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Center for Environmental Health in Northern Manhattan
Mailman School of Public Health, Columbia University

World Trade Center Supplement

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Progress Report October 2002

This report provides progress updates on the work being carried out as part of the supplemental funding provided by NIEHS to Columbia's Center for Environmental Health in Northern Manhattan for epidemiological and exposure assessment studies related to the World Trade Center (WTC) attacks.

Highlight

A major goal of Columbia's work related to World Trade Center exposures was to put them into context with pre 9/11 New York City air pollution levels. To do this, we have compared concentrations of a wide array of elements measured in personal total suspended particle filters collects as part of the Hopkins teamsters study to levels measured in several studies carried out pre 9/11. The pre 9//11 data included that collected in the Toxic Exposure Assessment-A Columbia Harvard Study (TEACH), the NY State Dept of Environmental conservation speciation data and the Dept of Energy Environmental Measurements Laboratory. Median concentrations for a number of elements were elevated by a factor of about 100 compared to pre 9/11 data. Calcium showed the highest elevation, >500-fold.

Data from EPA monitoring sites at ground zero indicate Pb levels in mid to late September 2001 were more than 200-fold above recent background values for NYC. These levels were similar to those measured on monthly composite total suspended particle samples collected about 1.8 km north of ground zero in the late 1960s to mid 1970s. Values observed from the end of October to February at these EPA sites were about a factor of 10 above recent NYC background levels and similar to values observed at the EML site in the early to mid-1980s. EPA perimeter sites located at positions normally upwind from ground zero (southern and western sites) had values which were only slightly elevated in Pb compared to pre-9/11 data (about 3-fold), similar to values observed at the EML site in late-1980s to mid-1990s. These data demonstrate that although Pb levels were dramatically elevated after 9/11, they were comparable to values routinely observed in NYC air when leaded gasoline was used and municipal waste was incinerated.

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Exposure Assessment

Work Proposed

For the exposure assessment portion of the supplement, the overall goals listed in our proposal were to place WTC related contaminant levels into perspective and to identify compositional tracers of WTC contaminant fluxes that can be used to identify the transport and deposition of WTC emissions. Our strong collaboration with Johns Hopkins led to us to develop the objective of building a database of both pre and post September 11 contaminant levels in NYC so as to provide the largely missing perspective of whether certain contaminants were elevated above levels observed prior to the WTC attacks. Although EPA has taken on the creation of a WTC database, we understood that their efforts would probably be limited to post September 11 data. Furthermore, it was not clear who would have access and what data would be included. Given our additional goal of bringing together the pre- and post-September 11 data and our commitment to make a database available to all, we believed that there was substantial cause for proposing the creation of what we call the WTC-ITEA (World Trade Center Inter-agency Total Exposure Assessment) database. The creation of a database of NYC air quality data fits into the overarching theme of this administrative supplement, which is to place WTC related exposures into perspective.

Very little to no data prior to September 11 exists for certain WTC related contaminants such as brominated diphenyl ethers (BDPE) and brominated dioxins/furans. Thus, we proposed two approaches for obtaining base line levels. First, we proposed to return to lower Manhattan in May of 2002 with our Johns Hopkins collaborators to do additional air sampling and analysis as a proxy for pre-September 11 or base line data. Second, we proposed to collect and analyze sediment cores that would both integrate and archive atmospheric depositional inputs to NY Harbor, central Brooklyn and mid-Manhattan.

Progress on exposure assessment investigations

Since our last progress report, field work that has been carried out includes collecting additional airborne samples (area samples) at ground zero and personal samples from the truck drivers in April 2002 as part of the Teamsters study with Johns Hopkins and collection of sediment cores at Central Park Lake (with Richard Bopp from the Mt Sinai Superfund Basic Research Program).

Two additional staff members have recently been hired, including a programmer to work on the database under Diane Levy's supervision and a post-doc to work at LDEO under Dr. Chillrud's supervision.

