Particulate Monitoring and Control in Lower Manhattan During Large Urban Redevelopment

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ABSTRACT

The Lower Manhattan Construction Command Center (LMCCC) is a relatively new State and City agency with a leading role in coordinating the redevelopment of the World Trade Center site and the rest of Lower Manhattan. This presentation focuses on LMCCCs environmental enforcement efforts, particularly ambient air monitoring and control of particulate matter. This program may be a model for future pollutant control efforts in urban and non-attainment areas.

The redevelopment includes $20+ billion of construction within a 3.74-square kilometer area south of Canal Street during a 5-year period from 2006 through 2010. The Master Plan is intended to transform this largely business-oriented location into a mixed-use residential, business and tourist area. The LMCCC has been tasked to achieve environmental performance commitments (EPCs), primarily concerning dust, noise, vibration and traffic.

The EPCs were partly based on EPA experiences during the Central Artery Tunnel Project (a.k.a. the Big Dig) in Boston. Findings in particulate matter (PM) toxicology over recent years and concern over dust from the collapse of the World Trade Centers also influenced EPC development.

LMCCC established a neighborhood-scale air quality monitoring program (AQMP) with four stations, each with PM_{10} and $PM_{2.5}$ monitors and meteorology sensors. The stations send near real-time data to a restricted-access website to help assess if elevated PM concentrations are from construction activities versus other sources, such as rush-hour traffic. The website database generates automated e-mail notifications of alarm conditions. Personnel then perform fence line monitoring at construction sites upwind of monitoring stations that experience alarms.

This rapid awareness of neighborhood environmental conditions aids enforcement of regulations, such as anti-idling laws and visible dust emissions. Additional measures to

control PM include diesel particulate filters (DPFs) and Ultra-Low Sulfur Fuels (ULSF) for construction equipment. These control technologies are expected to see increased usage, especially in locations with non-attainment status for $PM_{2.5}$.

INTRODUCTION

The Lower Manhattan Construction Command Center (LMCCC) is a State and City agency created by the New York State Governor's office and New York City Mayor's office as a result of recommendations from federal government agencies, including the US Environmental Protection Agency (EPA) and Federal Transportation Authority (FTA), based on experiences during the Central Artery Tunnel Project in Boston, MA. Environmental Performance Commitments (EPCs) were issued by FTA with specific objectives for the LMCCC and other stakeholders in the Lower Manhattan redevelopment master plan.

Monitoring and control of particulate matter is one of the key concerns in the EPCs for Lower Manhattan. The EPCs stipulate the installation of a particulate monitoring system that includes continuous real-time monitoring from fixed stations that are consistent with ambient air monitoring for particulate matter conducted under the National Ambient Air Quality Act. The rationale and design criteria for the monitoring and information dissemination program are explained in EPA document EPA/625/R-02/012, dated November 2002, "Planning and Implementing a Real-time Air Pollution Monitoring and Outreach Program for Your Community: The AirBeat Project of Roxbury, Massachusetts." While this document was developed for the Central Artery Tunnel Project, it served as a model for the Lower Manhattan project with regard to monitoring, data management, public outreach and program management.

The monitoring phase included development of a Monitoring and Quality Assurance/Quality Control Plan, equipment installation, operation and maintenance. Data Management entailed substantial software development to: automate data collection, data validations, report graphics, and transfer of data to the systems intended for public dissemination.

Project management under AirBeat was handled by the Suffolk County Conservation District (SCCD), a body of elected individuals who volunteered their time to the agency, and an independent firm hired to manage day-to-day operations of the project. Management duties included project coordination, scheduling and facilitating meetings of the AirBeat team, and partnership building. The management team also helped select subcontractors, wrote reports, and managed the budget.

The monitoring and outreach program implemented by LMCCC for the Lower Manhattan renewal program included provisions for the same components as did the AirBeat program for the Central Artery Tunnel Project in Boston, MA: monitoring, data management, public outreach and program management The most significant changes started with enhancements of enforcement efforts to the program management that impacted other areas of the project.

