10 <sup>-6</sup>	2 x 10 <sup>-7</sup>
Low Exposure Location (2 <sup>nd</sup> Floor)	9 x 10 <sup>-7</sup>	8 x 10 <sup>-8</sup>
Low Exposure Location (5 <sup>th</sup> Floor)	2 x 10 <sup>-7</sup>	na <sup>1</sup>

1 – PCME air concentrations could not be calculated for the low exposure 5<sup>th</sup> floor location.

**Resuspension Efficiencies (cm<sup>-1</sup>) for Chatfield & Kominsky (2001)  
High and Low Exposure Locations – Use of Arithmetic Mean Calculations**

Resuspension Efficiency	Structures >0.5 µm	PCME Fibers
High Exposure Location	8 x 10 <sup>-6</sup>	2 x 10 <sup>-7</sup>
Low Exposure Location (2 <sup>nd</sup> Floor)	4 x 10 <sup>-7</sup>	4 x 10 <sup>-8</sup>
Low Exposure Location (5 <sup>th</sup> Floor)	2 x 10 <sup>-7</sup>	na <sup>1</sup>

1 – PCME air concentrations could not be calculated for the low exposure 5<sup>th</sup> floor location.

As observed from these calculations, use of the arithmetic or geometric mean for calculation of air or surface concentrations makes no difference in calculating the RE for the high exposure apartment or the low exposure apartment on the 5<sup>th</sup> floor. However, RE calculated from arithmetic mean data are approximately one-half of the values based on geometric mean data for the low exposure location – 2<sup>nd</sup> floor.

Health-based surface concentrations of total asbestos structures (i.e., structures greater than 0.5 µm in length) were calculated for the following scenario:

- Target Cancer Risk: 1 x 10<sup>-6</sup>
- Exposure Duration: 25 years
- Exposure Frequency: 250 days per year
- Daily Workplace Inhalation Rate: 10 m<sup>3</sup>
- Inhalation Unit Risk: 0.23 (f/cc)<sup>-1</sup>

Using this exposure scenario, the PCME fiber asbestos air concentration resulting in a  $1 \times 10^{-6}$  cancer risk is  $2.6 \times 10^{-5}$  f/ml, or  $0.00004$  f/cm<sup>3</sup>. The total structure surface concentrations (s/cm<sup>2</sup>) resulting in this PCME air concentration can be calculated from the various RE presented above. These calculated values are presented in the following table.

**Risk-Based TEM Asbestos Structure Surface Concentrations (s/cm<sup>2</sup>) Calculated from Chatfield & Kominsky, 2001 Resuspension Efficiencies**

Data Source	Geometric Mean	Arithmetic Mean
High Exposure Location	178	178
Low Exposure Location (2 <sup>nd</sup> Floor)	444	889
<b>Mean</b>	<b>281<sup>a</sup></b>	<b>534<sup>b</sup></b>

a – geometric mean

b – arithmetic mean

Based on these calculations, it can be seen that the health-based surface concentration of total TEM asbestos structures for the use scenario proposed for the Building will be approximately 300 to 500 s/cm<sup>2</sup>. Since the arithmetic mean has been generally used for all other calculations related to assessment of contamination in the Building, the Building-specific health-based asbestos surface and air screening levels were set at **500 s/cm<sup>2</sup>** and **0.00004 f/cm<sup>3</sup>**, respectively.

*b) Lead*

A health-based benchmark level of 25 µg/ft<sup>2</sup> is listed by the COPC Committee as the screening level for lead on surfaces and derives from the HUD criterion in 24 CFR 35.1320 which lists a “Lead Hazard Screen” level of 25 µg/ft<sup>2</sup> for floors. Indoor surface testing demonstrating lead concentrations in excess of this level require that a formal risk assessment be performed in accordance with the regulations. The actual HUD clearance criterion for lead-contaminated floor surfaces is 40 µg/ft<sup>2</sup>. The EPA indicates that “floor dust levels at 40 µg/ft<sup>2</sup> correspond to 5% or less probability of blood lead levels exceeding 10 µg/dL.” (66 Federal Register 1217, January 5, 2001). According to the Centers for Disease Control (CDC), blood lead levels of 10 µg/dL and greater are associated with adverse health effects on children and fetuses (CDC, 1991). A children’s daycare facility was located in the Building and would be assumed to be used for that purpose again were the Building successfully remediated and reoccupied. Due

to the conservative nature and regulatory precedent for the values presented above, we have identified a Building-specific health-based screening level for lead on surfaces of **25  $\mu\text{g}/\text{ft}^2$** . The air screening level selected by the COPC Committee (**0.7  $\mu\text{g}/\text{m}^3$** ) was adopted for the Building.