Data interpretation has primarily focused on putting elemental composition of airborne particulate matter measured at or near ground zero into context by comparison to pre-September 11th data sets generated at LDEO or at government agencies. The data sets used are listed in Table 1 while the sample site locations are shown in Figure 1. Both highlight that there are differences between the various data sets (e.g., site locations, integration times, size fraction)

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which potentially make comparisons between them less than ideal. However, several lines of evidence suggest that these comparisons are useful and that general conclusions drawn from them are valid.

Table 1: Data sets used for comparisons. TEACH (Toxic Exposure Assessment- A Columbia Harvard) Study. DOE EML = Dept of Energy's Environmental Measurements Laboratory.

Sample Set	Source	Size Fraction	Integration Time	When Collected
Pre-9/11				
TEACH	Unpublished	PM2.5	48 hr	Summer and winter 1999
NYS Speciation	NYS DEC	PM2.5	24 hr	2000 - 2002
DOE EML	EML/unpublished	TSP	7 day	1960s to 2001
Post-9/11				
EPA web site	EPA	PM2.5	24 hr	various post 9/11
WTC Teamsters	Unpublished	TSP, PM10, PM2.5	12 hr (N&D)	October 2001 & April 2002

In this progress report, we do not go into the details supporting this last claim other than to point out that while the differences that exist between studies, such as location or sample methods, potentially introduce relatively small uncertainties into the comparisons (probably much less than a factor of 2), the observed differences in levels between the pre and post data sets are large. For example, the median concentrations measured for a wide array of the elements measured in personal Total Suspended Particle (TSP) filters were elevated by a factor of about 100 above pre-September 11th "background NYC" levels (based on the median of ambient levels measured on PM2.5 samples collected outside of the homes of subjects from the TEACH study). Calcium showed the highest elevation relative to recent NYC background levels (>500x). A small number of elements including some associated with fuel oil/diesel emissions (e.g., V, La, etc) were the least elevated above "recent NYC background" (3-8x). The comparisons between these two data sets are probably the most reasonable to make since the analytical methods and personnel who made the measurements were identical.

Table 2: Results of factor analysis by SAS statistical package including six principal components with a varimax rotation; elements listed have values above 0.5. The italicized text shows the preliminary interpretation of the source associated with each factor.

Factor 1: Fe, Mn, Cr, Mo, Ni, Co, As, Cu *Interpretation: Largely elements associated with steel*
Factor 2: Pb, Tl, Cs, Cd, Zn, Sn, Sb, Ca, S *Interpretation: elements associated with WTC emissions (incineration/vaporization of building contents)*
Factor 3: Be, Mg, Ti, Al, Sc, K, Na, La *Interpretation: Largely crustal elements*
Factor 4: V, Pt, (La, Se) *Interpretation: Largely related to fuel combustion*

