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Ambient and Indoor Sampling and Public Health Evaluations for Residential Areas Near WTC

ATSDR/DHAC Version 9, October 18, 2001

I. Introduction:

This sampling protocol was developed to assess potential exposures to airborne and settled surface dust that entered residential areas following the collapse of the World Trade Center (WTC) buildings. The collapse of the WTC buildings resulted in a large number of residents being evacuated from their homes. Since the collapse, some residents have not reoccupied their apartments/homes near the WTC. Others have either visited to assess damage or to clean. Many have reoccupied their homes, and it is anticipated that more residents will soon be moving back. To date, environmental sampling efforts have focused on rescue/recovery areas (occupational); some sampling of commercial buildings to ensure office worker safety; and ambient (outdoor) air sampling for asbestos in a number of residential/commercial areas. Additional sampling is needed to ensure that residential areas are not adversely impacted by WTC collapse-related materials—both inside and outside of their residences.

Surface dust and debris containing asbestos have been found in lower Manhattan. Asbestos has been detected in personal air samples of "hot-zone" workers. In addition, low levels of asbestos have been detected in air samples collected on the "hot-zone" perimeter. Crystalline silica quartz has been detected in some of the 30 settled dust samples collected by NIOSH. Although most samples contained less than 5%, some samples contained from 15-20% crystalline silica quartz. Of the twelve personal air samples from the work site that have been analyzed for respirable crystalline silica, no detectable levels were found.

Dust, bulk, and air samples (mostly on or near the work site), as well as surface runoff water, river sediment, and river water have been analyzed for other contaminants, including metals, volatile organic compounds (VOCs), PAHs, dioxins and PCBs. The low levels of these contaminants that have been found do not indicate an immediate need to conduct widespread environmental testing for them.

Materials in airborne dust that may be of more immediate health concern—especially to residents who are returning to lower Manhattan—are those that can cause eye, nose, and throat irritation. Materials that can be inhaled or respired from airborne dust may cause respiratory irritation and exacerbation of pre-existing problems such as asthma, emphysema, and cardiopulmonary disease. Analysis of WTC-related residential surface and airborne dust, both indoors and outdoors, is to 1) determine if residents are being exposed to concentrations of materials that may be of public health concern; 2) whether areas already cleaned (inside and outside environments) contain materials that may be of public health concern; and 3) provide information to the public.

Information from residents support the need to further assess potential indoor and outdoor

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environmental health issues. Burning throats have been reported to be a common problem in the recently re-occupied residential areas. Residents in south Battery Park City, whose windows were open at the time of the WTC collapse, have settled dust in their homes. Some have disposed of furniture, stereo equipment, etc., because they were covered with "ash and dust." Homes in the Tribeca zone (Chambers Street to Murray Street, west of Broadway) are not yet occupied, but were reported to have roofs covered with hand-sized chunks of insulation-like material that contain small pieces of mica-like material. In addition, the mica-like material has clogged roof drains and resulted in standing pools of water on residential roof tops.

II. Sampling Objective:

The overall objective of this sampling is to provide results upon which public health agencies can further determine the potential for environmental exposures to WTC collapse-related materials and possible health implications of the exposures. Sampling will characterize ambient and indoor airborne and potentially airborne particles (surface dust) that remain in residential areas and commercial areas of lower Manhattan from the collapse of the World Trade Center. Specifically, the objective is:

Characterize the make-up and size distribution of settled dust and airborne breathing zone dust in residential areas—both indoors and outside—near the WTC. This information will be used to further determine if materials are present in air at levels of public health concern; and if materials are present in settled surface dust that can be re-entrained and result in continued exposures.

Sample locations will be selected in a concentric circle pattern, starting close to the WTC and ending in neighboring boroughs. Section V, Residence Selection/Sampling rationale, of this protocol describes this approach.

III. Data and Quality Assurance:

Co-located samples will be collected in 10% of the air samples. While not a true duplicate, evaluation of the results will provide some information on the quality of the sampling technique. Generally, analysis of duplicate samples should be within +/- 20% of each other.

At least two field blanks (or 10% of samples submitted, whichever is greater) per sample location will be submitted with the air samples. Blank cassettes should be opened at the same time as the sample cassettes are opened (just prior to sampling). Blank cassettes and their covers should be stored in a clean area (e.g., closed bag or box) with the covers from the sampling cassettes during the sampling period.

Each air sampling pump will be calibrated with a representative sampling device in-line before and after sample collection. Sample flow rates will be documented in the sampling log. The average

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of pre- and post-calibration flow rates will be used as the sample flow rate, for sample volume calculations.

Dust samples will be collected using the EPA Environmental Response Team (ERT) indoor dust sampling standard operating procedure (SOP). Duplicate samples are not feasible with indoor surface dust sample collection. Co-located samples (samples collected from adjacent areas of the floor) will be collected in 10% of the indoor surface dust sample locations. While not a true duplicate, evaluation of the results will provide some information on the variability of contaminants in the dust.

Chain of custody will be established and maintained throughout sample collection, transport, and analysis of the samples. Laboratory analysis shall follow all method-required quality assurance and quality control procedures.

All samples collected, unless analyzed with destructive methods, will be archived until further notice.

Samples should not be packaged in untreated polystyrene—electrostatic forces may cause fiber loss from some sample filters.

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IV. Sampling Parameters:

Parameter	Sample Type	Indoor/Outdoor	Rationale for Selection
Asbestos	breathing ht., time-weighted air	I/O	known use in building construction, evidence of presence in early air sampling and in settled dust, known inhalation carcinogen
Total Suspended particulates	breathing ht., Continuous, real- time, air	O	Characterize amount of airborne dust that is inhalable ($\leq 100 \mu\text{m}$ aerodynamic diameter)
PM10 and PM2.5	breathing ht., Continuous, real- time, air	O	Characterize the amount of airborne dust that is respirable
Inhalable ($<100\mu\text{m}$)* thoracic ($<10\mu\text{m}$)* respirable ($<4\mu\text{m}$)*	breathing ht., time-weighted, air	I/O	To determine relative amounts of each fraction present and to have each fraction analyzed for silica, gypsum, asbestos, mica, fiberglass, and calcite to qualitatively determine potential hazards.
Respirable crystalline silica	breathing ht., time-weighted, air	I/O	Known component of concrete, evidence of presence in some settled dust samples, known inhalation carcinogen.
pH**	dust	I/O	Concrete has a high pH, if dust has a high pH, it may be contributing to reported symptoms of ENT irritation
Asbestos**	dust	I/O	Determine if asbestos is present in dust
gypsum, silica, mica, fiberglass, calcite**	dust	I/O	Associated with building materials (concrete, drywall) and known to be irritating to ENT
magnesium	dust	I/O	May act as a tracer for WTC-related dust, levels found in metals analysis of settled dust from 16,000-29,000 ppm