The EPCs tasked LMCCC with assuring use of dust control measures such as tracking pads, and water mists. LMCCC also guided contractors through provisions for diesel particulate filters (DPFs) and Ultra Low Sulfur Fuel (ULSF). In essence, these changes resulted in increased emphasis on enforcement efforts focused toward individual contractors.

LMCCC pursued these objectives with the addition of mobile monitoring at construction sites for compliance and coordination meetings with contractors to ensure they are aware of mandatory and recommended practices. LMCCC further enhanced the program with routine fenceline monitoring for dust. The mobile monitoring effort included visual, olfactory, and the collection of data with handheld monitors.

This paper looks at the LMCCC monitoring and outreach program with emphasis on enhancements to the AirBeat program at the Central Artery Tunnel Project and how these changes affected the various program components.

MONITORING

Fixed Stations

LMCCC installed four fixed monitoring stations in the 3.74-square kilometer area south of Canal Street. Each station had equipment for continuous measurement of PM_{10}, $PM_{2.5}$, wind speed, wind direction, temperature and barometric pressure. Title 40 of the Codified Federal Register, Part 58 "Ambient Air Quality Surveillance," Appendix E, "Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring" distinguishes micro-scale, middle-scale, neighborhood-scale, urban-scale and region-scale monitoring networks according to characteristics. The foremost distinguishing characteristic is typically the size of the Air Quality Monitoring Area (AQMA) and the distances between monitoring stations. Specific conditions and objectives help guide the planners on the number and preferred locations of monitoring equipment.

When evaluating specific locations, considerations include height from ground level, spacing from roads, obstructions, airflow restrictions, and street canyon or building effects. Stationary source emissions must be evaluated for various scale influences. Restaurant exhausts, bus stations, boilers and other potential sources may impact local influence and power plants, large boiler plants and other permitted discharges may impact conditions on large-scale consideration. Program objectives help determine the appropriate scale and considerations in preferential sites. Figure 1 shows the locations of nearby potential sources including stationary sources and locations known for traffic congestion.

Figure 1: Location of fixed monitoring stations

Four monitoring stations were installed in Lower Manhattan in addition to one location that was already present within this AQMA and operating under the New York State Air Monitoring Program. The stations were arranged roughly in quadrants of the Lower Manhattan. The monitoring stations were intended to surround the former Deutsche Bank Building at 130 Liberty Avenue, which was heavily damaged during the collapse of the World Trade Center buildings on September 11, 2001. The environmental remediation and deconstruction of this building was a central concern for potentially elevated particulate concentrations.

Project personnel found difficulties in finding suitable locations within an area of highly limited public spaces and tall buildings in close proximity. Two of the stations were sited on the roofs of public schools. One station was sited on the deck roof above a parking garage and the fourth location was sited on a semi-public plaza alongside a skyscraper. This provided a range of elevations from street level and distances from nearby roadways consistent with neighborhood-scale monitoring networks as described in 40 CFR 58.

The particulate monitors selected for the project were Thermal Environmental Instruments (TEI) Tapered Element Oscillating Microbalance (TEOM®) units, Model

1400ab, outfitted for PM_{10} and $PM_{2.5}$ sized particles. The units were housed in Ekto brand environmental enclosures specifically designed for the TEOM® instruments. Figure 2 shows a $PM_{2.5}$ monitor operated by the New York State Department of Environmental Conservation (NYSDEC) situated on a Lower Manhattan rooftop.

Figure 2: PM measurement device on Lower Manhattan roof

LMCCC completed three months of background monitoring prior to the start of construction on December 1, 2005. Data collected during this period was used to establish normal background conditions with consideration of long-term trends and seasonal variations that was ascertained with summaries and data collected by the NYSDEC as part of the National Ambient Air Quality Act State Implementation Plan (SIPs).

The TEOMs® can be configured to collect particulate concentrations over preset time periods. Generally, TEOMs® used to monitor particulate concentrations under the National Ambient Air Quality Act programs are configured to collect readings every 30 minutes. Since the LMCCC focuses more emphasis on enforcement of prevention of off-site releases from construction sites and other potential construction-related sources (e.g. idling trucks), LMCCC configured the TEOMs® to collect and transmit data in 5-minute intervals. This was deemed appropriate for near-real-time conditions while not subjecting data analysis to intervals prone to wide variations (i.e. 1-minute data points). Data is collected to record 30-minute, 1-hour, and 24-hour time-weighted averages in addition to the 5-minute averages.