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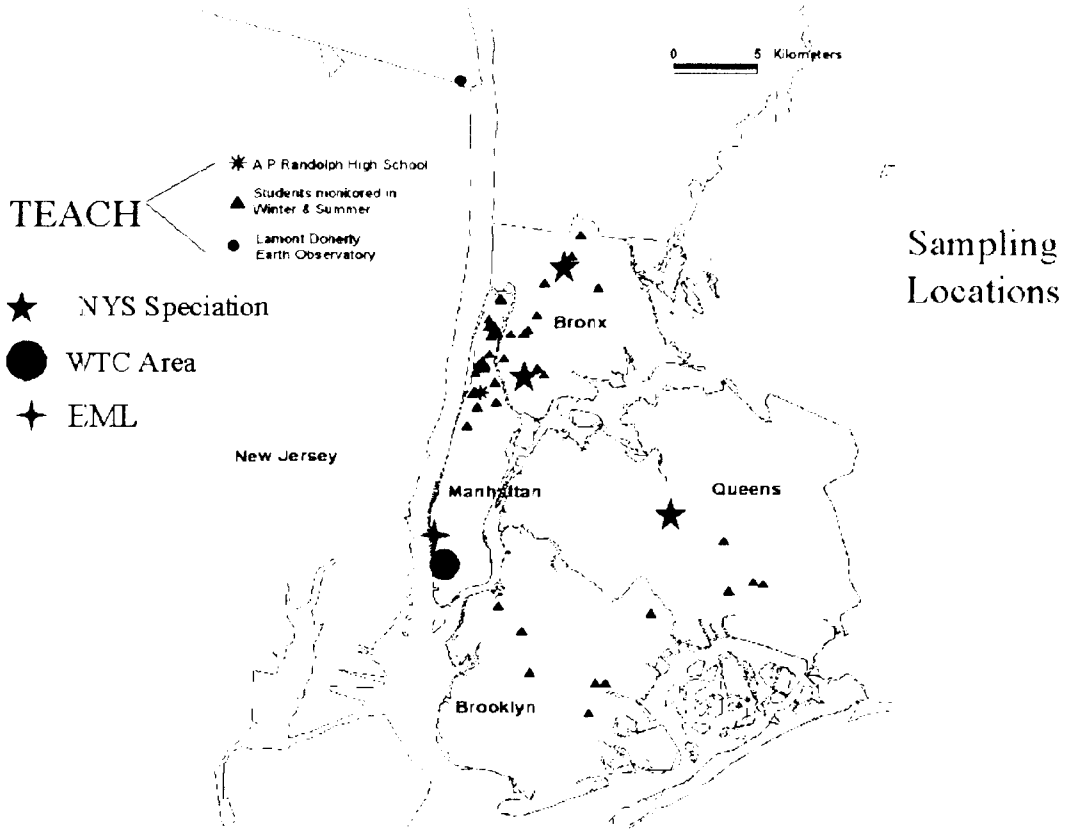
Factor 5: Ag: Unknown???
Factor 6: (Ca and S): *Interpretation: Concrete and Gypsum*

Figure 1: Sampling locations of pre-9/11 data sets in relation to the WTC area.



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The results and preliminary interpretation from a factor analysis of particle associated elements made on personal and area samples collected in October 2001 as part of the Teamsters study are shown in Table 2. The concentrations used for the analysis were not the volume normalized concentrations but rather the particulate-mass normalized concentrations (mass of element per unit mass of suspended particulate matter). The interpretations of the first three factors are consistent with steel, combustion/incineration/vaporization of an occupied building, and crustal material. Two of the other factors may be consistent with emissions from the combustion of fuel sources on site (diesel engines, generators etc) and the predominance of Ca and S sources (concrete and gypsum board) within the buildings.

Figure 2 shows lead data from EPA monitoring sites at ground zero or at the downwind perimeter sites (i.e., sites along the northern and eastern perimeter). Pb levels in mid to late September 2001 were more than a factor of 200 above recent background values for NYC. These levels were similar to those measured on monthly composite TSP samples collected on the rooftop of the Environmental Measurements Lab (EML) about 1.8 km north of ground zero in the late 1960s to mid-1970s. Values observed from the end of October to February at these EPA sites were about a factor of 10 above recent NYC background levels and similar to values observed at the EML site in the early to mid-1980s. EPA perimeter sites located at positions normally upwind from ground zero (southern and western sites, figure not shown) had values which were only slightly elevated in Pb compared to pre-9/11 data (about 3-fold), similar to values observed at the EML site in late-1980s to mid-1990s.

Although the composition and elemental ratios are potentially useful for tracing the transport of WTC emissions off site, the absolute levels measured at ground zero or in its close proximity are only relevant to the exposures of the individuals who spent time at ground zero (e.g., rescue and clean up workers at the site). However, these absolute values and their comparisons to pre-Sept. 11 values are potentially very misleading to people who worked or lived even a few blocks away in the surrounding community. Recognizing this, Dr. Chillrud recently reached out to Dr. Alan Vette at US EPA (Reston) and Dr. Lung Chi Chen of NYU about the idea of publishing a set of companion papers together in a single journal. Both of these individuals work with groups that had monitoring sites about 5 blocks away from ground zero, typically in downwind directions, and both groups have also measured a large suite of particle associated elements from samples collected at their sites. Whereas the compositions at these other two sites were very similar to what was observed at ground zero, the absolute concentrations were substantially lower. Publishing all of our results as a set of companion papers would allow readers to put each individual study into better context. The idea was enthusiastically discussed at the recent AAAR meeting in Charlotte NC, and it is our current plan to do so.

