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Planning and Implementing a Real-time Air Pollution Monitoring and Outreach Program for Your Community

The AirBeat Project of Roxbury, Massachusetts

EMPACT

Environmental Monitoring for Public Access
& Community Tracking

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1 INTRODUCTION

In many urban areas, outdoor air pollution is still a concern.

Over the past 15 years, an epidemic of asthma has been occurring in the United States. Children, in particular, have been severely affected. EPA's Office of Children's Health Protection estimates that 4.8 million children under 18 years of age—one out of every fifteen children—have asthma. Asthma rates have increased 160 percent in the past 15 years in children under 5 years of age.

The problem is even worse among some inner-city populations. In certain neighborhoods of New York City, for example, one out of every five children has asthma. In Roxbury, an urban neighborhood in the heart of Boston, the asthma hospitalization rate is annually among the highest in Massachusetts (in 1992, it was five times the state average). Although people of all ages, races, and ethnic groups have been affected by asthma, nationwide data show that the epidemic is most severe among lower income and minority children.

These data have lead to heightened concern about the quality of air that inner-city children are breathing—both indoors and out. In recent years, scientists have developed a better understanding of the role that air pollutants can play in exacerbating asthma symptoms and triggering asthma attacks. Much work has been done to reduce children's exposures to indoor air pollutants and allergens such as cigarette smoke, cockroach particles, dust mites, and animal hair since these are considered among the most common asthma triggers. At the same time, there is growing recognition of a need for better information on children's exposures to outdoor air pollutants.

Throughout most of the United States, levels of outdoor air pollutants are much lower today than in the past. However, in some parts of the country (particularly urban areas), outdoor air pollution is still a concern. Pollutants of concern[1] include ground-level ozone (which is formed by the chemical reaction of pollutants from cars, trucks, buses, power plants, and other sources) and particulate matter (which includes dust, dirt, soot, smoke, and liquid droplets emitted into the air by sources such as cars, trucks, buses, factories, and construction activities). Both of these pollutants have been linked to asthma and other respiratory illnesses.

To protect their respiratory health, inner-city residents need timely access to air quality data. Levels of outdoor air pollutants such as ozone and particulate matter vary from day to day and even during the course of a single day. Access to air quality forecasts and real-time data can allow residents to reduce their exposures when pollutant levels are high. For children and others with asthma, reducing exposures to asthma triggers can be part of a multi-faceted approach to managing symptoms that also includes behavior changes, drug therapy, and frequent medical follow-ups. Patient education is also key to this approach.

[1] Another class of pollutants that can cause special threats in urban areas is air toxics, which are those air pollutants that are known or suspected to cause cancer or other serious health problems. Air toxics are not addressed in this handbook. For more information on nationwide efforts to monitor and reduce emissions of air toxics, visit EPA's Air Toxics Web site at *http://www.epa.gov/ttn/atw/*.

In 1999, a team of academic, community, and government organizations launched a pilot project to collect and communicate real-time data[2] on air pollution in the Roxbury neighborhood of Boston, Massachusetts. This pilot project, which became known as AirBeat, was funded with a grant from EPA's EMPACT Program. The AirBeat project had two main goals: 1) to develop and implement real-time ambient air pollution monitoring and data management techniques for ozone, fine particulate matter ($PM_{2.5}$), and other air quality parameters, and 2) to communicate real-time air quality data to the public in a way that can be easily understood and used by community residents to reduce human exposure.

To meet these goals, AirBeat established an ambient air quality monitoring station in the center of Roxbury. This station continuously collects air pollution data, which are presented in real time for public access on the AirBeat Web site *(http://www.airbeat.org/)* and via a telephone hotline system (617-427-9500). The AirBeat team also developed an extensive outreach program for educating the public about air pollution, health effects, and precautionary measures.

This technology transfer handbook presents a case study about the AirBeat project. It describes how AirBeat got its start, how the project's partners approached the technical and human challenges facing them, and what lessons they learned in the process. The handbook also provides information, recommendations, suggestions, and tips to assist other groups in developing or refining a comparable program for their own community. These recommendations, tips, and suggestions come primarily from the AirBeat project, but also to a limited extent from case studies, lessons learned, and recommendations gleaned from other comparable environmental monitoring projects. The handbook is written primarily for community organizers, non-profit groups, local government officials, tribal officials, and other decision-makers who will implement, or are considering implementing, air quality monitoring and outreach programs.

1.1 ABOUT THE EMPACT PROGRAM

This handbook was developed by EPA's EMPACT Program *(http://www.epa.gov/empact).* EPA created EMPACT (Environmental Monitoring for Public Access and Community Tracking) to promote new and innovative approaches to collecting, managing, and communicating environmental information to the public. Working with communities across the country, the program takes advantage of new technologies to provide community members with timely, accurate, and understandable environmental information they can use to make informed, day-to-day decisions about their lives. EMPACT projects cover a wide range of environmental issues, including water quality, ground water contamination, smog, ultraviolet radiation, and overall ecosystem quality. Some projects were initiated by EPA, while others (including the AirBeat project) were launched by EMPACT communities themselves through EPA-funded Metro Grants.

1.2 ABOUT THE AIRBEAT PROJECT

Planning for the AirBeat project began in 1997 and 1998. EMPACT began funding AirBeat in 1999, and that spring the project started operating its air pollution monitoring station in the center of Roxbury. Real-time delivery of air quality data began in 2000 with the launch of the AirBeat Web site and telephone hotline system.

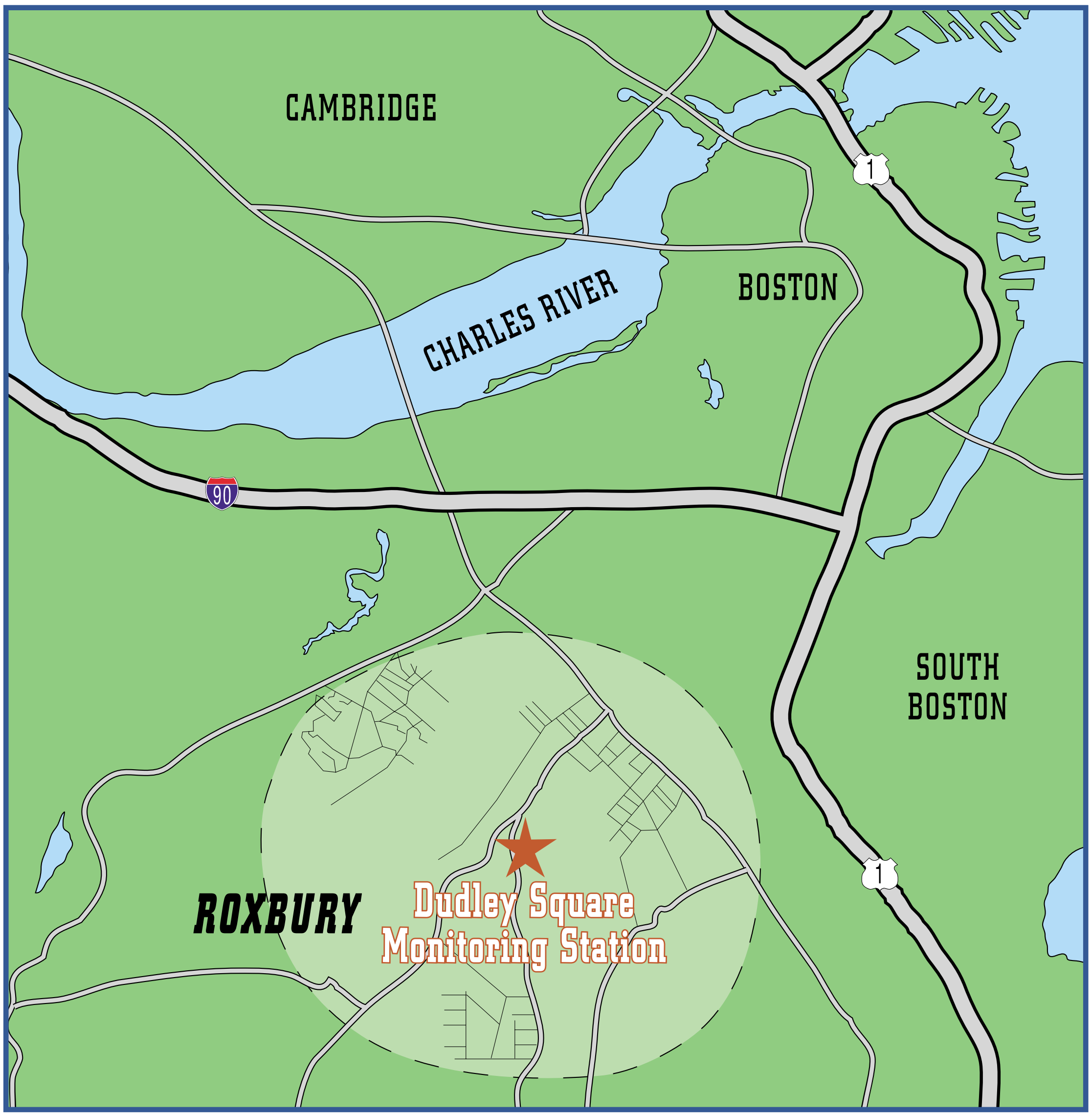
AirBeat focused on the Roxbury neighborhood for two reasons. First, there has been heightened concern over outdoor air quality in Roxbury due to high rates of asthma and other respiratory illnesses. And second, there are a number of strong community organizations in Roxbury that have been working for years on a variety of environmental health and justice issues.

[2] In this handbook, the term "real time" is used to indicate that data are presented to the public almost as soon as they are collected, with only a slight delay for data processing and quality assurance. AirBeat reports pollutant concentrations as hourly averages, with results generally made available to the public within 15 minutes of the end of the averaging period.