* results will be used to better understand the potential for ENT and respiratory irritation, and possibly for determining the possibility of acute/chronic health

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problems. Results will assist in providing information/recommendations to the public (e.g., what is contributing to irritation, how to reduce exposures)

** to assist in characterizing dust that can become airborne (re-entrainment of settled dust that may be the source of continuing air contamination), and to make recommendations for outdoor dust remediation

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V. Residence Selection/Sampling Rationale

The selection of residential sampling locations will be decided upon by NYC DOH. The general NYCDOH approach is described as follows: A total of approximately 60 residential units will be sampled (a unit is an individual apartment or a common area in a multi-apartment building). A series of three concentric circles is being drawn around the WTC location. These circles will be divided by direction or zone from the WTC (north, south and west, and east). From five to seven of the multi-residential buildings will be selected for testing from within each zone.

Testing locations will mainly focused on occupied residences. However, approximately five unoccupied units nearest the WTC will be targeted for testing. In addition, approximately ten units will be selected outside of the concentric circles, in neighboring boroughs, to serve as background sample locations.

Sampling personnel will document the rationale for selecting buildings and residential units for sampling. They will also document sample locations, conditions during sampling, and possible interfering factors (e.g., traffic, construction). In addition, unit occupants and building owner/operators will be requested to provide information that will better assist in evaluating the results. Section IX of this plan contains the information needed/requested.

It should be noted that types of contaminant/materials and their concentrations may vary as the distance of the residence from the WTC. increases

All samples collected, unless analyzed using destructive methods, will be archived until further notice.

VI. Sampling/Analysis Approach:

I. Interior

Air and dust sampling will focus on both common/high traffic areas of the building (e.g., lobbies, front entryways) and on a selected number of apartments/units in the building. Attempts will be made to select apartments/units where dust is visible as well as units where dust is not visible. Selecting entryways and common areas should be representative of worst case conditions for contaminant/material track-in from outdoors. Selecting several apartments/units in the same building--with and without visible dust--should provide information on the ranges of contaminants found in indoor living spaces.

If the building is unoccupied, aggressive (leaf blower, high-power fan) indoor air sampling should be conducted. If the building is occupied, air sampling should be conducted with the building/unit HVAC system's fan in continuous operation. After sampling is completed, filters for the HVAC system, if applicable, should be inspected. If dust is present, recommend filter replacement.

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Indoor air sampling for asbestos will be conducted and analyzed using NIOSH method 7400. If an action level is exceeded subsequent filter analysis using NIOSH 7402 to determine if the fibers present are asbestos will be conducted. Respirable crystalline silica will be sampled and analyzed using NIOSH method 7500. Air sampling for inhalable, thoracic, and respirable size particles will be conducted using the IOM™ sampler. The relative amounts (percent weight) of each fraction present will be determined. Each fraction will be analyzed for silica, gypsum, mica, fiberglass, and calcite using X-ray diffraction (XRD) analysis, and for asbestos using PLM analysis (and TEM analysis if PLM indicates <1%).

Indoor floor dust samples will be collected using EPA ERT SOP for household dust collection. As much dust as possible will be collected; the area vacuumed will be measured and reported. Samples will be analyzed for crystalline silica, gypsum, mica, fiberglass and calcite using XRD. Asbestos will be analyzed using PLM; if <1% if found, TEM analysis will be conducted. The pH of the dust will be tested using EPA SW846 Method 9045C.

2. Exterior

Outdoor air and settled dust sampling will occur in areas adjacent to the residential building being tested indoors. Sampling will occur concurrently with indoor sampling.

Ambient air sampling will be conducted at breathing height. Air sampling for asbestos will be conducted and analyzed using NIOSH method 7400. If an action level is exceeded subsequent filter analysis using NIOSH 7402 to determine the amount of asbestos fibers present will be conducted. Respirable crystalline silica will be sampled and analyzed using NIOSH method 7500. Air sampling for inhalable, thoracic, and respirable size particles will be conducted using the IOM™ sampler. The relative amounts (percent weight) of each fraction present will be determined. Each fraction will be analyzed for silica, gypsum, mica, fiberglass, and calcite using X-ray diffraction (XRD) analysis, and for asbestos using PLM analysis (and TEM analysis if PLM indicates <1%). Twelve-hour, continuous, real-time TSP, PM10 and PM 2.5 sampling will be conducted—again at breathing zone height.

Settled surface dust samples will be collected by scraping visible dust into a glass container. A minimum of 25-30 grams of sample is required. Samples will be analyzed for crystalline silica, gypsum, mica, fiberglass and calcite using XRD, and for asbestos using PLM analysis (and TEM analysis if PLM indicates <1%). The pH of the dust will be tested using EPA SW846 Method 9045C.

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Sample/Analytical Methods

<u>Parameter</u>	<u>Environmental Media</u>	<u>Sampling/Analytical Method</u>	<u>Sample Flow/time</u>	<u>Analytical LOD / LOQ*</u>
Asbestos	I/O** air	NIOSH 7400, NIOSH 7402 Breathing zone sample height	16 L/min -4 hr (3840L) 5 hr (4800L) 6 hr (5760L)	0.010 f/cc (LOQ) 0.008 f/cc 0.007 f/cc
Total Suspended Particulates	O air	EPA Method # (continuous realtime) Breathing zone sample height	12-hr	
PM10 and PM2.5	O air	EPA Method # (continuous real-time) Breathing zone sample height	12-hr	
Inhalable (<100µm) thoracic (<10µm) respirable (<4µm)	I/O air	IOM personal sampler. Analyze each fraction for asbestos,(TEM), and for crystalline silica, gypsum, fiberglass calcite (XRD)	2 L/min -5 hr (600L)	30 ug / 50 ug/m³
Respirable crystalline silica	I/O air	NIOSH 7500	2.5 L/min-5.3 hr(800L)	5 ug / 6 ug/m³
pH	I/O dust	EPA SW 846 Mtd 9045C (soils)	10-25 g	
asbestos	I/O dust	PLM, and if <1% TEM	"	
silica, gypsum, gypsum, fiber- glass, calcite	I/O dust	XRD	"	

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* LOD: Limit of analytical detection; LOQ: Limit of analytical quantitation

** I: indoor; O: outdoor

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VII. Screening Levels/Data Interpretation:

Screening levels and actions are outlined in Section XI of this proposal.