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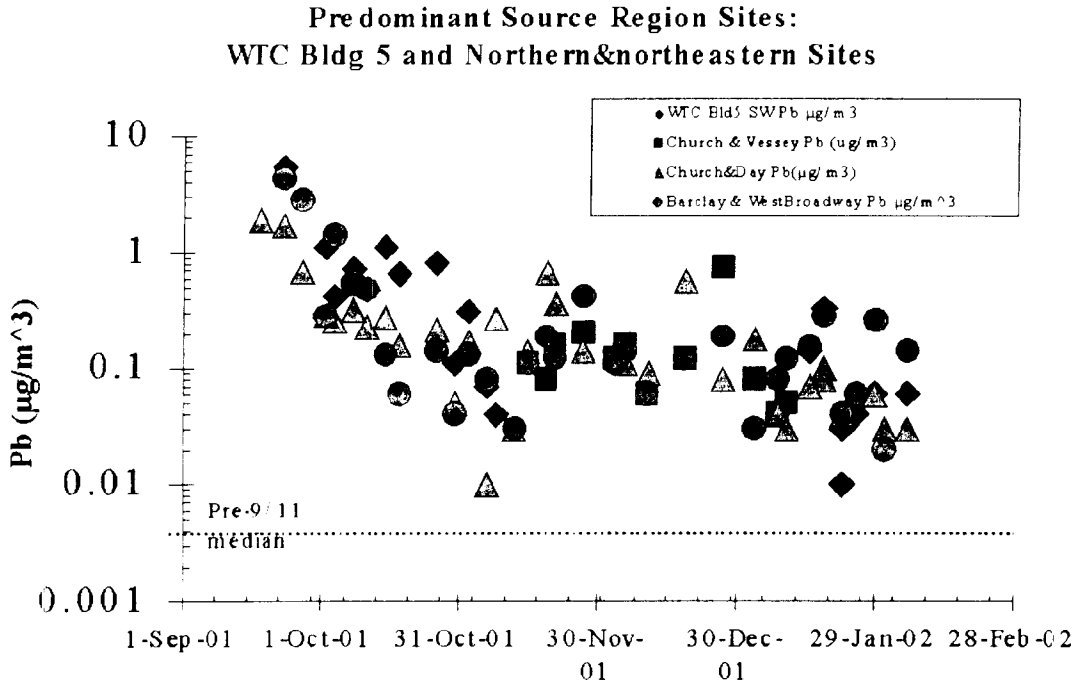

Figure 2: Temporal trends in lead concentration measured at EPA monitoring sites which were often downwind of ground zero emissions (sites to the north and east). The red dashed line is the median Pb level for ambient samples collected in recent pre-9/11 studies (6 ng/m^3).

Other Collaborative Interactions

Formal active collaborations supported by supplemental NIEHS funding include collaborations with:

1) Alison Geyh at Johns Hopkins (both on the exposure assessment of Teamsters at WTC and development of a database of agency data of pre and post 9/11 ambient data)
2) Lung Chi Chen at NYU (analysis of samples by SEM/EDX and ICP-MS). This interaction has included providing advice to NYU investigators on some of their other projects.
3) Phil Landrigan at Mt. Sinai (Basic science project assessing whether remote sensing data (primarily NASA's Airborne Visible Infrared Imaging Spectrometer (AVIRIS)) can be used to determine fine scale spatial extent and structure of the plume in lower Manhattan on September 16, 18 and 23). Investigators at Columbia University on this project include Steven Chillrud, Christopher Small, Mark Becker and Patrick Kinney.