Roxbury is a heavily urbanized neighborhood. Its population of 60,000 people is about 70 percent African American and 18 percent Latino. The poverty rate is more than 30 percent in the neighborhood and 45 percent for children under 18 (U.S. Census Report, 1990). Environmental concerns in Roxbury include high traffic volumes, vacant lots, illegal trash dumps, and pollution from autobody shops.

In the mid 1990s, concern over outdoor air quality in Roxbury began to focus on motor vehicles, especially exhaust from diesel trucks and buses. Research conducted in 1996 revealed that there were more than 15 truck and bus depots within a one-mile radius of Roxbury, garaging more than 1,150 diesel vehicles. In 1997, local environmental and community organizations formed a coalition called Clean Buses for Boston to pressure the regional transit agency to convert its bus fleet from diesel to cleaner alternatives. Some of these organizations also began discussions with the Massachusetts Department of Environmental Protection (MA DEP) aimed at establishing an ambient air quality monitoring station in Roxbury.

AirBeat's monitoring and outreach project grew out of these efforts. In 1998, MA DEP decided to set up a monitoring station in the Dudley Square area of Roxbury (see map) to measure levels of PM2.5 in the ambient air. The station was to be part of MA DEP's statewide monitoring network. With funding from an EMPACT grant, the AirBeat team was able to expand the Dudley Square monitoring effort to include continuous measurements of $PM_{2.5}$, ground-level ozone, and black carbon soot (BC). (Black carbon, a



component of $PM_{2.5}$, was chosen because it is a strong indicator of local diesel emissions. See Section 3.3 for more information about BC.) The team also decided to set up a state-of-the-art data management and delivery system so that the Dudley Square monitoring station would be the first station in the commonwealth to present air quality data to the public in real time, using a Web site *(http://www.airbeat.org)* and other communication venues. In addition, the AirBeat team planned an extensive outreach program to educate the public about the connections between air pollution and health effects.

The AirBeat project is a partnership between:

- *Alternatives for Community & Environment (ACE),* a Roxbury-based, non-profit environmental justice organization that coordinates AirBeat's education and outreach efforts.
- *Harvard University School of Public Health,* which developed some of the innovative instrumentation set-ups for the AirBeat monitoring station and shared responsibility for implementing the real-time measurements.
- *MA DEP,* which operates 42 ambient air monitoring stations throughout Massachusetts and has overall responsibility for the Roxbury station.
- *Northeast States for Coordinated Air Use Management (NESCAUM),* an interstate association of air quality control agencies that managed AirBeat's data management and mapping efforts and the development of the project's Web site and hotline.
- *Suffolk County Conservation District,* which acted as the lead agency, responsible for coordinating the AirBeat project.

Chapters 4 through 7 of this handbook provide more details about the roles each of these partners played in the AirBeat project.

Current Status and Sustainability of the AirBeat Project

Since the end of the EMPACT grant period, in 2001, AirBeat has continued to provide real-time data on air pollution to the Roxbury community. The Dudley Square monitoring station (and all of its instrumentation) is maintained by MA DEP, which operates the station as part of its statewide monitoring network with state and federal funding. AirBeat's Data Management Center runs on an automated basis from the offices of NESCAUM, with little human oversight needed. The ongoing operation of this equipment means that, for the foreseeable future, air pollution data will continue to be downloaded from the Dudley Square monitoring station and posted to the AirBeat Web site for public access.

AirBeat outreach activities will also continue, but at a scaled-back level. Air quality is still a major concern in Roxbury, and AirBeat information has become woven into the fabric of many of ACE's community education and empowerment initiatives in the neighborhood. So as ACE continues its work, the AirBeat message will continue to go out to Roxbury residents.

1.3 ABOUT THIS HANDBOOK

A number of communities throughout the United States have expressed interest in beginning projects similar to AirBeat. The purpose of this handbook is to help interested communities and organizations learn more about AirBeat and to provide them with the technical information they need to develop their own programs. The Technology Transfer and Support Division of the EPA Office of Research and Development's (ORD's) National Risk Management Research Laboratory initiated the development of this handbook in collaboration with EPA's Office of Environmental Information. ORD, working with AirBeat's project partners, produced the handbook to leverage EMPACT's investment in the project and minimize the resources needed to implement similar projects in new areas.

Both print and CD-ROM versions of the handbook are available for direct online ordering from ORD's Technology Transfer Web site at *http://www.epa.gov/ttbnrmrl*. A PDF version of the handbook can also be downloaded from that site. In addition, you can order a copy of the handbook (print or CD-ROM version) by contacting ORD Publications by telephone or mail at:

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Please make sure that you include the title of the handbook and the EPA document number in your request. We hope that you find the handbook worthwhile, informative, and easy to use.

1.4 FOR MORE INFORMATION

Try the following resources for more on the issues and programs this handbook discusses:

The EMPACT Program
http://www.epa.gov/empact/

The AirBeat Web site
http://www.airbeat.org

Alternatives for Community & Environment
http://www.ace-ej.org/

Massachusetts Department of Environmental Protection
http://www.state.ma.us/dep/dephome.htm

NESCAUM
http://www.nescaum.org/

EPA's Office of Children's Health Protection
http://www.epa.gov/children/

American Lung Association
http://www.lungusa.org/asthma/

National Asthma Education and Prevention Program, National Heart, Blood and Lung Institute
http://www.nhlbisupport.com/asthma/index.html

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2 How to Use This Handbook

This handbook presents a case study of the AirBeat project. The handbook also provides information, recommendations, suggestions, and tips to assist other groups in developing or refining a real-time air pollution monitoring and public outreach project for their own community. The handbook covers the following key steps in developing an AirBeat-type project:

Identifying target communities and selecting program partners → ***Developing a monitoring system for making continuous measurements of air pollutants*** → ***Using state-of-the-art technology for managing data and delivering it to community residents in real time*** → ***Creating an outreach program to educate residents about air pollution and health effects***

The handbook provides simple “how to” instructions on each facet of planning and implementing an AirBeat-type program, along with important background information on air pollution and health effects:

- *Chapter 3* provides information about ground-level ozone and fine particulate matter, the two major air pollutants that are the focus of AirBeat’s monitoring efforts. The chapter covers pollutant sources and health effects and gives an overview of existing monitoring programs that are in place nationwide for measuring ambient concentrations of ozone and particulate matter.
- *Chapter 4* describes the steps in beginning an AirBeat-type program: identifying potential target communities, getting to know the community, selecting partners for the program, and estimating program costs.
- *Chapter 5* discusses the key steps in developing a monitoring system: preparing a quality assurance plan; siting a monitoring station; selecting monitoring instrumentation and equipment; and installing, operating, and maintaining the equipment.
- *Chapter 6* provides detailed information about data management and delivery, focusing on the equipment and software needed to establish a data management center and such data-delivery tools as a Web site and telephone hotline system.
- *Chapter 7* provides guidance on education and outreach to community residents about air pollution, health effects, and the benefits of using real-time air quality data to reduce exposures to harmful pollutant levels. The chapter includes detailed information on outreach tools and approaches used by the AirBeat project, along with sample outreach materials.

Interspersed throughout the handbook are stories about the lessons learned in the course of the AirBeat project. The handbook also refers you to supplementary sources of information, such as Web sites, guidance documents, and other written materials. In addition, the handbook includes appendices that present alternatives to the approaches used by the AirBeat project:

- *Appendix A* presents a case study of the Paso del Norte Environmental Monitoring Project, an international effort to provide the public with real-time data on air quality, traffic, and weather for a region along the U.S.-Mexican border that is home to a rapidly growing and bilingual population.
- *Appendix B* gives an overview of the St. Louis Community Air Project (CAP), a multi-year commitment to better understand the presence of air pollutants in St. Louis and take the necessary steps to improve the air quality. CAP provides an excellent model for involving the local community in all aspects of planning and implementing an air quality monitoring and outreach program.
- *Appendix C* describes another Missouri-based effort: the St. Louis Regional Clean Air Partnership, a public-private partnership formed to raise awareness of regional air quality issues and to encourage activities to reduce emissions of air pollutants. The Partnership demonstrates how a program can cost-effectively leverage monitoring data from existing state-run monitoring networks and deliver it to the public in the context of an innovative education and outreach effort.

The handbook is designed for managers and decision-makers who may be considering whether to implement an AirBeat-type monitoring and outreach program in their community, as well as for organizers who are interested in improving or refining their existing programs.

3 ABOUT GROUND-LEVEL OZONE AND FINE PARTICULATE MATTER

This chapter provides background information about ground-level ozone and fine particulate matter ($PM_{2.5}$), the two major air pollutants that are the focus of AirBeat's monitoring efforts. Sections 3.1 and 3.2 describe the sources and health effects of these two pollutants and identify those people most at risk from unhealthy exposures. Section 3.3 presents information about the sources and health effects of black carbon, a component of $PM_{2.5}$ that is monitored by the AirBeat project. Section 3.4 summarizes the National Ambient Air Quality Standards that EPA has established for ozone and particulate matter to protect people and the environment from adverse effects. Section 3.5 provides an overview of the existing monitoring programs that are in place nationwide for measuring ambient concentrations of ozone, particulate matter, and other major air pollutants. Finally, Section 3.6 introduces readers to the Air Quality Index, a tool developed by EPA to provide people with timely and easy-to-understand information on local air quality and whether it poses a health concern.

The information in this chapter should be useful to any person interested in air pollution and the national strategies for monitoring pollutant levels in ambient air, whether that person be a community organizer responsible for implementing a monitoring program or a member of the public concerned about elevated pollutant levels in his or her community.