Data will be evaluated by local, state and federal public health agencies. Evaluations will include:

- 1) Indoor sample results will be evaluated on a residence-by- residence basis (for the individual occupants)
- 2) All indoor data will be evaluated to determine the extent of public health implications for residents near the WTC
- 3) All outdoor data will be evaluated to determine the extent of public health implications for the general public living near the WTC
- 4) The relationship between materials found in indoor and outdoor samples will be evaluated.

If results of testing show contamination/materials present at levels of concern, efforts should be made to reduce these levels and to take steps that eliminate transporting them indoors (e.g., reduce contaminant track in by removing or changing shoes prior to entering residence, use HEPA filters on HVAC systems, keep windows closed).

VIII. Interference from existing bldg materials:

It is anticipated that some of the contaminants/materials found in this sampling effort will be un-related to the WTC event. Attempts will be made during sample collection to note other possible sources of contaminants (Section IX, Sample Description Needs).

To better determine if contaminants/materials found are within area background levels, approximately ten residential units outside of the concentric circle zones will be selected testing (indoor air and surface dust, outdoor air and surface dust).

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IX. Information Needs for Samples/Sample Locations:

In order to interpret results, the following information should accompany each area sampled:

A. Sample Collection Assessment Form

1. Description of reason for selection of site for sampling (e.g., apartment had windows open or broken during the WTC event; visible dust present in ambient air adjacent to apartment building)

- ☐ Occupied residence
☐ Unoccupied residence
☐ Common area

Justification for sample location (describe):

2. Physical address

3. Apartment/floor number

4. Contact Phone #

5. Side of building (N, S, E, W)

6. Was HVAC system in operation during entire sampling event?

☐ Yes ☐ No

If NO, how was system running (hrs.): _____

7. For surface dust sampling, measurement of area sampled (square meters or square feet) _____

8. Sketch of area showing air and surface dust sample locations

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For outdoor sampling, provide the following:

9. Location of samples relative to main entryways of residential buildings

10. Side of building (N, S, E, W)

11. Location of samples relative to roadways

12. Location of samples relative to dust-generating activities (describe activities)

- ☐ construction
- ☐ Remodeling
- ☐ Roadwork
- ☐ Other (describe)

13. Is visible dust present (air, surfaces)

☐ Yes ☐ No

If YES, describe

14. Weather prior to and during sampling

(Avoid ambient sampling during or just following rain events)

- ☐ date of last rain event
- ☐ wind velocity and direction

15. Sketch of area showing air and surface dust sample locations

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B. Questionnaire for Occupant/Resident

1. Has area been cleaned since WTC event

☐ Yes ☐ No

2. If YES to Question 1,

_____ Date(s) of cleaning

3. Description of cleaning

☐ wet mopping

☐ dusting

☐ sweeping (Broom, vacuum, HEPA vacuum)

☐ carpet cleaner

☐ furniture removed/cleaned (describe)

☐ window treatments (curtains, etc) removed/cleaned (describe)

☐ Other (describe)

4. Who conducted the cleaning

☐ Tenant/occupant

☐ Building owner/operator

☐ Cleaning company (provide name)

5. Was visible dust present?

☐ Yes ☐ No

If YES, describe

6. Is dust still present?

☐ Yes ☐ No

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If YES, describe

7. Have you been using your heating/AC system since the WTC event?

☐ Yes ☐ No

If YES, is it ☐ recirculating air or ☐ drawing from the outside?

8. Is your heating/AC system in your apartment/condominium (vs. a bldg-controlled system)?

☐ Yes ☐ No

If YES, what type of filter do you have (describe)?

Name

Size

Type

What was the date of the last filter change?

9. Do you or does anyone who lives here, or visits frequently, smoke tobacco products?

☐ Yes ☐ No

10. During this air and dust sampling, did you:

Cook on the stove

☐ Yes ☐ No

If yes, was the exhaust fan on

☐ Yes ☐ No

Have a fire in your fireplace

☐ Yes ☐ No

Smoke cigarettes or other tobacco

☐ Yes ☐ No

Clean or vacuum

☐ Yes ☐ No

If yes, describe

Burn candles, incense, etc.

☐ Yes ☐ No

Open your windows

☐ Yes ☐ No

Turn off the heating/AC system fan (it should be on during the entire sampling period)

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☐ Yes ☐ No

If YES, what time did you turn off the system _____

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C. Questionnaire for Building Owner/Operator—for general bldg condition, common areas of the building, and heating/air system descriptions

Note: Please provide the sampling team with a copy of your latest NYDEP check list/building inspection report

1. Has the building interior been cleaned since WTC event
☐ Yes ☐ No

2. If YES to Question 1,
 _____ Date(s) of cleaning

What areas were cleaned (describe)?
 e.g., common areas (entryways, lobbies, hallways, etc), individual units

3. Description of cleaning
☐ wet mopping
☐ dusting
☐ sweeping (Broom, vacuum, HEPA vacuum)
☐ carpet cleaner
☐ furniture removed/cleaned (describe)

_____ window treatments (curtains, etc) removed/cleaned (describe)

_____ Other (describe)

4. Who conducted the cleaning
☐ Tenant/occupant
☐ Building owner/operator
☐ Cleaning company (provide name)

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5. Was visible dust present?

☐ Yes ☐ No

If YES, describe (include location(s))

6. Is dust still present?

☐ Yes ☐ No

If YES, describe (include location(s))

7. Is there a building-wide HVAC system (as opposed to each apartment having separate systems)?

☐ Yes ☐ No

If YES, has the HVAC system been used since the WTC event?