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Additional interactions include

a) providing advice and data to the pregnancy studies run by the Childrens' Centers at Mt Sinai and Columbia University,
b) working with Bob Leifer at Dept of Energy's Environmental Measurements Laboratory with the idea that we will analyze a subset of the pre and post 9/11 high volume filters collected on the rooftop of EML building in lower Manhattan,
c) working with Richard Bopp located at RPI and an active member of Mt. Sinai's Superfund Basic Research Program on collecting sediment samples from Central Park Lake and NY Harbor to look at transport and deposition of WTC emissions to these sites,
d) providing advice to the EPA on their Indoor Air program (sampling and analysis) at a meeting at 290 Broadway (attended by Drs. Kinney, Hazi and Chillrud.

Additional fieldwork still planned:

Collection of a limited number of air filters at ground zero as a proxy of pre-Sept 11 data and collection of additional sediment cores at Prospect Park Lake and NY Harbor.

Database Development

Our goal is to create a database containing pre and post 9/11 ambient air quality data. After obtaining the data, performing systems analysis to thoroughly understand the data, and then loading them into a database, our plan is to create a front-end application (web) to allow users to query the database. In addition, the NIEHS has asked Columbia University to coordinate the database requirements for all the NIEHS centers that received grants to perform research associated with the WTC disaster.

We have hired a full time programmer (Elise Chettiar) to work on the World Trade Center project. For the pre 9/11 data, we have obtained two flat file datasets containing all ambient air monitor readings from all monitors in NYC and New Jersey for the past 30 years (The AIRS database). Data collected during the 1970's through the end of 1999 were stored in the EPA's original mainframe system. Data collected after 1/1/2000 were stored in an Oracle database. We have had meetings with EPA to review the structure of the data from the original mainframe system. The meeting enabled us to begin to write a technical specification for a Microsoft SQL Server database. We are currently loading data into temporary tables to determine the completeness of the data. Supporting files from the EPA website do not appear to be 100% inclusive of supporting data for all of the readings we have obtained. (e.g., measurement methods used in the late 70's are not included in the methods reference table downloaded from the web site.) We are currently searching through supplementary code books to determine if the full set of supporting data are included. Steven Chillrud and Alison Geyh are meeting with Elsie Chettiar and Diane Levy to review the preliminary technical specification for the pre 9/11 data. Once there is agreement on the specifications, Elsie will create the database, process the data, and load the tables. (Data was received in flat files containing up to 8 hourly readings per record. We will parse the data so that one record represents one reading.) We will perform extensive testing to validate that the parsing program, as well as the programs used to load the data, performed correctly. After testing has been completed, we plan to release datasets to other NIEHS centers

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that require these data in order to proceed with their projects.

We have also received the speciation data via the NYS DEC web site for the elemental composition of PM2.5 samples collected between the Year 2000 and March 2002 for 3 locations in Northern NYC (2 in the Bronx and 1 in Queens). We are in the process of following many of the steps outlined above to process, load and test this dataset

For the post 9/11 data, we are still in discussions with EPA with regard to obtaining the Oracle database that includes all air quality monitoring data collected at the disaster site by a range of agencies, and was originally intended for use by the agencies only. EPA has indicated that they plan to make the database more widely available, but have not indicated when this might happen. To date, requests for access to the post 9/11 data have not been approved. Accordingly, we have submitted a FOIA request to EPA for electronic versions of the data. We have not received notification about when we will receive those data.

After we receive the post 9/11 data, we will follow many of the steps outlined above to process, load and test the data. Many groups have mentioned that pulling together the metrological data would be very useful. Alan Huber at US EPA is in the process of doing the quality assurance checks on the vertically stratified measurements that he made. He has also obtained the Bureau of Land Management data (surface wind speeds and directions) that were installed and is willing to discuss ways in which we could collaborate. Then there is always the met data from Central Park and the regional airports.

For the Web based front-end, our current plan is to design, program and test a system that will allow users to query the data amassed in the Microsoft SQL Server database.