3.1 ABOUT OZONE

Ozone is an odorless, colorless gas composed of three atoms of oxygen. It occurs both in the Earth's upper atmosphere and at ground level. Ozone can be good or bad, depending on where it is found:

- *Good ozone (upper level).* Ozone occurs naturally in the Earth's upper atmosphere—10 to 30 miles above the Earth's surface, where it forms a protective barrier that shields people from the sun's harmful ultraviolet rays. This barrier is sometimes called the "ozone layer."
- *Bad ozone (ground level).* Because of pollution, ozone can also be found in the Earth's lower atmosphere, at ground level. Ground-level ozone is a major ingredient of smog, and it can harm people's health by damaging their lungs. It can also damage crops and many common man-made materials, such as rubber, plastic, and paint.

3.1.1 SOURCES OF GROUND-LEVEL OZONE

Ground-level ozone is not emitted directly into the air but forms when two kinds of pollutants—volatile organic compounds and nitrogen oxides—mix in the air and react chemically in the presence of sunlight. Common sources of volatile organic compounds (often referred to as VOCs) include motor vehicles, gas stations, chemical plants, and other industrial facilities. Solvents such as dry-cleaning fluid and chemicals used to clean industrial equipment are also sources of VOCs. Common sources of nitrogen oxides include motor vehicles, power plants, and other fuel-burning sources.

3.1.2 OZONE HEALTH EFFECTS

Ozone can affect people's health in many ways:

- *Ozone can irritate the respiratory system.* When this happens, you might start coughing, feel an irritation in your throat, and/or experience an uncomfortable sensation in your chest. These symptoms can last for a few hours after ozone exposure and may even become painful.

- ***Ozone can reduce lung function.*** When scientists refer to "lung function," they mean the volume of air that you draw in when you take a full breath and the speed at which you are able to blow out the air. Ozone can make it more difficult for you to breathe as deeply and vigorously as you normally would.
- ***Ozone can aggravate asthma.*** When ozone levels are high, more asthmatics have asthma attacks that require a doctor's attention or the use of additional asthma medication.
- ***Ozone can aggravate chronic lung diseases,*** such as emphysema and bronchitis.
- ***Ozone can inflame and temporarily damage the lining of the lung.*** Ozone damages the cells that line the air spaces in the lung. Within a few days, the damaged cells are replaced and the old cells are shed. If this kind of damage occurs repeatedly, the lung may change permanently in a way that could cause long-term health effects.

3.1.3 POPULATIONS MOST AT RISK FROM OZONE

In most parts of the United States, ozone pollution is likely to be a concern during the summer months, when the weather conditions needed to form ground-level ozone—lots of sun, hot temperatures—normally occur. Ozone pollution is usually at its worst during summer heat waves when air masses are stagnant. Ozone levels also vary during the day, and are typically highest during late afternoon and decrease rapidly at sunset.

Most people only have to worry about ozone exposure when concentrations reach high or very high levels. However, some groups of people are particularly sensitive to ozone, and members of these groups are likely to experience health effects before ozone concentrations reach high levels. People most sensitive to ozone include:

- ***Children.*** Active children are the group at highest risk from ozone exposure. Such children often spend a large part of their summer vacation outdoors, engaged in vigorous activities either in their neighborhood or at summer camp. Children are also more likely to have asthma or other respiratory illnesses. Asthma is the most common chronic disease for children and may be aggravated by ozone exposure.
- ***Adults who are active outdoors.*** Healthy adults who exercise or work outdoors are considered a "sensitive group" because they have a higher level of exposure to ozone than people who are less active outdoors.
- ***People with respiratory diseases, such as asthma.*** There is no evidence that ozone causes asthma or other chronic respiratory disease, but these diseases do make the lungs more vulnerable to the effects of ozone. Thus, individuals with these conditions will generally experience the effects of ozone earlier and at lower levels than less sensitive individuals.
- ***People with unusual susceptibility to ozone.*** Scientists don't yet know why, but some healthy people are simply more sensitive to ozone than others. These individuals may experience more health effects from ozone exposure than the average person.

Scientists have found little evidence to suggest that either the elderly or people with heart disease have heightened sensitivity to ozone. However, like other adults, elderly people will be at higher risk from ozone exposure if they suffer from respiratory disease, are active outdoors, or are unusually susceptible to ozone.

3.2 ABOUT FINE PARTICULATE MATTER

Particulate matter (PM) is the general term used for a mixture of solid particles and liquid droplets found in the air. These particles and droplets come in a wide range of sizes. Some are large or dark enough to be seen as soot or smoke. Others are so small they can be detected only with an electron microscope.

PM can harm people's health when it is inhaled into the lungs. PM is also the major cause of reduced visibility (haze) in many parts of the United States. Deposition of PM from the atmosphere can damage environmental ecosystems and man-made objects such as monuments and statues.

The environmental and health effects of PM can vary, depending on the size of the particles. Because they are less heavy, smaller particles stay in the air longer and travel farther when emitted to the atmosphere, contributing to haze. Smaller particles also can be inhaled more deeply into human lungs, increasing the potential for severe health effects. In addition, smaller particles generally include more toxic substances than do larger particles.

Because of these differences, EPA maintains two separate ambient air quality standards for particulate matter. One standard addresses levels of "fine" particulate matter (known as $PM_{2.5}$), which contains particles less than 2.5 micrometers in diameter. The other standard addresses PM_{10}, containing particles that are less than 10 micrometers in diameter.

3.2.1 SOURCES OF FINE PARTICULATE MATTER

Particulate matter originates from many different stationary and mobile sources as well as from natural sources. Particles larger than 2.5 micrometers in diameter (often referred to as coarse particles) are generally emitted from sources such as vehicles traveling on unpaved roads, materials handling, and crushing and grinding operations, as well as windblown dust. Fine particles (less than 2.5 micrometers in diameter), which are the focus of the AirBeat project, result from fuel combustion from motor vehicles, power generation, and industrial facilities, as well as from residential fireplaces and wood stoves. The particles originating from these sources often include certain heavy metals and organic compounds that have been associated with excess cancer risk.

Some fine particles are emitted directly from their sources, such as smokestacks and cars. In other cases, gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds interact with other compounds in the air to form fine particles. Their chemical and physical compositions vary depending on location, time of year, and weather.

3.2.2 $PM_{2.5}$ HEALTH EFFECTS

When people inhale, they breathe in air along with any particles that are in the air. The air and the particles travel into their respiratory system (the lungs and airway). Along the way, the particles can stick to the sides of the airway or travel deeper into the lungs. If particles are small and get very far into the lungs, special cells in the lung trap the particles and then they can't get out.

Scientific studies have linked fine particles (alone or in combination with other air pollutants), with a series of significant health problems, including:

- Premature death.
- Respiratory related hospital admissions and emergency room visits.
- Aggravated asthma.
- Acute respiratory symptoms, including aggravated coughing and difficult or painful breathing.
- Chronic bronchitis.
- Decreased lung function that can be experienced as shortness of breath.
- Work and school absences.

To fully understand the potential health effects of fine particles, scientists must have information about the chemical composition of $PM_{2.5}$, which is known to vary from location to location and from season to season. To help characterize trends in chemical composition, EPA is currently establishing a network of $PM_{2.5}$ speciation monitors across the United States. The information from this network will allow scientists to better understand the emission sources contributing to $PM_{2.5}$ and the potential for long-term health effects (including cancer) from human exposures. For more information on EPA's $PM_{2.5}$ speciation program, go to *http://www.epa.gov/ttn/amtic/speciepg.html.*

3.2.3 POPULATIONS MOST AT RISK FROM FINE PARTICULATE MATTER

The following people are most at risk from exposures to $PM_{2.5}$:

- ***The elderly.*** Studies estimate that tens of thousands of elderly people die prematurely each year from exposure to ambient levels of fine particles. Studies also indicate that exposure to fine particles is associated with thousands of hospital admissions each year. Many of these hospital admissions are elderly people suffering from lung or heart disease.
- ***Individuals with preexisting heart or lung disease.*** Breathing fine particles can also adversely affect individuals with heart disease, emphysema, and chronic bronchitis by causing additional medical treatment. Inhaling fine particulate matter has been attributed to increased hospital admissions, emergency room visits, and premature death among sensitive populations.
- ***Children.*** Because children's respiratory systems are still developing, they are more susceptible to environmental threats than healthy adults. Exposure to fine particles is associated with increased frequency of childhood illnesses, which are of concern both in the short run, and for the future development of healthy lungs in the affected children. Fine particles are also associated with increased respiratory symptoms and reduced lung function in children, including symptoms such as aggravated coughing and difficulty or pain in breathing. These can result in school absences and limitations in normal childhood activities.
- ***Asthmatics and asthmatic children.*** More and more people are being diagnosed with asthma every year. Fourteen Americans die every day from asthma, a rate three times greater than just 20 years ago. Children make up 25 percent of the population, but comprise 40 percent of all asthma cases. Breathing fine particles, alone or in combination with other pollutants, can aggravate asthma, causing greater use of medication and resulting in more medical treatment and hospital visits.

3.3 ABOUT BLACK CARBON

Black carbon (BC), an air pollutant that is monitored by the AirBeat project, is a component of $PM_{2.5}$ (typically about 10 percent by mass in urban areas). BC is similar to soot and is emitted directly into the air from virtually all combustion activities. It is especially prevalent in exhaust from diesel-burning trucks and buses, which tend to be the primary source of BC in urban areas. Other sources of BC include coal-burning power plants, jet fuel, forest fires, and wood-burning stoves and fireplaces.

EPA has not established a national health standard specifically for BC. The reasons are two-fold. First, because black carbon is a component of $PM_{2.5}$, BC levels in ambient air are regulated under the National Ambient Air Quality Standard for $PM_{2.5}$ (see Section 3.4). Second, not enough is known about the specific health effects of black carbon to set a national standard. However, a large number of human epidemiology studies have shown that diesel exhaust as a whole (which contains black carbon) is associated with increases in lung cancer and may aggravate asthma. More information on the health effects associated with diesel exhaust can be found in EPA's *Health Assessment Document for Diesel Exhaust,* located online at *http://www.epa.gov/ncea/dieslexh.htm.*

AirBeat measures BC concentrations as a surrogate for diesel exhaust. In other words, the data on BC concentrations help the AirBeat team evaluate the degree to which diesel trucks and buses are contributing to overall $PM_{2.5}$ levels.