Mobile Monitoring

Fenceline measurements were collected with a handheld MIE personal DataRAM™ (pDR) 1000, manufactured by TEI, at construction sites with potential for release of particulate matter, such as sites with active earthwork. Fenceline monitoring was also completed at sites upwind of locations that sustained elevated readings. Since alarms for elevated concentrations are automated, personnel typically received information of elevated concentrations within minutes of, or during, the incident. This permitted prompt review of potential sources and a rapid determination of occasions when construction activities were suspected to have contributed to the elevated readings.

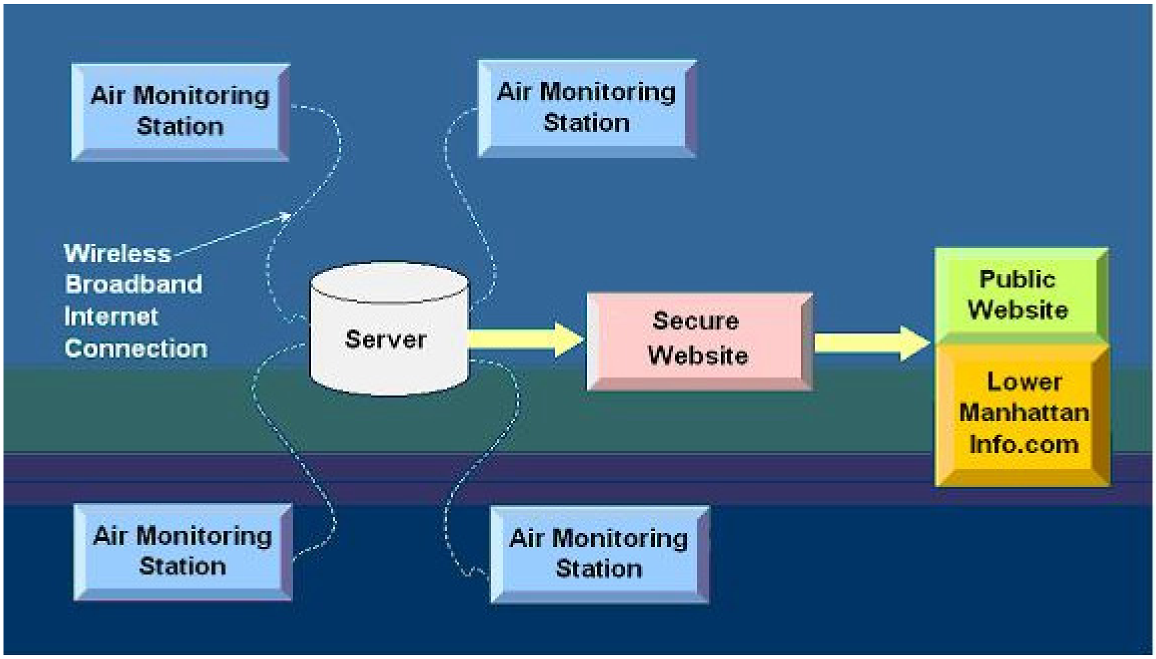
Following a visual assessment of construction activities and the potential for off-site migration of particulate matter, personnel typically collected real-time measurements with a handheld particulate monitor. Typical neighborhood particulate concentrations, recorded at street level in this manner, have been 15 – 90 micrograms per cubic meter ($\mu g/m^3$).

LMCCC communicates regularly with contractors at scheduled meetings, and as circumstances warrant. Situations where personnel observed apparent violations of dust control requirements, such as anti-idling regulations, use of tracking pads, or lack of dust suppression water sprays would be discussed as well as monitoring results. Situations where the particulate concentrations downwind of a construction site were more than 100 ug/m3 above the upwind level resulted in prompt on-site meetings with contractors to discuss the findings, recommendations, and requirements.