☐ Yes ☐ No

Has the system been _____ recirculating air or _____ drawing from the outside?

What type of filter(s) are in the system (describe)?

Name(s) _____

Size(s) _____

Type(s) _____

What was the date of the last filter change (if more than one filter, include date of each filter change)? _____

8. During this air and dust sampling, was there:

Foot traffic (people leaving/entering the common spaces being tested)

☐ Yes ☐ No

Likely cigarette or other tobacco smoking

☐ Yes ☐ No

Cleaning or vacuuming

☐ Yes ☐ No

If yes, describe

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Use of candles, incense, etc.

☐ Yes ☐ No

Open windows

☐ Yes ☐ No

Open doors

☐ Yes ☐ No

Turn off the heating/AC system fan (it should be on during the entire sampling period)

☐ Yes ☐ No

If YES, what time did you turn off the system _____

9. Have you seen evidence of dust being tracked into the building since the WTC collapse?

☐ Yes ☐ No

If YES, name/describe the entryway locations

Describe the material being tracked indoors

Is the material still being tracked indoors?

☐ Yes ☐ No ☐ Can't tell

10. Has the exterior of the building been cleaned since WTC event?

☐ Yes ☐ No

11. If YES to Question 10,

_____ Date(s) of cleaning

12. Description of cleaning

☐ sweeping

☐ vacuuming

☐ water spray

☐ high pressure wash

☐ Other (describe)

13. Who conducted the cleaning

☐ Building maintenance

☐ Cleaning company (provide name)

☐ Other (describe)

14. Was visible dust present?

☐ Yes ☐ No

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If YES, describe

15. Is dust still present?

☐ Yes ☐ No

If YES, describe

16. Have the grounds of the building been cleaned since WTC event?

☐ Yes ☐ No

17. If YES to Question 10,

_____ Date(s) of cleaning

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18. Description of cleaning

- ☐ sweeping
- ☐ vacuuming
- ☐ water spray
- ☐ high pressure wash
- ☐ Other (describe)

19. Who conducted the cleaning

- ☐ Building maintenance
- ☐ Cleaning company (provide name)
- ☐ Other (describe)

20. Was visible dust present?

☐ Yes ☐ No

If YES, describe

21. Is dust still present?

☐ Yes ☐ No

If YES, describe

22. Have there been any recent or ongoing construction or remodeling activities inside or outside the building?

☐ Yes ☐ No

If YES,

☐ Date(s) of activities

Describe activities, including location(s):

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X. Community Notification of Results:

Resident in Unit

Residents in Building/Owner-Operator of building

Residents in area(s)

-results

-health implications

-recommendations

XI. Screening Values/Recommended Actions:

Sampling results will be evaluated by individual residence and by building. Each contaminant level will be compared with its screening values (tables that follow). Actions associated with screening values include: no further action, clean the area, and clean and resample the area.

Recommendations for sensitive members of the population are also included. If a screening value is exceeded, sample collection and questionnaire information will be reviewed to determine if the levels could be due to other sources (e.g., cigarette smoke, nearby construction). If other sources are plausible, recommendations will still be made, but qualified.

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ASBESTOS

Considerations for using the asbestos "1% rule" for cleaning up bulk contamination associated with the World Trade Center terrorists attacks.

Purpose: The purpose of this fact sheet is to discuss the basis of the 1% rule for asbestos containing material (ACM) and suggest how it may be applied to cleaning up asbestos contaminated debris from the World Trade Center collapse. The intent is to provide guidance for the use of bulk sampling results that will be protective of public health.

Background: The definition of asbestos containing material was first found in the Asbestos Hazard Emergency Response legislation of the United States Code. The term "asbestos-containing material" means any material which contains more than 1 percent asbestos by weight (see, United States Code, Title 15 - Commerce and Trade, Chapters 53 - Toxic Substances Control, Subchapter II - Asbestos Hazard Emergency Response, Sec. 2642. Definitions; which can be found at <http://www4.law.cornell.edu/uscode/15/2642.html>).

This definition was codified in the Code of Federal Regulations (40 CFR Ch1, Part 763 [7-1-00]) where a counting technique using polarized light microscopy (PLM) is used to determine percent asbestos.

% asbestos = (a/n) X 100% where
 a = number of asbestos counts,
 n = number of nonempty points counted (400),
 If a = 0, report "No asbestos detected",
 If $0 < a \leq 3$ report "<1% asbestos".

Historical derivation of the definition of "asbestos containing material": Two different accounts of the discussions leading to the definition of asbestos-containing material containing greater than 1% asbestos exist were identified.

- 1) The first account suggest that in the late 1970's when EPA was looking at the different methods to examine bulk material for asbestos they considered several different methods including polarized light microscopy (PLM), electron microscopy, x-ray diffraction (XRD), and others. EPA eventually settled upon XRD. XRD had a detection limit of approximately 1% asbestos in bulk material. Eventually the limitations of XRD became an obstacle to reliable asbestos determinations and EPA looked toward PLM to replace XRD as the analytical tool of choice. However, even though PLM can detect well below 1% asbestos, the 1% number had become well accepted and had been written into legislation, and so therefore 1% remained the legally enforceable number.
- 2) The second account suggests that the 1% rule has a political basis and resulted as a

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compromise between regulators and the regulated industry. An account of the politics and decision process leading to the selection of the 1% rule has been well described by Michael Moss and Adrienne Appel in an investigative report in the July 9, 2001 edition of the New York Times.

Regardless of which account is most accurate or even if the two accounts actually emerged about the same time resulting in the final definition of asbestos containing material, neither account indicates that the derivation of the 1% rule was in a manner that employed considerations of human health. The 1% rule is not based on health.

Two main short-comings of the 1% rule exist.

- * The 1% rule is not derived from a risk assessment or any other type of health based analysis.
- * The 1% rule does not insure that asbestos air levels will be at levels that are protective of human health.