3.4 NATIONAL AMBIENT AIR QUALITY STANDARDS FOR OZONE AND PARTICULATE MATTER

Ground-level ozone and particulate matter are regulated under the Clean Air Act, which is the comprehensive federal law that regulates air emissions in the United States. The Clean Air Act requires EPA to set standards for six "criteria" air pollutants that are commonly occurring, including ozone and particulate matter.[3] These standards are known as the National Ambient Air Quality Standards (NAAQS). EPA is required to re-evaluate each NAAQS every 5 years and either affirm the current standard or promulgate a new standard based on the currently available scientific research.

Under the Clean Air Act, EPA develops two standards for each pollutant of concern:

- *A primary standard to protect public health.* The primary NAAQS can be defined as the levels of air quality that EPA has determined to be generally protective of people's health.
- *A secondary standard to protect public welfare.* Public welfare includes effects on soils, water, crops, vegetation, buildings, property, animals, wildlife, weather, visibility, transportation, and other economic values, as well as personal comfort and well-being.

For ozone, the primary and secondary standards are identical. The same is true for particulate matter.

You can find out more about the Clean Air Act and the NAAQS in EPA's Plain English Guide to the Clean Air Act, found online at *http://www.epa.gov/oar/oaqps/peg_caa/pegcaain.html.*

3.4.1 ABOUT THE NAAQS FOR OZONE

In 1997, EPA adopted new, more stringent standards for ozone, based on research that found that the original NAAQS for ozone, known as the 1-hour standard, was not adequately protective of human health. The 1-hour standard limited ozone levels to 0.12 parts per million averaged over a 1-hour period. The new standard, known as the 8-hour standard, requires that a community's ozone levels be no higher than 0.08 parts per million when averaged over an 8-hour period.

3.4.2 ABOUT THE NAAQS FOR PARTICULATE MATTER

EPA also revised the NAAQS for particulate matter in 1997. Up to that point, federal PM standards had applied only to particles up to 10 microns in diameter (PM_{10}). A review of the scientific data indicated, however, that it is the smaller (or fine) particles—less than 2.5 microns in diameter—that are largely responsible for the health effects of greatest concern and for visibility impairment.

Based on this information, EPA issued revisions to strengthen the particulate matter standards by keeping the existing PM_{10} standards and adding new standards that provide more stringent goals for fine particles in air. The revised standards are shown in the following table.

[3] The other criteria pollutants are carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2).

Table 3-1. NAAQS for PM_{10} and $PM_{2.5}$

Pollutant	24-hour Standard	Annual Standard
PM10	*150 micrograms per cubic meter* To attain this standard, the 99th percentile of the distribution of the 24-hour concentrations for a period of 1 year, averaged over 3 years, must not exceed 150 micrograms per cubic meter at each monitor within an area.	*50 micrograms per cubic meter* To attain this standard, the arithmetic mean of the 24-hour samples for a period of 1 year, averaged over 3 consecutive years, must not exceed 50 micrograms per cubic meter.
PM2.5	*65 micrograms per cubic meter* To attain this standard, the 98th percentile of the distribution of the 24-hour concentrations for a period of 1 year, averaged over 3 years, must not exceed 65 micrograms per cubic meter at each monitor within an area.	*15 micrograms per cubic meter* To attain this standard, the 3-year average of the annual arithmetic mean of the 24-hour concentrations from single or multiple population oriented monitors must not exceed 15 micrograms per cubic meter.

3.5 Existing Monitoring Programs for Ozone and Particulate Matter

Under the Clean Air Act, states are required to establish air monitoring networks—air quality surveillance systems that consist of a series of carefully placed monitoring stations. Each station measures the ambient concentrations of important air pollutants, including ground-level ozone and PM, in the immediate vicinity of the station. States are required to report the data gathered from the monitoring stations to EPA.

Information provided by the state air monitoring networks is used for a number of purposes. Two key objectives are:

- *Determining what areas of the United States are in compliance with the NAAQS.* A geographic area that meets the primary health-based NAAQS is called an attainment area. Areas that do not meet the primary standard are called non-attainment areas. The Clean Air Act requires each state to develop State Implementation Plans (SIPs) describing the programs a state will use to maintain good air quality in attainment areas and meet the NAAQS in non-attainment areas.
- *Provide information to the public about local air quality.* Each year, EPA issues a National Air Quality and Emissions Trends Report, which examines trends among the six criteria pollutants. In addition, efforts are increasingly being made to deliver timely air quality information directly to the public for use in daily decision making. EPA's AirNow Web site *(http://www.epa.gov/airnow)* provides the public with daily air quality forecasts as well as real-time air quality data for over 165 cities across the United States. A number of local and regional programs have also been launched to deliver real-time information to the public. The AirBeat project is just one example. See the appendices of this handbook for summaries of other, similar programs.

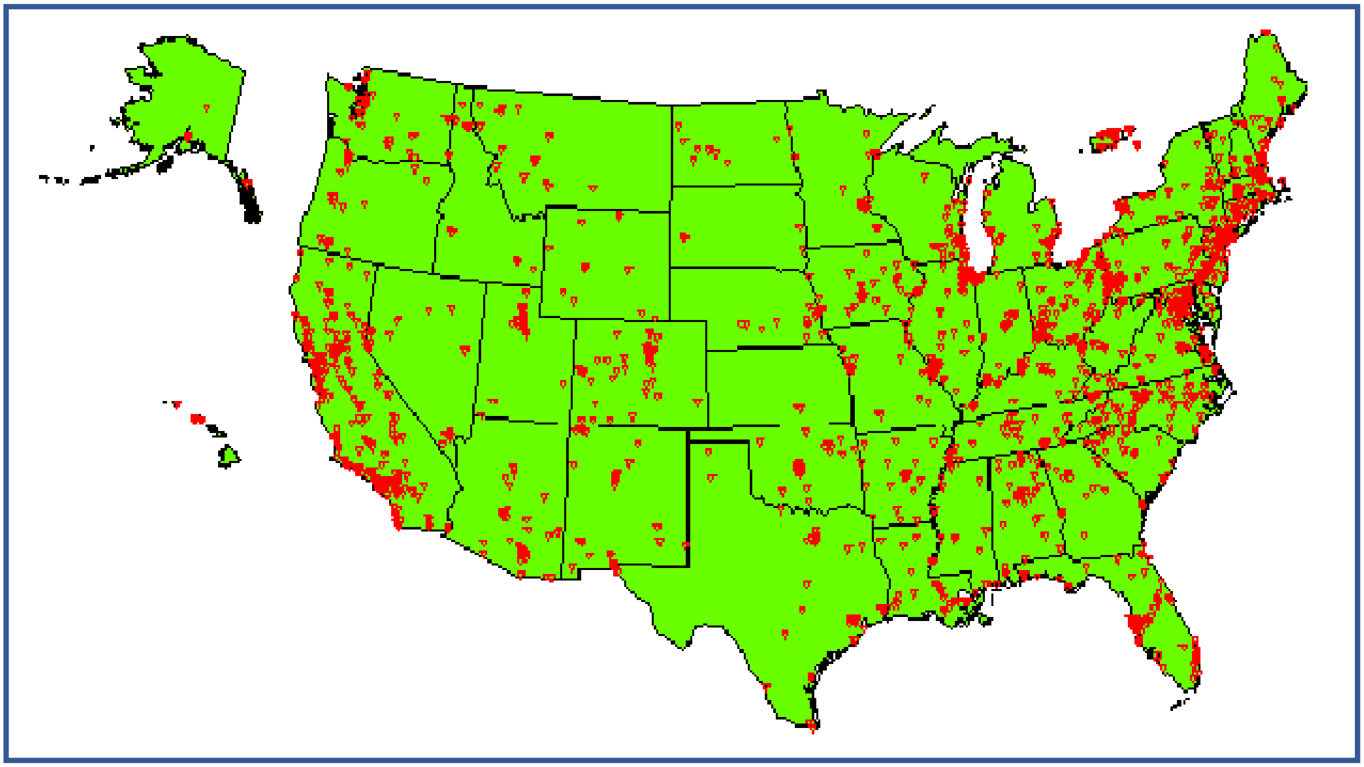
Other objectives of air quality surveillance include: 1) determining source impacts, 2) determining general background levels, 3) measuring regional transport, 4) evaluating effects such as visibility impairments and ecosystem impacts, and 5) developing and evaluating strategies for controlling pollution levels.

3.5.1 TYPES OF MONITORS

Four different types of monitoring systems are used to carry out ambient air monitoring for criteria pollutants under the Clean Air Act:[4]

- *State and Local Air Monitoring Stations (SLAMS).* The AirBeat monitoring station in Roxbury is part of the SLAMS network operated by the Massachusetts Department of Environmental Protection. SLAMS stations are used to demonstrate if an area is meeting the NAAQS. A SLAMS system consists of a carefully planned network of fixed monitoring stations, with the network size and station distribution largely determined by the needs of state and local air pollution control agencies to meet their SIP requirements. EPA gives states and localities flexibility in determining the size of their SLAMS network based on their data needs and available resources. Nationwide, the SLAMS network consists of around 4,000 monitoring stations (see map).