DATA MANAGEMENT

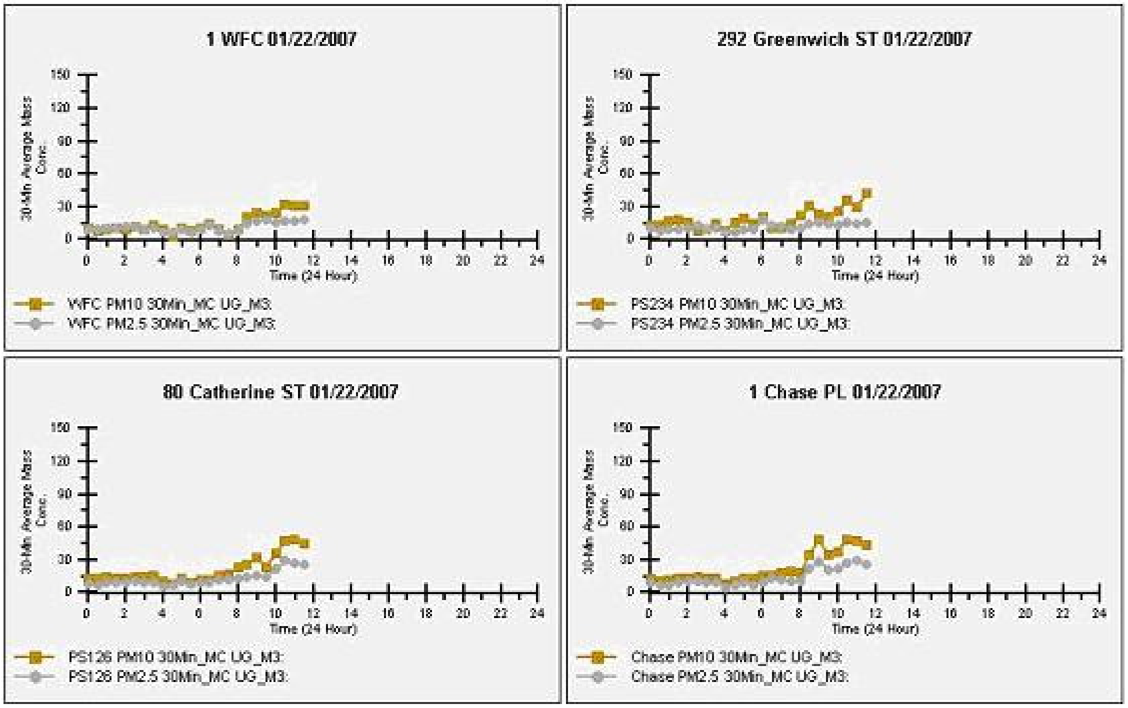
Data is transmitted from the fixed stations and from mobile monitoring equipment to a central server where it is entered into a database constructed for this project, as shown in Figure 3. The database provides data and related information to a secured website where project personnel can review real time and historic conditions. This permits review of data relevant to the potential for construction activities to impact concentrations of airborne particulates, especially in the event of a high-level alarm.