The second point is not well documented in the literature. But two personal communications indicate this is a major problem with the 1% rule. OSHA (personal communication with Dan Krane, OSHA) has examined over 6000 work places in which asbestos existed in bulk material between 0% and 1 %. Four percent of these work places had asbestos air levels at or above the OSHA permissible exposure limit (PEL) of 0.1 f/cc. The measurements were point determinations and not 8 hour time weighted averages (TWA). But had the exposures continued for 8 hours, 4 % of the work places would have exceeded the PEL even though materials in these work places did not exceed 1% asbestos w/w.

The second indication of the limits of the 1% rule comes from Libby, Montana (personal communication with Chris Weis, EPA). Preliminary data from investigations into different types of activities show that tilling the soil in gardens with < 1% detectable levels of asbestos resulted in air levels close to the OSHA PEL.

Conclusion: The 1% rule has the advantage of being a legally enforceable level and precedence for its use is available. However the rule is not health based and may not provide adequate protection from airborne asbestos under a variety of conditions. Because of these limitations great care should be used in using any type of w/w percentage as guidance to protect human health. If percent determinations have to be made, they should be used only to confirm the presence or absence of asbestos or to recommend clean-up followed by further air testing. A possible guideline is suggested below.

Interpretation of bulk and air samples: The following table provides a general guide for determining public health actions based upon sampling of both bulk material and indoor air. The

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table integrates the Environmental Assessment Workgroup multi-agency recommendations for reoccupation of residences in lower Manhattan (see attachment 1). It is important to note that the ultimate decision criteria for reoccupation is the ambient air level of asbestos. Bulk asbestos determinations are useful for (1) determining the potential for recontaminating ambient air and (2) for determining the type of further sampling needed.

In general the sampling and resampling strategy encompasses testing of bulk material and clean up until such a time that further clean up will not lower bulk asbestos levels. Confirmation is made by air sampling; reoccupation of residents is acceptable below 0.01 f / cc.

ATSDR, with multi-agency concurrence, has provided guidance for re-entry into New York City buildings and has concluded that the 0.1 f/cc OSHA PEL is not acceptable for schools or residences (see attachment 1 ATSDR, CDC, EPA, OSHA Environmental Assessment Workgroup Asbestos Action Levels for World Trade Center Response October 11, 2001).

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Follow up Recommendations Based on Sampling Results from ATSDR's Residential Sampling

Asbestos level (bulk and air)	Sequential steps for follow up	Comments/Notes:
Settled dust > 1% asbestos w/w (PLM) air any level	1. Clean-up 2. Resample air and bulk 3. Evaluate data 4. Determine next actions based on follow up recommendations	Clean-up should follow OSHA standards for training and worker protection and any state laws for licensing. Consideration should be given to removing hard to clean furnishings, like carpet and upholstery, if sampling data remains elevated after repeated cleaning
Settled dust >Detection Limit - $\leq$ 1% w/w (PLM) air > 0.01 f/cc (TEM)	1. Clean-up 2. Resample air and bulk 3. Evaluate data 4. Determine next actions based on follow up recommendations	Consideration should be given to removing hard to clean furnishings, like carpet and upholstery, if sampling data remains elevated after repeated cleaning
Settled dust >Detection Limit - $\leq$ 1% w/w (PLM) air <0.01 f/cc (TEM)	1. Evaluate all appropriate data related to asbestos (air, bulk, personal monitors - PLM, XRD, PCM, TEM) 2. Determine appropriate follow up based on professional judgement 3. If clean up is recommended, resample and reevaluate results	Special attention should be paid to hard to clean surfaces. (e.g., certain fabrics, furniture, carpet, and curtains).
Settled dust Non-detect (PLM) air > 0.01 f/cc (TEM)	1. Clean-up 2. Resample air 3. Evaluate air data 4. Determine follow up actions	Remain advised of outdoor levels. If high levels are frequent retesting may be appropriate.
Settled dust Non-detect (PLM) air <0.01 f/cc (TEM)	No further action	

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Attachment I

FINAL (October 11, 2001)		ATSDR, CDC, EPA, OSHA Environmental Assessment Workgroup		Asbestos Action Levels for World Trade Center Response	
Action Level & Analysis Method	General Public/Recommendations ¹	Supporting Information ²	Comments		
NYC Background ³ PCM/PCMe ⁴ f/cc (see footnotes 2 and 3)	<ul style="list-style-type: none"> No restriction on access to any area. 	AHERA standards (40 CFR 763); ATSDR Toxicological Profile for Asbestos; OSHA 29 CFR 1926.1101	<ul style="list-style-type: none"> Remediation goal is to achieve background levels. AHERA guidance for schools requires that when schools are remediated for asbestos, the indoor air levels of asbestos should be similar to local outdoor air levels. Lowest attainable cancer risk 		
NYC Background to 0.01 f/cc PCM/PCMe ³	<ul style="list-style-type: none"> No restriction on access to streets and public/commercial building; continue to monitor Evaluate to determine if long-term access is acceptable; evaluate trends over months. <ul style="list-style-type: none"> Identify source Take action, as practical, to reduce levels to background 	AHERA standards (40 CFR 763); ATSDR Toxicological Profile for Asbestos; IRIS; OSHA 29 CFR 1926.1101	<ul style="list-style-type: none"> No significant cancer risk for short-term occupancy for residential and school buildings. AHERA guidance for schools requires that when schools are remediated for asbestos, the indoor air levels of asbestos should be similar to local outdoor air levels 		
70 structures/mm ² TEM	<ul style="list-style-type: none"> If < than 70 s/mm², no restrictions on access to buildings If > 70 s/mm², resample to confirm and analyze field blanks; take action to identify source and reduce levels to < 70 s/mm² 	AHERA standards (40 CFR 763) NYC Clearance standard for buildings	<ul style="list-style-type: none"> AHERA standards apply only to schools, and by NYC ordinance to buildings. Method sensitivity and counting rules should follow Appendix A (Table 1) in AHERA 40 CFR 763; Method sensitivity based on # grids analyzed and air sample volume and must be maintained at 0.005 f/cc. 		
0.01 - 0.1 f/cc PCM/PCMe ³	<ul style="list-style-type: none"> Continue to monitor; consider the need for additional sampling sites. If air levels are consistently between 0.01 to 0.1 f/cc, evaluate the need for advisories, the need to limit access and the need for dust suppression. 	Lowest limit set at 1/10 PEL/REL/TLV; AHERA standards (40 CFR 763); ATSDR Toxicological Profile for Asbestos; IRIS; OSHA 29 CFR 1926.1101;	<ul style="list-style-type: none"> Long-term exposures may increase cancer risk in the general public. Unlike workers the general population, includes children and sensitive persons, does not receive exposure monitoring and does not participate in annual health screening 		
> 0.1 f/cc PCM/PCMe ³	<ul style="list-style-type: none"> Evaluate the need to restrict general public access. Continue to monitor; consider the need for additional sampling sites. 	Unacceptable cancer risk following long-term exposure; AHERA standards (40 CFR 763); ATSDR Toxicological Profile for Asbestos; IRIS; OSHA 29 CFR 1926.1101	General public should not be exposed to levels suspected of adverse health effects upon long-term exposure.		