STATE AND LOCAL AIR MONITORING STATIONS (SLAMS)



- *National Air Monitoring Stations (NAMS).* NAMS are used to supply data for national policy and trend analyses and to provide the public with information about air quality in major metropolitan areas. NAMS are required in urban areas with populations greater than 200,000. NAMS monitoring stations are selected from a subset of the SLAMS network, and EPA requires a minimum of two NAMS monitors in each of these metropolitan areas. There are two categories of NAMS monitoring stations: stations located in areas of expected maximum ozone concentration, and stations located in areas where poor air quality is combined with high population density.
- *Special Purpose Monitoring Stations (SPMS).* SPMS provide data for special studies needed by state and local agencies to support SIPs and other air program activities. The SPMS are not permanently established and can be adjusted easily to accommodate changing needs and priorities. The SPMS are used to supplement the fixed monitoring network as circumstances require and resources permit.

[4] For information on existing monitoring efforts targeted at air toxics, visit the Web site of the National Air Toxics Assessment at *http://www.epa.gov/ttn/atw/nata/*. Because the AirBeat project does not focus on air toxics, this class of pollutants is not discussed in this handbook.

- *Photochemical Assessment Monitoring Stations (PAMS).* PAMS are required to obtain more comprehensive and representative data about ozone air pollution in ozone non-attainment areas designated as serious, severe, or extreme. PAMS networks are used to monitor surface and upper-air meteorological conditions and ozone precursors (these are the various pollutants, such as volatile organic compounds and nitrogen oxides, that mix in the air and react chemically in the presence of sunlight to create ground-level ozone).

EPA's standards for monitoring networks are found in the Code of Federal Regulations (40 CFR Part 58, National Primary and Secondary Ambient Air Quality Standards). You can access and review these CFR sections from the Ambient Monitoring Technology Information Center (AMTIC) Web site at *http://www.epa.gov/ttn/amtic/40cfr58.html.*

EPA is currently revising its national air monitoring strategy. In starting new AirBeat-type programs in the future, organizations should gather information on the latest air monitoring network designs that are in use.

3.6 THE AIR QUALITY INDEX—A TOOL FOR REPORTING AIR QUALITY INFORMATION

The Air Quality Index (AQI) is a tool developed by EPA to provide people with timely and easy-to-understand information on local air quality and whether it poses a health concern. It provides a simple, uniform system that can be used throughout the country for reporting levels of major pollutants regulated under the Clean Air Act, including ground-level ozone and particulate matter.

The AQI converts a measured pollutant concentration to a number on a scale of 0 to 500. The higher the index value, the greater the health concern. For most of the criteria pollutants, the AQI value of 100 corresponds to the National Ambient Air Quality Standard established for the pollutant under the Clean Air Act. This is the level that EPA has determined to be generally protective of human health. For $PM_{2.5}$, the AQI value of 150 corresponds to the 24-hour NAAQS of 65 micrograms per cubic meter.

As shown below, the Air Quality Index scale has been divided into six categories, each corresponding to a different level of health concern. Each category is also associated with a color.

Color	Air Quality Index Value	Health Descriptor
Green	0 to 50	Good
Yellow	51 to 100	Moderate
Orange	101 to 150	Unhealthy for Sensitive Groups
Red	151 to 200	Unhealthy
Purple	201 to 300	Very Unhealthy
Maroon	301 to 500	Hazardous

The level of health concern associated with each AQI category is summarized by a descriptor:

- *Good (green).* When the AQI value for your community is between 0 and 50, air quality is considered satisfactory in your area.
- *Moderate (yellow).* When the index value for your community is between 51 and 100, air quality is acceptable in your area. (However, people who are extremely sensitive to ozone may experience respiratory symptoms.)

- *Unhealthy for Sensitive Groups (orange).* Some people are particularly sensitive to the harmful effects of certain air pollutants. For example, people with asthma may be sensitive to sulfur dioxide and ozone, while people with heart disease may be sensitive to carbon monoxide. Some groups of people may be sensitive to more than one pollutant. When AQI values are between 101 and 150, members of sensitive groups may experience health effects. Members of the general public are not likely to be affected when the AQI is in this range.
- *Unhealthy (red).* When AQI values are between 151 and 200, everyone may begin to experience health effects. Members of sensitive groups may experience more serious health effects.
- *Very Unhealthy (purple).* AQI values between 201 and 300 trigger a health alert for everyone.
- *Hazardous (maroon).* AQI values over 300 trigger health warnings of emergency conditions. AQI values over 300 rarely occur in the U.S.

For more information about the AQI, check out the EPA brochure entitled *Air Quality Index—A Guide to Air Quality and Your Health* (EPA-454/R-00-005), found online at *http://www.epa.gov/airnow/aqi_cl.pdf.*

3.6.1 HOW IS THE AIR QUALITY INDEX CALCULATED?

SLAM networks take measurements of levels of ozone, particulate matter (both $PM_{2.5}$ and PM_{10}), and other criteria pollutants several times a day. These are then converted into corresponding AQI values using standard conversion scales developed by EPA. For example, an ozone measurement of 0.08 parts per million, which happens to be National Ambient Air Quality Standard for ozone, would translate to an AQI value of 100.

Once the AQI values for the individual pollutants have been calculated, they are then used to calculate an overall single index value for the local area. The single AQI value is determined simply by taking the highest index value that was calculated for the individual air pollutants. This value becomes the AQI value reported in a community on a given day. For example, say that on July 12, your community has an AQI rating of 115 for ozone and 72 for carbon monoxide. The AQI value that will be reported that day for your community is 115. On days when the AQI for two or more pollutants is greater than 100, the pollutant with the highest index level is reported, but information on any other pollutant above 100 may also be reported.

Guidelines for reporting air quality using the AQI can be found online at
http://www.epa.gov/ttn/oarpg/t1/memoranda/rg701.pdf.

3.7 FOR MORE INFORMATION

3.7.1 EPA PUBLICATIONS ON GROUND-LEVEL OZONE AND PARTICULATE MATTER

Ozone and Your Health (EPA-452/F-99-003)
http://www.epa.gov/airnow/ozone-c.pdf
This short, colorful pamphlet tells who is at risk from exposure to ozone, what health effects are caused by ozone, and simple measures that can be taken to reduce health risk.

Smog—Who Does It Hurt? (EPA-452/K-99-001)
http://www.epa.gov/airnow/health/smog.pdf
This 8-page booklet provides more detailed information than "Ozone and Your Health" about ozone health effects and how to avoid them.

Haze—How Air Pollution Affects the View (EPA-456/F-99-001)
http://www.epa.gov/ttn/oarpg/t1/fr_notices/haze.pdf
This two-page pamphlet gives a general description of what regional haze is, where it comes from, and what is being done to reduce it.

PM—How Particulate Matter Affects the Way We Live & Breathe
http://www.epa.gov/air/urbanair/pm/index.html
This short pamphlet describes the sources and health effects of particulate matter and summarizes EPA's strategies for reducing PM.

3.7.2 ONLINE RESOURCES ABOUT THE NATIONAL AMBIENT AIR QUALITY STANDARDS

EPA Office of Air Quality Planning and Standards Web site
http://www.epa.gov/oar/oaqps/

EPA's Plain English Guide to the Clean Air Act (EPA-400/K-93-001)
http://www.epa.gov/oar/oaqps/peg_caa/pegcaain.html

EPA's Updated Air Quality Standards for Smog (Ozone) and Particulate Matter
http://www.epa.gov/ttn/oarpg/naaqsfin/

EPA's Revised Ozone Standard (1997 fact sheet)
http://www.epa.gov/ttn/oarpg/naaqsfin/o3fact.html

EPA's Revised Particulate Matter Standards (1997 fact sheet)
http://www.epa.gov/ttn/oarpg/naaqsfin/pmfact.html

3.7.3 ONLINE RESOURCES ABOUT AMBIENT AIR MONITORING

EPA's Ambient Monitoring Technology Information Center (AMTIC) Web site
http://www.epa.gov/ttn/amtic/

EPA's AirNow Web site
http://www.epa.gov/airnow/

EPA's Monitoring Requirements for Particulate Matter (1997 fact sheet)
http://www.epa.gov/ttn/oarpg/naaqsfin/pmonfact.html

Ozone Monitoring, Mapping, and Public Outreach: Delivering Real-Time Ozone Information to Your Community (EPA-625/R-99-007)
http://www.epa.gov/airnow/empact/start.htm

3.7.4 EPA PUBLICATIONS ABOUT THE AIR QUALITY INDEX

Air Quality Index—A Guide to Air Quality and Your Health (EPA-454/R-00-005)
http://www.epa.gov/airnow/aqi_cl.pdf
This booklet explains EPA's Air Quality Index (AQI) and the health effects of major air pollutants.

Guideline for Reporting of Daily Air Quality—Air Quality Index (EPA-454/R-99-010)
http://www.epa.gov/ttn/oarpg/t1/memoranda/rg701.pdf
This guidance is designed to aid local agencies in reporting air quality using the AQI.

4 BEGINNING THE PROGRAM

This chapter provides information and recommendations, based on the experience of the AirBeat project, on important first steps that you will need to take as you start your community-based air pollution monitoring and outreach program. Section 4.1 presents a brief overview of the structure of an AirBeat-type program and outlines the roles and responsibilities of program partners. Section 4.2 discusses the critical process of selecting program partners who can best help you meet your program's objectives within your target community. Section 4.3 presents guidance on identifying potentially impacted communities that you may want to target with your program. Section 4.4 provides tips on getting to know your target community in terms of the cultures and languages of residents, their awareness of air quality issues, and other factors. Finally, Section 4.5 offers suggestions on estimating program costs and leveraging resources available to you.

The information in this chapter is designed primarily for managers and decision-makers who may be considering whether to implement AirBeat-type programs in their communities, as well as for organizers who are interested in improving or refining existing programs.

Get to know your target community, including the cultures and languages of the people who live there.

4.1 PROGRAM STRUCTURE: OVERVIEW OF A COMMUNITY-BASED AIR POLLUTION MONITORING AND OUTREACH PROGRAM

AirBeat is a multifaceted project that engages in a variety of activities—everything from writing and distributing flyers to developing Web sites and calibrating monitoring equipment. These activities can be grouped into four main categories, which make up the main components of the project: monitoring, data management and delivery, education and outreach, and project management.