The 25  $\mu\text{g}/\text{ft}^2$  screening level for lead in settled dust for the Building is justified given the use of portions of the Building as a daycare, the highly bioavailable nature of lead in WTC Dust and the importance of ingestion of dust to overall lead exposure<sup>2</sup>. Ingestion of lead in dust and soil is the main pathway by which individuals in the general population are currently exposed to lead. In its lead exposure modeling to support development of the 0.7  $\mu\text{g}/\text{m}^3$  action level for lead in air, the COPC Committee used the Integrated Exposure/Uptake Biokinetic (IEUBK) Model. According to the IEUBK modeling performed by the COPC Committee, ingestion of lead in soil and dust comprises about 75% of overall exposure to lead from all sources (COPC Committee, 2003a). The default EPA assumption for the bioavailable fraction of lead in soil and dust is 0.30, i.e., 30% bioavailable. The term “bioavailable” refers to the fraction of lead in dust that is released from dust and absorbed into the bloodstream from the digestive tract. According to the EPA, the 0.30 fraction represents the assumption that 60% of lead in dust is available for absorption and that 50% of the lead is absorbed ( $0.60 \times 0.50 = 0.30$ ). In contrast, bioavailability testing of lead in dust from the Building indicates that about 90% of lead in WTC Dust is available for absorption. Thus, in contrast to the EPA default bioavailable fraction of lead in soil (0.30), the fraction of bioavailable lead in WTC Dust from the Building is 0.45, 50% higher than the default assumption assumed by the EPA.

Thus, while the 40  $\mu\text{g}/\text{ft}^2$  value results in an acceptably low probability (i.e., 5%) of exceeding the 10  $\mu\text{g}/\text{dL}$  blood lead level of concern for lead sources with the presumed default level of bioavailability, the Health Group has selected a more conservative 25  $\mu\text{g}/\text{ft}^2$  value as the Building-specific screening level due to the higher bioavailability of the lead present in WTC Dust. Given the relative importance of the dust ingestion exposure pathway and the high bioavailability of lead in WTC Dust from the Building, a lead screening level of 25  $\mu\text{g}/\text{ft}^2$  is justified for the protection of public health.

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<sup>2</sup>In determining whether an employer has maintained surfaces of hygiene facilities free from contamination, OSHA recommended in 1993 that the extant HUD lead level of 200  $\mu\text{g}/\text{ft}^2$  be used to evaluate the cleanliness of change areas, storage facilities, and lunchrooms/eating areas. It is noteworthy that the HUD level was lowered to 40  $\mu\text{g}/\text{ft}^2$  after the 12/13/1993 rule (29 CFR 1926.62(i)) appeared.

c) *Dioxins/Furans*

The COPC Committee has no settled dust guidelines that specifically address office worker exposures to “dioxins”. In its September 2002 and May 2003 reports in which settled dust guidelines are presented, the COPC Committee discusses the development of settled dust criteria for dioxins that are for “indoor surfaces in residences impacted by the WTC attack” (COPC Committee, 2002, 2003a). The amount of dioxins on a surface refers to the total amount of 2,3,7,8-tetrachlorodibenzo-p-dioxin equivalents (“TEQ”) on the surface.

Exposure guidelines for dioxins on surfaces have been developed since at least 1988. In 1988, the Subcommittee on Dioxin of the Committee on Toxicology (COT) of the National Research Council (NRC) developed an acceptable level of dioxin for office buildings in its report entitled *Acceptable Levels of Dioxin Contamination in an Office Building Following a Transformer Fire* (NRC, 1988). The NRC recommended a “re-entry exposure guideline” for dioxins of 25 nanograms per square meter (25 ng/m<sup>2</sup>). Expressed in terms of picograms (pg) per 100 cm<sup>2</sup>, this level is 250 pg/100 cm<sup>2</sup>.