In terms of the coordination effort for NIEHS, we have received responses from Mount Sinai School of Medicine, University of North Carolina, and New York University Medical Center concerning moving forward towards a cooperative effort in collecting data and creating a database. A separate progress report was submitted to Allen Dearry and Claudia Thompson detailing this effort.

Columbia Center for Children's Environmental Health WTC Pregnancy Study. Frederica Perera, DrPH, Principal Investigator, Sally Ann Lederman, Ph.D. Project Leader

The Columbia Center for Children's Environmental Health (CCCEH) is jointly funded by the National Institute of Environmental Health Sciences and the Environmental Protection Agency. In the wake of the WTC disaster on 9/11/01, CCCEH received funding from the New York Community Trust and the New York Times Company Foundation to study the effects of exposure to the dust and fumes resulting from the WTC collapses and fires on pregnant women and their offspring.

The resulting project, the WTC Pregnancy Study, enrolled more than 360 women over the course of nearly 7 months when they appeared for delivery at one of 4 delivery sites in lower Manhattan, Beth Israel Medical Center, St. Vincent's Medical Center, Elizabeth Seton Childbearing Center, or NYU Downtown Hospital. Enrolled women were interviewed to assess eligibility, exposure experience and an array of potentially confounding factors and provided

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blood and urine samples after delivery. Fetal cord blood was obtained at the time of delivery and a newborn meconium sample was collected after delivery.

The WTC Pregnancy Study was designed to follow the infants' development after birth by assessing health and development in the first postpartum year, although funding was only committed for the delivery period. Foundation support is currently pending for the assessment of child development at one year of age. We received $50,000 to fund the work needed after enrollment was completed, during the children's first postpartum year. With these funds we have done the following:

- Developed an infant feeding questionnaire to
  (1) determine the mother's history of breastfeeding with all children each mother has had, to allow study of possible relationships between prior breastfeeding duration and intensity and the mother's body burden of toxicants, as determined by measurement in blood and urine.
  (2) determine the proportion breast milk and formula fed to the WTC child, to assess the role of breast milk in mitigating adverse developmental effects of other exposures or in increasing the magnitude of the child's exposure to maternal fat-soluble toxicants.

- Developed a questionnaire to record hospitalizations of the WTC child during the first six months of life and determine the underlying cause of the hospital admissions.

- Initiated a 6-month phone interview protocol. Each mother is contacted by phone when her child is 6 months of age. Women are interviewed in detail about their prior breast- and bottle-feeding of all infants, including the WTC Study child, and are also interviewed about any hospitalizations of the WTC Study child during the first six months of life. Through to the end of September 2002, 141 children enrolled in the WTC cohort will have reached 6 months of age. By September 23, 111 mothers (79%) had completed the 6-month interview, 12 of them in Chinese. Twenty-four interviews were pending (12 in Chinese) and 6 of the 141 mother/infant pairs (4%) seem to have been lost to follow-up. Most of the pending interviews will be completed by the end of September. During the phone interview, information is up-dated to allow us to reach the woman when the child is one year old to arrange for developmental assessment, if the woman agrees to continue participation.

- Completed delivery log book abstractions at the participating delivery sites. We had been abstracting information from the delivery log book records of the participating sites, to allow us to compare our study participants to the total pool of women delivering concurrently at the hospital sites of enrollment. The log book abstractions were completed in part with the support from NIEHS.

- Started preliminary analyses of the WTC Pregnancy Study data. Grant funds from NIEHS have enabled us to provide staff support to the Data Core to speed data entry and cleaning to accelerate analysis and publication of the findings.

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- Assisted the Data Core in formatting WTC participant addresses (work and residence locations) for use in a GIS (Geographical Information System) computer program so that we can determine proximity of each participant to the WTC site in the month following 9-11-01.

In the coming months, we expect to complete the 6 month interviews with all remaining subjects as their child reaches 6 months of age and begin staff training for administration of the Denver Developmental Test to be performed when the children reach 1 year of age. The first WTC child will reach this age in the middle of December.

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