The following paragraphs summarize these activities to provide an overview of how the AirBeat project works. These activities are described in much greater detail in Chapters 5 through 7.

Monitoring During the planning stages for monitoring, a quality assurance plan is developed by senior technical experts familiar with the monitoring technologies to be applied.[5] Based on the plan, the monitoring site is then selected and the specific monitoring equipment to be used is identified and procured. On-site installation of the monitoring shelter and equipment is typically performed by a skilled field technician who will be responsible for the operation and maintenance of the equipment during the program. After equipment installation and checkout are completed, method-specific Standard Operating Procedures (SOPs), reflecting all technologies being applied, must be developed. Monitoring activities are conducted by field technicians in accordance with the SOPs and the monitoring schedule previously developed.

[5] In the case of AirBeat, the two partner organizations responsible for monitoring (MA DEP and the Harvard School of Public Health) already had well-established quality assurance (QA) programs in place. These programs included QA protocols for many of the measurement methods run at the Dudley Square monitoring station. AirBeat's senior technical experts developed a separate QA narrative to cover the operation of measurement methods run specifically for the AirBeat project. See Chapter 5 for more information about this narrative.

Data Management AirBeat's data management and delivery activities are performed by an automated Data Management Center (DMC), which is comprised of several hardware and software components. The DMC was developed during the EMPACT grant period (1999 to 2001) by AirBeat's information technology experts, and continues to operate today with minimal human oversight. The DMC executes numerous functions: downloading data files from the monitoring station via a modem-to-modem connection; storing the raw data to a database; validating data completeness and integrity; translating data into Air Quality Index values for reporting pollutant levels; generating graphics; and delivering data to the public via the AirBeat Web site and telephone hotline.

Outreach AirBeat's outreach efforts include two types of activities: 1) disseminating air quality data, and 2) educating Roxbury residents about the connections between air pollution and respiratory illnesses and about the steps that people can take to reduce harmful exposures. AirBeat has two automated systems for data dissemination—the AirBeat Web site and telephone hotline—which are still in operation today. During the EMPACT grant period, the AirBeat team conducted an extensive education campaign that relied on multiple approaches and outreach tools, including fact sheets and flyers, contextual materials posted on the Web site, press releases, curriculum modules, workshops and presentations, and events and tours. AirBeat also conducted direct outreach to nurses and other health care providers. Some education and outreach efforts are still ongoing (see Section 1.2 for the current status of the AirBeat project).

Management Project management under AirBeat was handled during the EMPACT grant period by the Suffolk County Conservation District (SCCD), a body of five elected individuals who volunteer their time to the agency, and Charles Consulting, a small, independent firm that was hired to manage the day-to-day operations of the project during the start-up phase. 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 need for a defined project management team ended in 2001 with the conclusion of the grant period.

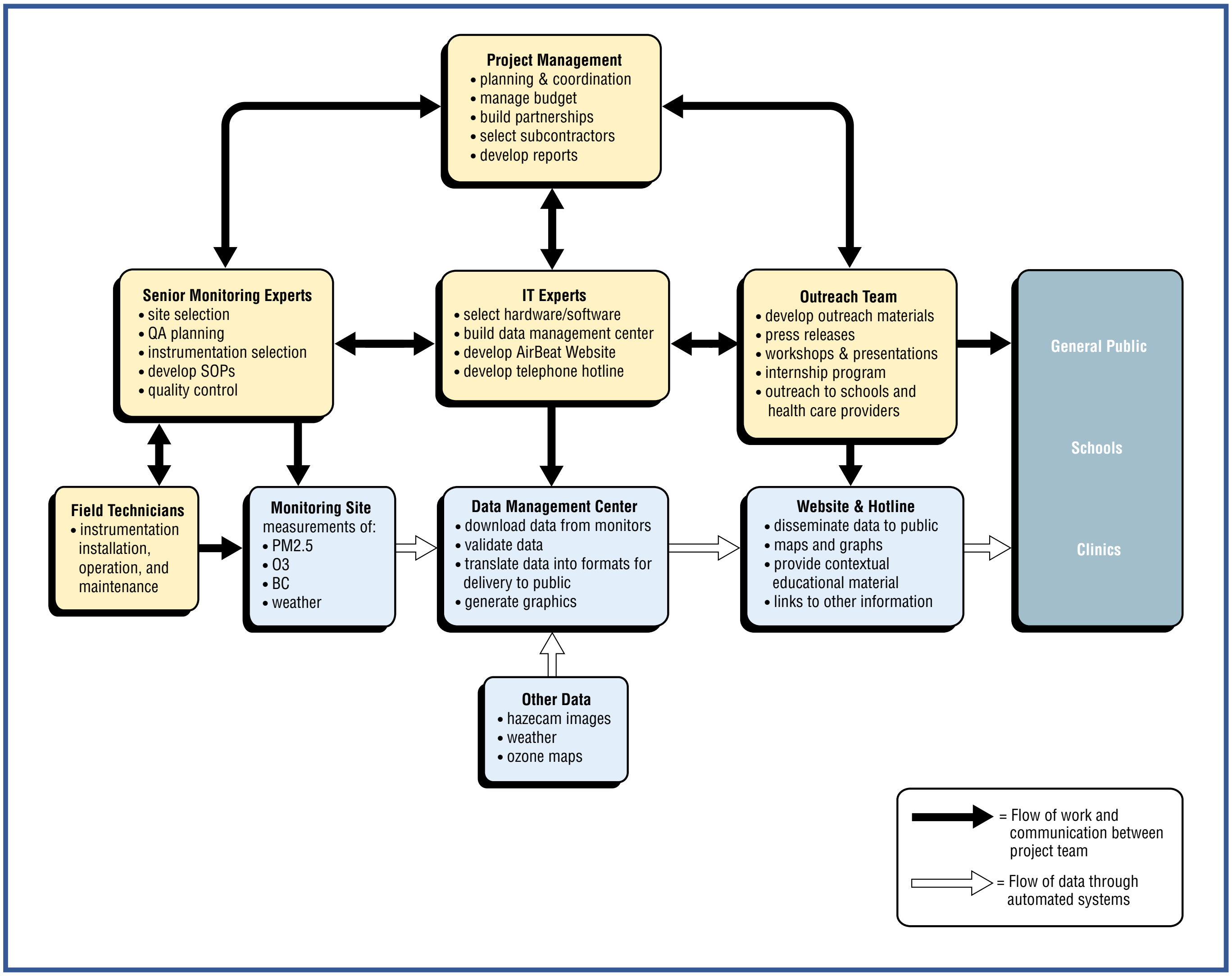
The flow chart on the following page summarizes the basic structure of the AirBeat project. The chart identifies the main activities of the project, the team members responsible for these activities, and the flow of work and communication between team members. It also shows the flow of data.

4.2 SELECTING PROGRAM PARTNERS

As described in Chapter 1, AirBeat grew out of a partnership between several public, private, and non-profit organizations. These included a university, a state environmental agency, a county conservation agency, an interstate air quality association, and a community-based environmental justice organization.

Why were so many partners needed for what is essentially a small-scale program? The activities conducted by AirBeat during the EMPACT grant period (1999 to 2001) demanded a number of specialized skills, from communication and language skills to air monitoring training, from Internet design experience to project management skills. Each partner played a different role in the project, based on the specific skills and qualifications that partner had to offer.

Structure of the AirBeat Project



For example, the Harvard School of Public Health, a founding AirBeat partner, offered the technical skills needed for developing innovative instrumentation set-ups for the Roxbury monitoring station. Harvard's staff also had the expertise to develop quality assurance plans for validating monitoring data. Alternatives for Community & Environment (ACE), the project's community partner, did not offer these kinds of technical skills, but contributed something just as important: familiarity with the Dudley Square neighborhood and the communication skills necessary to work closely with its residents.

In starting your own air pollution monitoring and outreach program, you'll need to assemble a team of individuals or organizations who offer a similar range of skills and qualifications. To select partners or team members, you should think about how each will fit into the overall program structure, and how different partners can work together to create a successful program. You will also need to consider their relationship to the target community. For example:

- An organization or agency that already has strong ties to the community can be ideal for conducting outreach and education for your program. Community action programs or neighborhood health centers can be a good choice.

- Partnering with a state or local air pollution control agency can allow you to tap into the existing monitoring infrastructure in your area and can ease the financial burden of setting up a monitoring station and procuring the necessary equipment and instrumentation. Agency staff can also offer your program a wealth of monitoring expertise. Depending upon which state you live in, air pollution monitoring may be carried out at the state level, or at the local, county, regional, tribal, or territorial level. EPA Regional Offices also can be valuable partners in your monitoring efforts.

  To find the agency (or agencies) responsible for air monitoring in your area, check out the Clean Air World Web site *(http://www.cleanairworld.org/).* The Web site allows you to search by state for air pollution control agencies, and provides contact names and information.

- A nearby college or university can help with any research components of your program, or may be able to provide assistance and equipment for the monitoring activities.

4.3 IDENTIFYING POTENTIALLY IMPACTED COMMUNITIES

The first step in beginning an air quality monitoring and outreach program is to identify target communities in your area that may be impacted by air pollution. There are two main approaches to doing this: using existing air quality data, or using air pollution predictors.

4.3.1 USING EXISTING AIR QUALITY DATA

In attempting to identify potentially impacted communities, you should start by doing some research to find out what types of air quality monitoring or testing is being (or has been) conducted in your area. Your state or local air pollution control agency should be able to provide you with information about its own monitoring programs and will likely know about any other local monitoring efforts (for example, air quality testing done by nearby universities or community organizations). See Section 4.2 for tips on contacting state and local agencies. EPA Regional Offices can also serve as a source of information.