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1. General public includes adults and children not directly involved in emergency response and recovery activities. 2. Documents and information that were considered in setting the action level. 3. Background levels for NYC are being determined. 4. PCM equivalents (PCMe) is determined using TEM analysis and counting fibers $> 0.3 \mu\text{m}$ in diameter and $> 5 \mu\text{m}$ in length. PCMe should be determined using consistent methods to provide comparable concentrations. If PCM is exceeded, may need to determine PCMe using TEM. Use professional judgement to determine if PCMe is needed by evaluating the frequency and magnitude of exceedance, size of geographic area involved, and trends in data.

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Action Levels for Respirable Silica <i>General Public/Residents</i> Draft 10-18-01, 3:30 p.m.		
Action Levels: Settled dust (XRD) and respirable silica < 4 μ m (NIOSH 7500)	Steps for follow up	Comments/Notes

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<p>Settled dust > 5% crystalline silica</p> <p>Air > 50 µg/m³</p>	<ol style="list-style-type: none"> 1. Evaluate data, including trends over time 2. Evaluate need to warn sensitive groups (people with breathing problems) 3. Evaluate the need to restrict general public access 4. Identify source and take action to reduce levels below 6 µg/m³ 5. Evaluate dust loading and silica content to determine if dust clean up is needed 6. Resample after actions have been taken, or if no action, continue to monitor to confirm elevated levels 	<p>Clean up should follow OSHA standards for training and worker protection and any state laws for licensing</p> <p>Consideration should be given to removing hard to clean furnishings, like carpet and upholstery, if sampling data remains elevated after repeated cleaning</p> <p>NIOSH REL occupational standard for 8 hour TWA exposure. Should limit exposure of general public to levels above occupational standards</p>
<p>Settled dust >5% crystalline silica</p> <p>Air 6 to 49 µg/m³</p>	<ol style="list-style-type: none"> 1. Evaluate data, including trends over time 2. Evaluate need to warn sensitive group (people with breathing problems) 3. Identify source and take action to reduce levels below 6 µg/m³ 4. Evaluate dust loading and silica content to determine if dust clean up is needed 5. Resample after actions have been take, or if no action, continue to monitor to confirm elevated levels 	<p>Lower limit for air considers detection limit and 1/10 NIOSH REL</p>

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Settled dust > 5% crystalline silica Air < 6 µg/m ³	1. No restrictions on access to any area 2. Evaluate dust loading and silica content to determine if dust cleanup is warranted 3. Air monitor under high activity conditions to determine if there is a potential for elevated silica in air due to dust content	Respirable silica defined as silica less than 4 µm. Air action level set as close to 1/10 NIOSH REL as practical based on sampling methods (NIOSH 7500). Activity level, as well as dust content and loading, will influence air levels of silica. If air sampling was under aggressive conditions, this represents worse case and the area can be cleared.
Settled dust < 5% respirable silica Air < 6 µg/m ³	No further actions	Respirable silica defined as silica less than 4 µm. Air action level set as close to 1/10 NIOSH REL as practical based on sampling methods (NIOSH 7500).

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PARTICULATE MATTER
AIR QUALITY: PARTICULATE MATTER

NOTE: This document was designed to assist public health officials in communicating specific air quality issues to the general public. Additional materials (e.g., fact sheets) will be supplied for public distribution.

Air Quality:

The Environmental Assessment Workgroup, comprised of members from the Agency for Toxic Substances and Disease Registry (ATSDR), Centers for Disease Control and Prevention (CDC), Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA), is recommending that people in New York City make an effort to reduce their exposure to air contaminants due to the fires, smoke, and dust (also known as particulate matter) created by the collapse of WTC and on-going response in Lower Manhattan. It is especially important for people with heart or respiratory disease, the elderly and young children to reduce their exposure to smoke and dust since they are likely to be more sensitive to the effects of particulate matter.

Health complaints from the area have been primarily irritant and respiratory in nature (such as coughing, irritation of the eyes, nose and throat, wheezing, difficulty in breathing and shortness of breath). Airborne particulate matter known to cause these types of acute health effects include smoke, fiberglass, and inhalable dust (e.g., cement and gypsum). Certain compounds in airborne particles may be present that may result in chronic health problems, including respirable silica and asbestos. Efforts to measure air quality are focusing on all these types of airborne particles.

Particulate Matter:

The term "particulate matter" (PM) includes both solid particles and liquid droplets found in air. Many human activities and natural events emit PM directly or emit other pollutants that react in the air to form PM. These solid and liquid particles come in a wide range of size. Particles less than 10 micrometers in aerodynamic diameter tend to pose the greatest health concern because they can pass through the nose and throat and be deposited in the lungs. Particles less than 2.5 micrometers in diameter are referred to as "fine" particles. Sources of fine particles include all types of combustion (motor vehicles, power plants, fires, etc.) and some industrial processes. Particles with diameters between 2.5 and 10 micrometers are referred to as "coarse" particles. Sources of coarse particles include crushing and grinding operations, and dust from paved and unpaved roads. The particle mix in most U.S. cities is dominated by fine particles generated by combustion with smaller amounts of coarse dust. The coarse dust resulting from the collapse of World Trade Center (WTC) buildings and the removal of rubble contains particles from building materials.