As discussed by the COT in its 1988 report, the lifetime cancer risk associated with office exposure to dioxins is  $9.2 \times 10^{-5}$  at the 250 pg/100 cm<sup>2</sup> level (NRC, 1988). As reviewed in other places in this report, the target risk level used by the State of New York for carcinogens in drinking water and soil and the EPA target risk level for carcinogens is one in one million ( $1 \times 10^{-6}$ ). Thus, the COT 250 pg/100 cm<sup>2</sup> exposure guideline is associated with a lifetime cancer risk that is 92 times higher than that targeted by the State of New York and the EPA.

Furthermore, since the derivation of the 250 pg/100 cm<sup>2</sup> exposure guideline in 1988, revisions to the dioxin slope factor have been proposed. In fact, the COPC Committee used the 2001 EPA proposed slope factor for dioxins/furans in its 2002 and 2003 reports. This factor is approximately 6-fold higher than that used in the 1988 NRC report (1,000,000 kg-day/mg versus 156,000 kg-day/mg). This indicates that in more recent risk assessments, dioxins are considered 6 times more potent than was previously considered in 1988 by the NRC. If the 250 pg/100 cm<sup>2</sup> exposure guideline is adjusted for the newer slope factor for dioxin/furan and the  $1 \times 10^{-6}$  target lifetime cancer risk level, the adjusted exposure guideline for dioxins/furans can be calculated as follows:

$$250 \text{ pg}/100 \text{ cm}^2 \times \frac{9.2 \times 10^{-5}}{1 \times 10^{-6}} \times \frac{156,000}{1,000,000} = 0.42 \text{ pg}/100 \text{ cm}^2$$

This calculation shows the adjusted exposure guideline for dioxins/furans is 0.42 pg/100 cm<sup>2</sup>. The adjusted NRC value is very similar to the dioxin level published in the 2002 and 2003 COPC Committee reports when the settled dust values are adjusted downward to the target lifetime cancer risk level of 1 x 10<sup>-6</sup>. The COPC Committee values for dioxin in settled dust were 4 ng/m<sup>2</sup> and 1.7 ng/m<sup>2</sup> in the 2002 and 2003 reports, respectively (40 pg/100 cm<sup>2</sup> and 17 pg/100 cm<sup>2</sup>). When adjusted for a target lifetime cancer risk of 1 x 10<sup>-6</sup> and units of pg/100 cm<sup>2</sup>, these levels are 0.4 and 0.17 pg/100 cm<sup>2</sup>, respectively.

Thus, depending on the methods and assumptions used, settled dust criteria for dioxins/furans based on the target lifetime cancer risk of 1 x 10<sup>-6</sup> are very similar and range from 0.17 pg/100 cm<sup>2</sup> to 0.42 pg/100 cm<sup>2</sup>. For the commercial use scenario of the Building, the Building-specific health-based screening level for dioxins/furans was set at **0.2 pg TEQ/100 cm<sup>2</sup>**.

#### *d) Mercury*

The Agency for Toxic Substances and Disease Registry (ATSDR) develops Minimal Risk Levels (MRLs) for chemicals with noncancer adverse health effects (ATSDR, 1999c). Exposure to a chemical at or below the MRL on a daily basis for a specified duration of exposure is not expected to produce adverse noncancerous health effects. The ATSDR has developed a chronic inhalation MRL for mercury of 200 ng/m<sup>3</sup> (ATSDR, 1999c). Similar standards have been developed such as a recommended exposure limit (REL) by the California EPA of 90 ng/m<sup>3</sup> and the EPA's Reference Concentration (RfC) of 300 ng/m<sup>3</sup>. As mentioned in section 4.3 and demonstrated through sampling activities in the Building, unpredictable levels of airborne mercury are present in the Building that may pose health risks to future occupants. Since these levels are difficult to predict, we selected the ATSDR's MRL of 200 ng/m<sup>3</sup> as a Building-specific health-based screening level intermediate between the California REL and the EPA RfC.