Agency staff should also be able to point you to state publications and online resources that present any monitoring results that are publicly available. Most states, for example, publish an annual air quality report that summarizes monitoring results and identifies long-term air quality trends. Increasingly, states are also posting monitoring results directly to the Internet.

On a national level, EPA's Office of Air Quality Planning and Standards (OAQPS) publishes an annual *National Air Quality and Emissions Trends Report,* which gives a detailed analysis of changes in air pollution levels over the last 10 years, plus a summary of the current air pollution status. Among other things, the report identifies those cities and regions of the country that have been designated non-attainment areas—areas where air pollution levels persistently exceed the National Ambient Air Quality Standards for criteria pollutants. Information on non-attainment areas can also be found in EPA's "Green Book" *(http://www.epa.gov/oar/oaqps/greenbk/index.html),* an online resource published by OAQPS.

Another valuable source of information is EPA's AIR*Data* Web site, found at *http://www.epa.gov/air/data/index.html.* The AIRData site gives you access to air pollution data for the entire United States. It presents annual summaries of air pollution data from three EPA databases:

- The AIRS (Aerometric Information Retrieval System) database, which provides data on ambient concentrations of criteria air pollutants at monitoring sites, primarily in cities and towns.
- The NET (National Emission Trends) database, which provides estimates of annual emissions of criteria air pollutants from point, area, and mobile sources.
- The NTI (National Toxics Inventory) database, which provides estimates of annual emissions of hazardous air pollutants from point, area, and mobile sources.

4.3.2 USING PREDICTORS OF AIR POLLUTION

Another approach to identifying potentially impacted communities involves looking for geographic areas where the important predictors of air pollution are present. These predictors include (but are not limited to):

- *Heavy traffic flows* (especially diesel traffic). Motor vehicles produce a variety of air pollutants, including particulate matter and other pollutants that combine to form ground-level ozone. Diesel trucks and buses, in particular, are a significant pollutant source. Most state departments of transportation (DOTs) conduct ongoing studies to evaluate traffic flows and the types of vehicles using the roads. Contact your state DOT to ask whether they can provide study results for your area. Communities located near major transit corridors have a high potential for impacts from vehicle emissions.
- *Industrial emissions.* The presence of nearby industrial facilities (such as oil refineries, chemical plants, power plants, and asphalt plants) can be a predictor of air pollution. You can find out where such industries are located by contacting your state environmental agency or EPA Regional Office. For information on emissions of toxic pollutants, try searching EPA's Toxic Release Inventory (TRI) database to identify facilities in your area that have reported releases of toxics to the environment. The TRI is found at: *http://www.epa.gov/tri/*
- *High density of smaller businesses that release air pollution.* Many small businesses (such as gas stations, autobody shops, and dry cleaners) produce air pollution. Though emissions from these individual sources may be relatively small, collectively their emissions can be of concern—particularly when large numbers are located in heavily populated areas.
- *Construction activity, materials handling, and crushing and grinding operations.* All of these activities can act as a source of air pollution (coarse particulate matter, especially).

As part of the process of identifying potentially impacted communities, you might also want to gather information on local asthma hospitalization rates and the prevalence of other respiratory illnesses. By themselves, high asthma hospitalization rates are not considered an indicator of outdoor air pollution. (After all, there are other types of exposures, such as exposure to cigarette smoke and indoor air pollutants, that can trigger asthma attacks requiring hospitalization.) However, statistics on asthma incidence can help you identify communities that are vulnerable and potentially in-need of the type of data that your program will be generating. If these statistics show that local asthma rates are elevated, you can do additional research to determine if the community might be impacted by outdoor air pollution.

Community concern about elevated asthma rates in Roxbury was a driving motivation in the launch of the AirBeat project. Yet the project might never have come to fruition without the work done by Roxbury community organizations to quantify the number and types of local air pollution sources. For example, youth associated with ACE's Roxbury Environmental Empowerment Project undertook an effort to map air pollution sources in Roxbury neighborhoods. This research revealed that there were more than 15 truck and bus depots within a one-mile radius of Roxbury, garaging more than 1,150 diesel vehicles. With this information in hand, community leaders were able to capture the attention of state environmental officials with their request that a monitoring station be sited in Roxbury.

4.4 GETTING TO KNOW THE COMMUNITY

Once you have identified your target community, your task is to learn more about it. Make sure you have your target area clearly mapped and marked so that you can begin planning. Next, find out the key "statistics" about the community. Some of the questions you will want to answer about the community include:

- What are the cultures and languages of the people who live there?
- What are the residents' income and education levels?
- What organizations and agencies are active in the community?

- What health care facilities are located there?
- How many children in the community suffer from asthma and other respiratory illnesses?
- What is the level of awareness among community members about air pollution issues and health effects? What concerns do community members have about local air quality?

Information such as income and education levels can be obtained from census data; other information about the community can be provided by your community partners (see Section 4.2) and by your local or state department of health. All of this information will help you form a clear picture of your target community and the best ways to reach them.

Lessons Learned: Gathering Community Input Through Public Meetings

One effective way of getting to know your target community is to hold public meetings. You can use these meetings to present your plans for developing an air pollution monitoring and outreach program and to gather input from community members about their air quality concerns. Once your program is underway, public meetings provide an opportunity for alerting the community about the availability of your real-time data and educating residents about connections between air pollution and respiratory illnesses. AirBeat's outreach partner, Alternatives for Community & Environment, incorporated AirBeat information into dozens of workshops for youth peer groups from community health centers and housing developments. ACE staff also made presentations at large community events such as the Youth Summit, which attracts roughly 200 youth participants.

One Missouri-based program, the St. Louis Community Air Project (CAP), holds monthly community partnership meetings. These meetings give community representatives an opportunity to help direct the CAP project, communicate to the project coordinators what resources the community would find most useful, and learn about the most recent findings of the ongoing program research. Community input gathered during these meetings is a driving force in the ongoing evolution of CAP. See Appendix B for more information on the St. Louis Community Air Project.

4.5 ESTIMATING PROGRAM COSTS

Another important step for your organization to take when it is considering setting up an air pollution monitoring and outreach program is to estimate how much your planned activities will cost. Although your program need not be as large or ambitious as AirBeat's, you may find it helpful to know how much money AirBeat spent.

Over its first two and a half years, AirBeat received roughly $500,000 in funding from EPA's EMPACT Program. These funds were allocated to the five partner organizations, each of which was responsible for specific activities involved in the startup and implementation of the project:

- *Project management* was handled by the Suffolk County Conservation District (SCCD). This cost roughly $100,000, or 20 percent of the overall EMPACT budget for AirBeat. Specific management responsibilities included coordinating and facilitating meetings, writing reports, managing the AirBeat budget, building partnerships, and helping select subcontractors. SCCD hired an independent contractor, Charles Consulting, to oversee the day-to-day operations of the project during the EMPACT grant period.

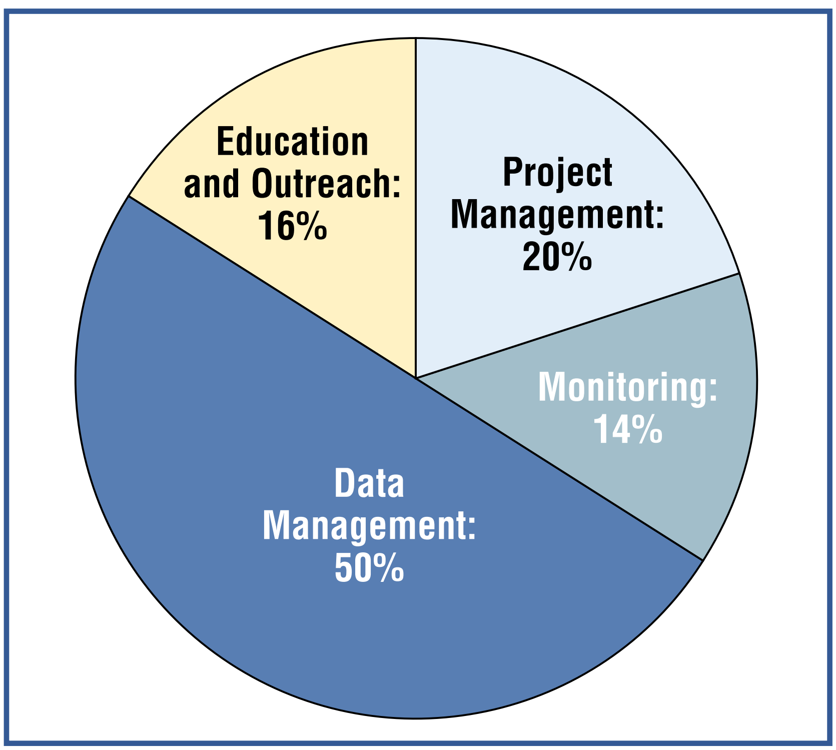
- *Air pollution monitoring* was conducted during the grant period by two organizations: the Harvard School of Public Health and the Massachusetts Department of Environmental Protection. HSPH staff were responsible for selecting the innovative measurement methods used at the Dudley Square station, developing quality assurance procedures for these methods, installing instrumentation, and operating and maintaining the monitoring equipment during the early project phases. This cost roughly $60,000. MA DEP held overall responsibility for the station (which is part of the state's monitoring network) and operated and maintained the station during the later phases of the grant period. MA DEP also purchased much of the instrumentation for the station. MA DEP's contributions to the AirBeat monitoring effort were generally paid for out of the agency's budget, although MA DEP did receive about $10,000 from AirBeat for the purchase of instrumentation.

  Overall, roughly $70,000, or 14 percent, of the AirBeat budget went toward the monitoring efforts. However, it should be noted that these figures don't represent the actual costs of the monitoring effort, since many costs were paid by MA DEP.