In order to address public health issues associated with PM in air, some characterization of airborne particulate matter is warranted to provide additional information. The likelihood for particles to produce certain health effects is also related to particle size. Larger particles are less likely to penetrate deeply into the lungs and can

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be deposited on mucous membranes of the eyes, nose and throat as part of the body's natural defense system. Particles deposited on these surfaces can cause irritation. As particle size decreases the likelihood for them to reach more deeply into the lungs increases. Particles depositing in the lower regions of the lungs can produce both short term effects, such as coughing and longer term effects such as changes in lung function. Specific characteristics (e.g. chemical composition) of these particles can also influence the types of health effects seen following exposure.

Based upon their ability to cause adverse health effects, the EPA has set levels of concern for particulate matter, as part of EPA's Air Quality Index. Currently EPA has a set such levels for airborne particles that are 10 micrometers in diameter or smaller (PM₁₀), and for fine particles that are 2.5 micrometers or less in diameter (PM_{2.5}). It is important to note that even in environments where fine and coarse particles are below these levels of concern, some people may still experience eye, nose, and throat irritation due to the presence of other substances such as larger particles or irritating gases.

It is possible that PM from the WTC fire and collapse could have entered homes. Indoor air quality may have been affected by the WTC fire and collapse even if the windows and doors were closed since smaller particles can enter through very small openings and cracks. Additionally, settled dust can be re-suspended into the air during routine activities, and it can also be tracked inside from outdoors by people, pets, and other activities. Therefore, if dust is in the home (e.g., on the couch, floors, counter tops, etc...), people should pay particular attention to the recommendations regarding: 1) cleaning the home, 2) checking the air conditioning and heating system, and 3) ways to prevent tracking dust indoors.

Health Effects of Particulate Matter:

1. Dust and smoke may irritate healthy people's eyes, nose, throat, and lungs, and might cause more serious problems in sensitive populations. Because dust and smoke are mixtures of different chemicals with different sizes, not everyone will experience the same effects. Most healthy adults and children will recover quickly from the symptoms of short-term dust and smoke exposures and will not likely suffer long-term consequences.
2. Certain sensitive populations, listed below, are susceptible to more serious problems, including cough, phlegm, wheezing, shortness of breath, bronchitis, increased asthma attacks, and aggravation of respiratory or cardiovascular disease.
 - **Individuals with asthma and other respiratory diseases.** Levels of pollutants that might not affect healthy people might cause breathing difficulties for people with asthma or other chronic lung diseases, especially children. Individuals with emphysema and chronic bronchitis may also experience a worsening of their conditions because of exposure to dust and smoke. Studies have linked particulate matter pollution to increased risk of hospitalizations for respiratory disease, asthma attacks, and respiratory mortality.
 - **Individuals with cardiovascular disease.** People with heart disease might also experience symptoms such as shortness of breath or chest tightness. Studies have also linked particulate pollution to increased risk of hospitalizations for cardiovascular disease and heart attacks, and cardiovascular mortality.
 - **The elderly.** The elderly are more likely to have preexisting lung and heart diseases, and therefore are more susceptible to health effects from exposure to particle pollution.
 - **Children.** Healthy children are sensitive to air pollution and more susceptible to pollution than healthy adults. Studies have shown that in children, particulate pollution is associated with increased episodes of coughing and difficulty breathing, and decreased lung function.

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3. In communicating to the public about levels of concern for concentrations of particulate matter in outdoor air, EPA uses the Air Quality Index (AQI). The AQI is composed of categories that represent different levels of air quality. EPA provides recommendations to the public about steps to reduce exposure above levels of concern for sensitive groups and the general public. When values are above these levels, it is recommended that members of sensitive groups reduce their exposure. Exposure to elevated concentrations of particles for periods of time less than a day are also of potential concern for sensitive groups.
 - For fine particles (PM_{2.5}), the level of concern is 40 micrograms per cubic meter of air (µg/m³), for a 24-hour average exposure.
 - * For fine and coarse particles combined (PM₁₀), the level of concern is 150 µg/m³, for a 24-hour average exposure.

Although total suspended particulate (TSP) is not included in the Air Quality Index, New York State estimates a screening level (i.e., a level requiring further evaluation) to be 250 µg/m³, for a 24-hour average exposure.

While there are State and Federal standards for selected particles in outdoor air and workplace, there are no standards for particles in residential settings, nor do we have a good characterization of what a "background" or average concentration would be. This is because there are many human and household factors that can dramatically influence air concentrations of particles in the home. The range of activities that can introduce particles into the air (e.g. smoking, cooking with natural gas, candle and incense burning, and cleaning) coupled with a home's ventilation status (which could remove or introduce particles) will determine airborne particle concentrations in a home at a specific time.

Recommendations:

The Environmental Assessment Workgroup is providing the following recommendations to help people reduce their exposure to particulate matter and make well-informed decisions about their health.

1. People with respiratory or heart disease, the elderly and young children, should avoid prolonged exposure to dust and suspended particles.
 - When dust and smoke are present outdoors, limit time outdoors.
 - Avoid physical exertion, indoors or outdoors, when dust or smoke levels are high.
 - Consult with your physician to determine if you should be cleaning up any dust from the WTC that may have entered your home.
 - If you have symptoms of heart or lung disease, including shortness of breath, chest tightness, chest pain, palpitations or unusual fatigue, contact your physician.
 - If you have asthma, bronchitis or other lung diseases, or cardiovascular disease make sure you have adequate medication on hand. In addition, if you have asthma, follow your asthma management plan.
2. People having symptoms (including those who have not been diagnosed with respiratory or heart disease), such as shortness of breath, wheezing, difficulty taking a full breath, painful breathing or persistent cough, should contact a physician. Be aware that onset of symptoms can appear even 24 to 48 hours after exposure.
3. In the home, car and workplace, keep windows and doors closed during hazy days or if dust is on the streets or entrances and/or smoke is in the air. If you are using your air conditioner or heater use the

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recycle/recirculate mode. Inspect and change air filters and air conditioning filters as needed. When the air quality improves, you should open up and air out your homes.