Figure 3: Schematic diagram of data flow



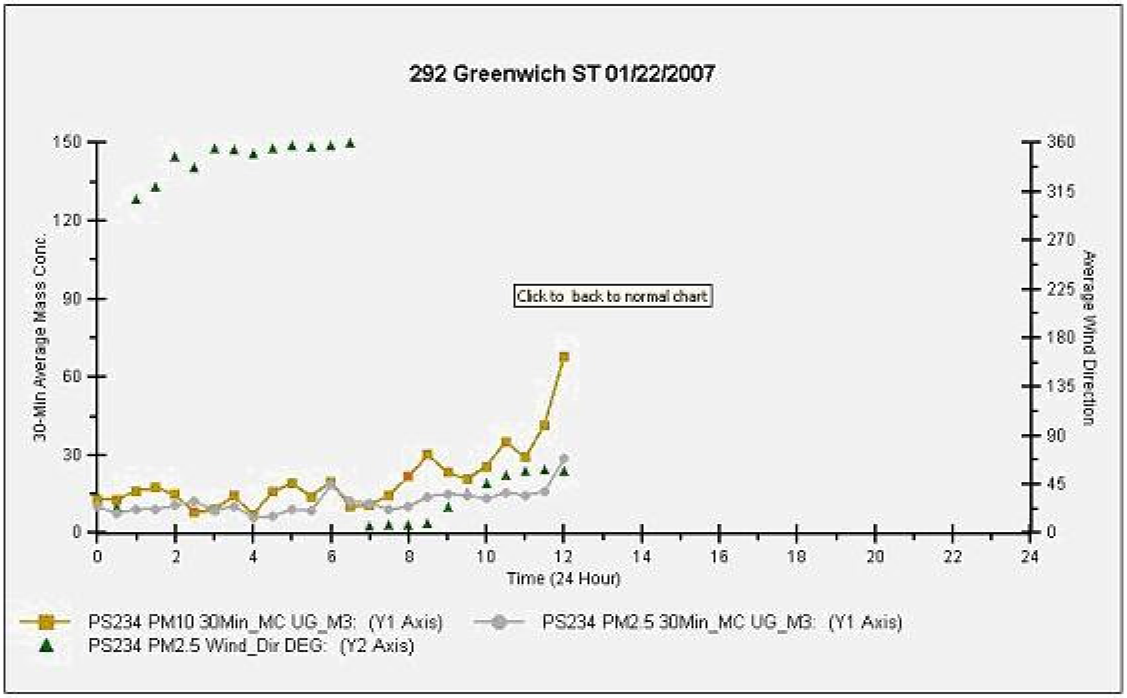
The program provides enforcement agents with an initial notification that particulate concentrations exceeded background conditions at specific locations within 5-minutes of detection at stationary monitoring locations. Evaluation of the data and local conditions (e.g. traffic congestion, wind direction, wind speed) are used to determine if local construction activities are potentially causing the elevated concentrations. This can be completed in minutes. Figures 4, 5, and 6 show successive page levels of the secured website intended to provide personnel with information to make this assessment. The first of the successive screens shows the website user data from the four stations. Figure 4 shows the screen at noon on a given day.

Figure 4: Example of page level 2 from secured website



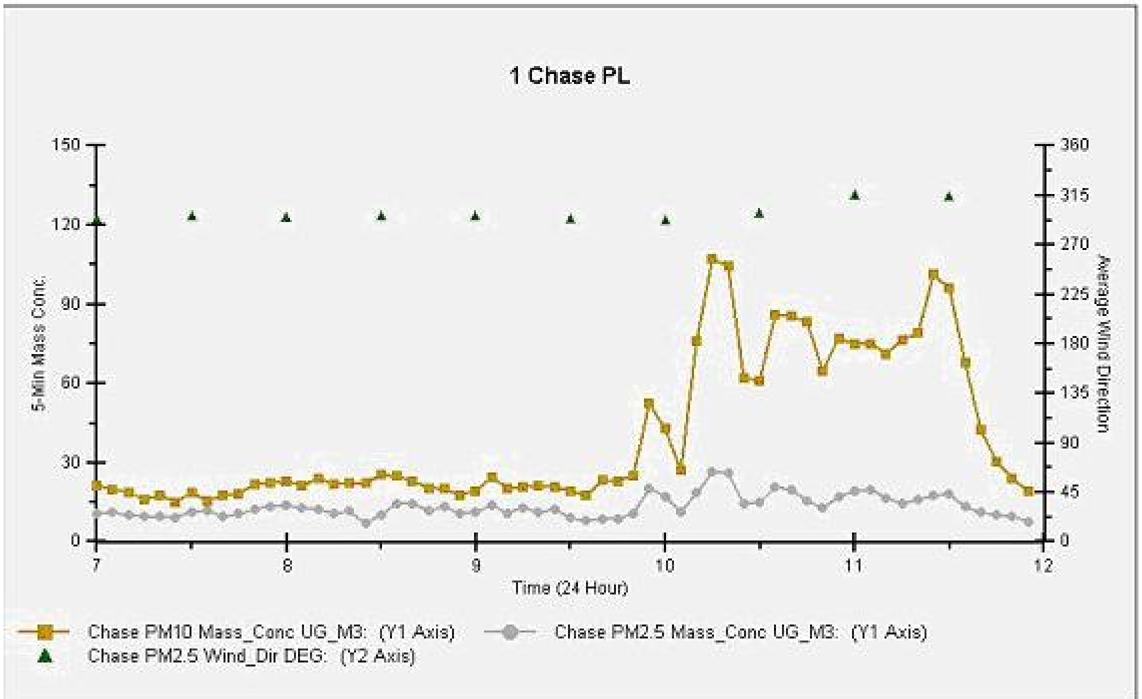
By clicking on any of the individual screens, the website user will see an enlargement of the data from one of the stations with the wind direction on the Y2 axis. Figure 5 shows the detailed data for the same time period at one of the four stations.