4. If your home has dust or suspended particles as a result of the WTC collapse, you should consider steps to minimize your exposure. If you decide to clean the dust yourself, the following suggestions can help to reduce the opportunities for dust to re-enter the air. Additional information can be obtained from EPA's indoor air quality website at <http://www.epa.gov/iaq>.
 - * A regular vacuum cleaner will clean dusty areas, furniture, and carpeting but small particles will pass through the vacuum and re-enter the air. Alternatively, using a High Efficiency Particulate Arresting (HEPA) vacuum without a beater bar is an effective method to clean and minimize resuspension of dust.
 - * Moisten dusty and sooty, non-porous surfaces prior to wiping them. This will reduce the amount of particulate matter becoming airborne. Some porous materials may be damaged by water and may require specialized cleaning techniques. Avoid breathing the dust if any is stirred-up by wiping, and make sure surfaces are dry once the dust is removed.
 - * Clean roof-top and building air conditioning and heating systems before use and assess duct work for signs of contamination.
 - * Replace or clean dirty air conditioner filters and set air conditioners and heaters to re-circulate if indoor air is relatively dust-free.
 - * Wash plants and furnishings prior to moving them indoors.
5. In dusty areas, minimize dust entering the home by leaving shoes outside, using a door mat and wiping pets feet at the doorway.

Air Quality Index:

Health Comparison Guideline Table for Ambient PM*

24 Hour Levels ($\mu\text{g}/\text{m}^3$) PM _{2.5} **	24 Hour Levels ($\mu\text{g}/\text{m}^3$) PM ₁₀ **	Air Quality	Cautionary Statements
0-15	0-55	Good	None
>15-40	>55-155	Moderate	None

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>40-65	>155-255	Unhealthy for Sensitive Groups	People with respiratory or heart disease, the elderly, and children, should limit prolonged exertion.
>65-150	>255-355	Unhealthy Sensitive groups may experience more serious health effects.	People with respiratory or heart disease, the elderly and children, should avoid prolonged exertion; everyone else should limit prolonged exertion.
>150-250	>355-425	Very Unhealthy Everyone may experience more serious health effects.	People with respiratory or heart disease, the elderly and children, should avoid any outdoor activity; everyone else should avoid prolonged exertion.
>250	>425	Hazardous The entire population is more likely to be affected.	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly and children, should remain indoors.

* Developed from EPA's Air Quality Index: A Guide to Air Quality and Your Health, EPA-454/R-00-005, June 2000 and EPA Guideline for Reporting of Daily Air Quality - Air Quality Index (AQI), EPA-454/R-99-010, July 1999 (at: <http://www.epa.gov/airnow/publications.html>).

** These comparison levels are guidelines to make public health decisions. Detected concentrations of PM above specific guideline levels does not mean that adverse health effects will occur.

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DRAFT (October 17, 2001, 2 p.m.)		ATSDR, CDC, EPA, OSHA Environmental Assessment Workgroup	PM Action
		Levels for World Trade Center Response	
Respirable Particulate 24 hour PM _{2.5} Ambient Action Level (µg/m ³)	Thoracic Particulate 24 hour PM ₁₀ Ambient Action Level (µg/m ³)	General Public/Recommendations	Comments
0-40	0-155	• No restriction	• Air quality is good to moderate.
>40-56	>155-255	• People with respiratory or heart disease, the elderly and children, should limit prolonged exertion.	• Air quality is unhealthy for sensitive groups.
>65-150	>255-355	• People with respiratory or heart disease, the elderly and children, should avoid prolonged exertion; everyone else should limit prolonged exertion.	• Air quality is unhealthy for all persons. • Sensitive groups may experience more serious health effects.
>150-250	>355-425	• People with respiratory or heart disease, the elderly and children, should avoid any outdoor activity; everyone else should avoid prolonged exertion.	• Air quality is very unhealthy for all persons. • Everyone may experience more serious health effects.
>250	>425	• Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly and children, should remain indoors.	• Air quality is hazardous for all persons. • The entire population is more likely to be affected.
Inhalable Particulate 24 hour TSP Screening Level (µg/m ³)		General Public/Recommendations	Comments
250		• Further characterization of particulate is warranted. • Dust suppression procedures may be warranted. • Respiratory protection while in the area may be warranted.	• Based on NY State Ambient Air Quality Standard. • Screening level for the general public that requires further evaluation.

1. Developed from EPA Air Quality Index at: <http://www.epa.gov/airnow/publications.html> and the NY State at:

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pH Guidelines

The pH of a substance represents the hydrogen ion concentration of the substance. The range of pH values is generally from 0 to 14 with 7 being considered a neutral pH. Substances with a pH of less than 7 are considered to be acidic and will yield hydrogen ions when they are in solution. Acids will change litmus paper red. A base is a substance with a pH greater than 7 and will yield hydroxyl ions in solution. Bases will react with acids to form salts and water. In the body, a normal balance between acids and bases is maintained that keeps the extracellular fluids in the body with a pH between 7.35 and 7.45. A pH out of this range indicates a state of acidosis or alkalosis. Regulation of the pH in the body depends on the function of the lungs and the kidneys.

Guidelines for the interpretation of the pH values of the dust samples being proposed are included in this plan to assist in defining what role if any that the pH may be in the irritant properties of the dust. An irritant effect is one where the tissue has been stimulated and responds with a reversible inflammatory response. Common symptoms from exposure to an irritant are cough, burning of eyes, nose, & throat, tearing, dyspnea, and wheezing.

There are very few standards for the regulation of the pH of a substance. The national Secondary Drinking water standards set the pH range at 6.5 - 8.5. EPA has established guidelines for the testing of the acute dermal irritation and the acute eye irritation properties of substances. Those guidelines state that it is not necessary to test substances with a pH of less than 2.0 or greater than 11.5 as they are known to be corrosive. A corrosive is a highly reactive substance that causes irreversible damage to living tissue after less than 4 hours of exposure. Using this information as a basis, the following guide is proposed:

pH	Acid/base	Properties
0 - 2.0	Strongly acidic	Corrosive
>2.0 - 6.5	Weakly acidic	Irritant
>6.5 - 8.5	Neutral	
>8.5 - 11.5	Weakly basic	Irritant
>11.5	Strongly basic	Corrosive

To put these levels into perspective, the pH of some common substances is included below.

Substance	pH
Gastric Juice	1.4
Lemon Juice	2.4
Vinegar	3.0
Tomatoes	4.2
Rain	5.5
Blood or Tears	7.0
Household Ammonia	11.5
Household Bleach	12.5