Figure 5: Example of page level 3 from secured website



Personnel can view data for 5-minute averages instead of the 30-minute data points seen in Figures 4 and 5 by selecting the detail report tab on the website keys. Figure 6 shows the 5-min data on particulate concentrations from 7:00 am until noon at one of the four stations. The 5-minute data was taken from one of the four stations on a different day where there had been a sharp increase of PM_{10} concentrations that were not accompanied by a change in $PM_{2.5}$ concentrations or wind direction. These conditions lead personnel to believe dust from construction sites is a likely cause of the PM_{10} increase and that site conditions should be tracked during the afternoon and a site visit may be warranted.

Figure 6: Example of page level 4 from secured website



Data from the TEOM® monitoring of PM_{10} and $PM_{2.5}$ concentrations, coupled with monitoring of meteorological conditions, was fed to a centralized database through internet connections from the equipment data loggers to the central computer server as seen in Figure 3. The Environmental Management Information System (EMIS) consists of user-friendly, browser-based applications that provide meaningful data presentation and issues automated alarms to selected email addresses and telephones. Web access to the database is protected by a password and by firewall security on the server, limiting access to authorized personnel, such as local enforcement authorities.

LMCCC agents are notified within a timeframe that allows prompt on-site evaluations. In some instances, elevated concentrations were found to be the result of construction activities, including idling trucks, despite anti-idling regulations. Other causes included lack of dust suppression, absence of tracking pads, and lack of tire washing. Prompt attention of enforcement agents to sites with active emission sources appeared to have encouraged better adherence to dust and emission control regulations.

The database compares time-weighted readings to background conditions and triggers an alarm when conditions exceed background concentrations. Program scientists evaluate alarm conditions to determine if the source(s) likely include construction activities or diesel exhaust from equipment. If site observations identify construction activities as the source of alarm-level conditions, the Environmental Management Department of the LMCCC can then notify personnel responsible for enforcement with near real-time speed.

The user is also able to identify the upwind direction and wind speed to assess where the particulate matter appears to be originating. A Background-Baseline Report prepared during the ‘pre-construction’ monitoring period showed the locations of frequent traffic congestion hot spots and other potential sources such as permitted emission sources.

The EMIS was also designed to allow the user to review data for various time-weighting periods. For instance, the user might first look at data collected over 30-minute increments, find one time period with elevated concentrations, and then observe 5-minute averages during that time period. The user is also able to compare long-term data records such as daily, weekly, or monthly averages.

Data collected during the pre-construction monitoring period was used to establish normal background concentrations. The EMIS compares data for various time periods (e.g. 5-minute, 1-hour, 24-hour, or weekly) and compares it to predefined limits of what is considered normal background. Elevated concentrations trigger a condition yellow notification that specifies the location and time period when the exceedance occurred.

Data Collection and Validation

Transmitted data included monitoring measurements, such as particulate concentrations, wind speed and direction; as well as operating characteristics such as flows and instrument temperatures. Operating characteristics were transmitted less frequently than monitoring measurements, with some characteristics transmitted once per day and some were transmitted hourly.

The Data Validation process was intended to help determine whether the data collected is representative of the area of interest and not the product of anomalous events, such as equipment malfunction or an unusually high release of particulate matter in the immediate vicinity of the air monitoring equipment. The process included removing the outliers in the data sets on the low and high ends and reviewing sensor measurements and operating conditions to provide initial verification. Data may be quarantined for review prior to inclusion or exclusion from summarized values.

EMIS was used to provide preliminary review of raw meteorological data (wind speed, direction, barometric pressure and temperature). Outlier data, such as repeated same values for wind speed or wind direction indicative of a sensor problem, were flagged and the EMIS provided automated notification of the conditions. Personnel would review flagged data and quickly identify malfunctions. The wind speed and wind direction values were compared between all four sites for reasonableness taking into consideration localized site effects, such as prevailing wind directions and street canyon effects.

DATA ARCHIVING AND RETRIVAL

A procedure for routine automated transaction log and complete database backups, including online and offline storage of backup files, was put in place to allow restoration of the database to within 15 minutes of a system failure, minimizing the potential for data loss.

Raw data were archived to a CD as backup files for storage every 6-months. If the project team determined during the course of the project that some project data could be removed, either to improve system performance or for any other reason, a full archive would be made before data were removed from the database. The archive was stored in the project files with appropriate documentation to indicate the purpose of the archive. Validated data were saved in the project file every week. The database was archived to CD every 6-months.

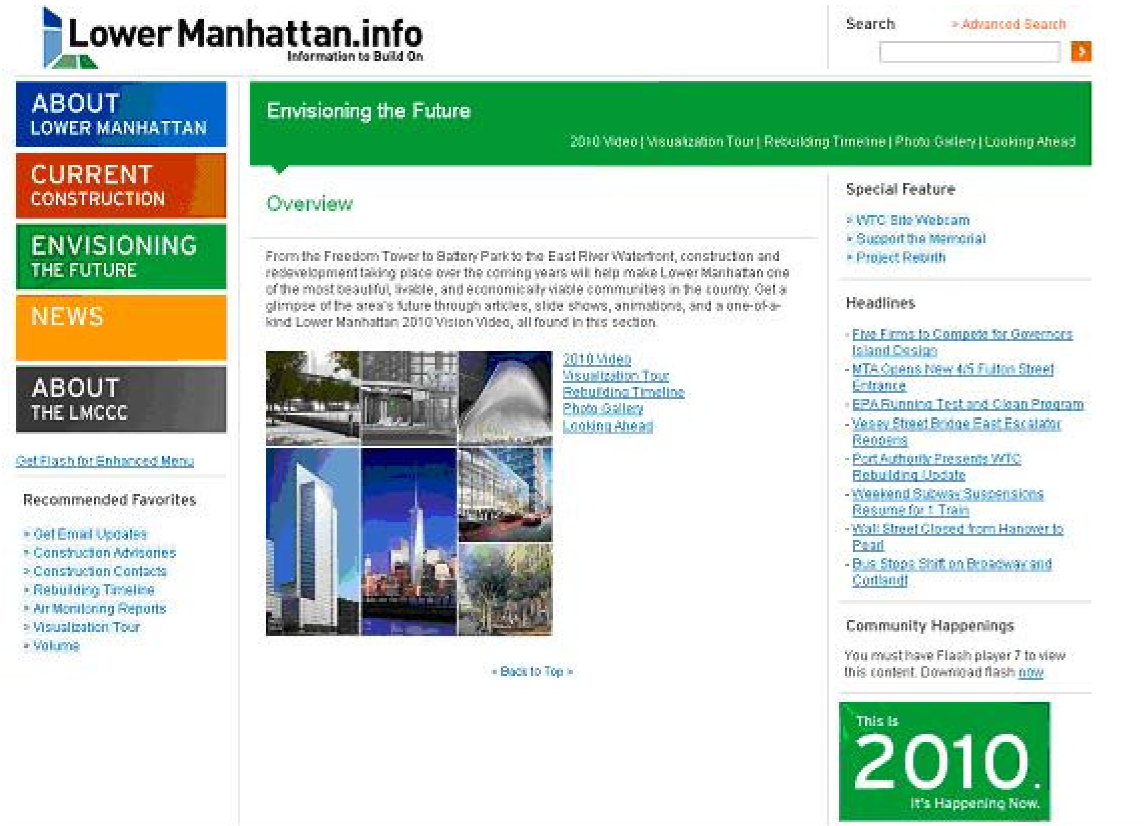
PUBLIC OUTREACH

The environmental monitoring program described above is a step forward for bringing the benefits of air pollution monitoring programs to alleviate neighborhood concerns. The field of ambient air monitoring has evolved for over 50 years. Early ambient air monitoring efforts in the United States included the development of equipment in the 1940's, and by the mid 1950s Los Angeles had created the first monitoring network capable of providing continuous air quality data, along with an alert system to warn the public in the event of an air pollution emergency.[1] The goals of today's air monitoring programs are essentially the same as 50 years ago: to gather accurate, timely data on air pollution, communicate it to the public in ways that can reduce exposures, document conditions, and gain information to focus regulatory efforts.

LMCCC utilized various media to pursue the public outreach program. This included the establishment and maintenance of websites, including www.lowermanhattan.info/ and www.renewnyc.com. Figure 7 shows one of the second tier pages from the lowermanhattan.info website.

[1] *Planning and Implementing a Real-Time Air Pollution Monitoring and Outreach Program for Your Community: The AirBeat Project of Roxbury, Massachusetts;* U.S. Environmental Protection Agency; National Risk Management Research Laboratory; Cincinnati, OH, November 2002; EPA/625/R-02/012.

Figure 7: Excerpt page from public website



In addition to the websites, LMCCC instituted a telephone hotline for public to reach appropriate representatives. Each call is logged and tracked in a database to document issues raised, replies, and follow-up actions. The telephone hotline already established for noise complaints and staffed 24 hours a day, 7 days a week by an operator, can also field questions and complaints from the public about traffic congestion, air quality, and particulate emissions.

LMCCC has also hosted a series of community meetings, open to the public, where members of the community were given an opportunity to address issues before other community members. Another major component of the outreach program is an exhibit, currently on display at the New York Public Library at 188 Madison Avenue, New York, NY. Public groups include: pre-existing associations, newly formed groups, and virtual groups reached via email and webpage announcements.

All of the public outreach efforts described here have been utilized to share information on the environmental monitoring efforts, including: describing the overall monitoring program, specific monitoring systems, and the websites are used for posting data summaries.

SUMMARY

A local or neighborhood scale environmental monitoring program is increasingly likley to employ the use of ambient air monitoring equipment, such as that used by the LMCCC to achieve its objectives during the current urban renewal program. While the use of ambient air monitoring equipment on the neighborhood or local scale may be consistent with methods utilized for State Implementation Programs of the National Ambient Air Quality Act, there are important differences. Depending on specific objectives, such as the control of local emission sources, it may be important for the air monitoring stations to provide near real-time data. This can be achieved with short duration monitoring data collection intervals (i.e. 5-minutes instead of 60-minutes) and data processing that includes automated alarms, such as email or telephone alerts of questionable contaminant concentrations.

Program objectives with neighborhood scale operations may be further facilitated through a 'boots-on-the-ground' approach that is likely to include frequent site surveillance (e.g. daily) and the use of mobile, street-level monitoring to accompany ambient air monitoring.

Ultimately, localized programs are likely to be primarily intended to aid neighborhood residents and businesses. Various public outreach efforts are intergral to achieving objectives. Community meetings and telephone hotlines were found to provide a forum for residents to voice concerns and a means for public involvement. Websites allow for prompt dissemination of data and program information.

Program sponsors understood from the onset that the amount of construction within a small, densely populated urban area was going to result in exposures to noise, dust, traffic congestion, vibration, and related inconveniences. To date, the philosophy of informing the residents of the ultimate benefit from the construction, advertisiing efforts to minimize disturbances and protect environmental quality, and providing an easily accessible venue for complaints, has been well received. Overall it is believed that this open-dialogue and informative approach has incurred an added measure of patience and satisfaction from neighborhood residents. Accomplishing this through a new govornmental agency has been seen as a further asset to establishing trust among residents.

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