- *Data management and delivery efforts* were conducted by NESCAUM (Northeast States for Coordinated Air Use Management). These efforts cost roughly $250,000, or 50 percent of the AirBeat budget. Most of these funds went toward the development of an automated Data Management Center, which downloads data files from the monitoring station, validates the data, and prepares the data for delivery to the public. NESCAUM's other responsibilities included development of the AirBeat Web site and telephone hotline system. Since the end of the grant period, the Data Management Center, Web site, and telephone hotline have continued to operate in automated fashion.

- *Education and outreach efforts* were conducted during the grant period by Alternatives for Community & Environment. These cost roughly $80,000, or 16 percent of the AirBeat budget. ACE's activities included developing fact sheets and flyers, issuing press releases, creating and teaching curriculum modules on air quality issues, delivering workshops and presentations, and staging events and tours. ACE also conducted direct outreach to nurses and other health care providers and ran an internship program for Roxbury youths. Some of these activities have continued since the end of the grant period.

AirBeat Cost Breakdown, 1999-2001



This breakdown represents the startup and implementation costs of a cutting-edge program over roughly two and a half years. These costs should not be taken as completely representative of the ongoing costs of other air pollution monitoring and outreach programs. Since the end of the EMPACT grant period, in 2001, AirBeat has continued to provide real-time data on air pollution to the Roxbury community, with MA DEP financing the operation of the Dudley Square monitoring station as part of its statewide monitoring network. AirBeat's Data Management Center, Web site, and telephone hotline operate on an automated basis, with NESCAUM providing the little human oversight that is needed.

It is certainly possible for new programs to avoid some of the major costs absorbed by the AirBeat project. Here's just one example: Today, many state and local air control agencies have the capability of providing the public with real-time data from their monitoring networks. In other words, these agencies have developed data management systems that can validate continuous monitoring data, process it, and deliver it via Web sites in real time. In 1998, at the start of the AirBeat project, MA DEP did not have this capability. Therefore, as described in Chapter 6, AirBeat needed to create a Data Management Center of its own that could perform the real-time validation and processing functions—and this was an extremely costly task. A new AirBeat-type program getting underway today might be able to avoid this cost altogether if it could download pre-processed data (rather than raw data) from a partner agency's network. A model for this type of cost-efficient program is the St. Louis Regional Clean Air Partnership, described in *Appendix C.*

Tip!

During the planning of an AirBeat-type program, one principle to keep in mind is to *always leverage existing resources.* Do some research and networking and find out what activities are going on in your area related to air pollution. Is there a Web site out there already that reports ambient pollutant levels to the public? Then think carefully if there's a need for another one. Is there a local community group that is educating the public on air pollution issues? That group might make an excellent outreach partner. Is there a professor at the local university who is mapping pollutant sources in your area? Perhaps he or she would be interested in contributing to your project.

In the end, the actual costs of your program will depend on the decisions you make in response to numerous questions, both small and large, that will arise during the planning and implementation stages of your program. Examples include: How many pollutants will your program monitor? Can you partner with a state or local air control agency that is already monitoring those pollutants in your target community? Will you need to purchase monitoring instrumentation? What other organizations will you partner with, and what resources and areas of expertise do they bring to the table? Will your team include a qualified Internet Technology specialist who can oversee the data management operation on a daily basis, or will you need to subcontract this work?

5 MONITORING

This chapter provides general information on how to develop a monitoring system for making continuous measurements of ozone, fine particulate matter ($PM_{2.5}$), and black carbon soot in ambient air. Section 5.1 gives an overview of AirBeat's monitoring efforts. Section 5.2 details the key steps in designing and implementing a monitoring system and provides illustrative examples from the AirBeat project. These key steps include:

- Quality assurance planning (Section 5.2.1).
- Siting a monitoring station (Section 5.2.2).
- Selecting monitoring instrumentation and equipment (Section 5.2.3).
- Installation, maintenance, and operation of monitoring equipment (Sections 5.2.4 and 5.2.5).

The information in this chapter is designed primarily for program managers and others who are interested in the monitoring process. The chapter is meant to provide an overview of the work and considerations that go into designing a monitoring system. The chapter is *not* meant to provide step-by-step instructions. Any organization that is interested in developing an ambient air monitoring program is advised to consult with senior technical experts before launching the process.

5.1 OVERVIEW OF AIRBEAT'S MONITORING EFFORTS

AirBeat's real-time pollution data come from a single monitoring station located in Dudley Square, a major commercial hub in the center of Roxbury. This monitoring station is part of a statewide network of 42 monitoring sites operated by the Commonwealth of Massachusetts to gather data on ambient concentrations of criteria pollutants. Under the Clean Air Act, every state is required to operate a similar network of monitors (called State and Local Air Monitoring Stations, or SLAMS) to ensure that air quality meets federal standards. See Chapter 3 of this handbook for more information on SLAMS and federal air monitoring requirements.

The Massachusetts Department of Environmental Protection (MA DEP), an AirBeat partner, is the agency in charge of siting and operating the monitoring stations in the commonwealth's SLAMS network. In 1997, MA DEP began investigating the possibility of siting a $PM_{2.5}$ monitor in Roxbury to comply with new $PM_{2.5}$ monitoring requirements set by EPA earlier that year (go to *http://www.epa.gov/ttn/oarpg/naaqsfin/pmonfact.html* for a summary of the requirements). These requirements call for states to operate at least one $PM_{2.5}$ monitor in every metropolitan area with at least 500,000 people. The requirements also direct the states to site $PM_{2.5}$ monitors in areas where there is both a likelihood of observing high $PM_{2.5}$ concentrations and also a potentially large affected population. Based on preliminary $PM_{2.5}$ monitoring that had been carried out by various groups, Roxbury seemed to meet the requirements for a Boston-based monitoring location.

In siting the monitor, MA DEP invited the input of several local community organizations, including Alternatives for Community & Environment (ACE), an environmental justice organization that had advocated the need for air quality monitoring in Roxbury. Together, they settled on the Dudley Square location. Out of this cooperative effort, the AirBeat project was born. The driving motivation behind the project was a desire to leverage the air quality information from the new monitoring site by making the data accessible to Roxbury residents in real time. The final AirBeat team included MA DEP, ACE, the Suffolk County Conservation District, and two locally based organizations with proven expertise in ambient air monitoring: the Harvard School of Public Health and Northeast States for Coordinated Air Use Management (NESCAUM).

MA DEP's original intention had been to outfit the Dudley Square monitoring station with the same instrumentation being used at the time (circa 1998) at other $PM_{2.5}$ monitoring sites around the commonwealth. This meant that the station would produce measurements of $PM_{2.5}$ and two other criteria pollutants: sulfur dioxide and oxides of nitrogen. The $PM_{2.5}$ measurements would not be continuous.

Once the other AirBeat partners became involved, the decision was made to augment the monitoring capabilities of the Dudley Square station to address concerns that are specific to the Roxbury community. Chief among these concerns was the suspicion that elevated concentrations of certain air pollutants, such as ozone and particulate matter, might be contributing to Roxbury's high asthma hospitalization rate and the incidence of other respiratory illnesses. Community members had also raised specific questions about potential health effects associated with diesel emissions from trucks and buses (research by ACE interns had revealed that more than 1,150 trucks and buses are garaged within 1.5 miles of Dudley Square).

To address these questions, the AirBeat team arranged to include the following monitoring capabilities at the Dudley Square site:

- Continuous monitoring for $PM_{2.5}$.
- Continuous monitoring for black carbon soot, which is a strong indicator of local diesel emissions. Although BC is a component of $PM_{2.5}$ (typically about 10 percent by mass), its temporal variation can be very different, often peaking during morning rush hour. The Dudley Square station is the only monitoring site in the commonwealth that measures BC.
- Continuous monitoring for ozone.[6]
- Meteorological monitoring to track weather conditions.

The AirBeat team also made arrangements with MA DEP to download the raw monitoring data directly from the Dudley Square station via a modem-to-modem connection, so that AirBeat could process the data and deliver it to the public in real time. The Dudley Square station became the first monitoring site in Massachusetts producing real-time data that are accessible to the public online *(http://www.airbeat.org)* or through a telephone hotline (617-427-9500).

In addition, the AirBeat team arranged to download images of the Boston skyline from a HazeCam located 12 miles northeast of the city. The images from the camera, posted hourly to the AirBeat Web site, are meant to demonstrate the effects of urban air pollution on visibility, in addition to public health. See Chapter 6 for more information on the use of HazeCam images.

In selecting the instrumentation for the Dudley Square station, the AirBeat team chose to test two innovative methods for air quality monitoring. The first of these, the Continuous Ambient Mass Monitor (CAMM), is a new tool for measuring $PM_{2.5}$ concentrations in ambient air. The CAMM was tested side by side with another, more-established PM monitor (the TEOM) and proved reliable. The AirBeat team also tested an innovative method for monitoring BC concentrations: the Aethalometer, which provides a surrogate measurement of diesel emissions. Like the CAMM, the Aethalometer proved reliable, and it is the first BC monitor capable of taking continuous measurements at unattended monitoring stations. Section 5.2.3.2, below, provides additional details about both of these innovative instruments.

Three AirBeat partners shared the work of planning, setting up and operating the project's monitoring system:

- The Harvard School of Public Health, which was responsible for selecting and setting up the innovative monitors for $PM_{2.5}$ and BC, developing standard operating procedures, and conducting routine reviews.

[6] Along with ozone and $PM_{2.5}$, the station also monitors other criteria pollutants, including carbon monoxide, sulfur dioxide, and oxides of nitrogen, although these data are not reported to the public by AirBeat.

- MA DEP, which was responsible for selecting and setting up much of the station's instrumentation consistent with other MA DEP monitoring sites, developing standard operating procedures, and managing day-to-day operation and maintenance of the monitoring equipment.
- NESCAUM, which established and operated data management systems for downloading air quality data from the Dudley Square station, validating the data, and delivering it to the public in multiple formats.

The efforts of these three organizations are described in more detail in the following sections and in Chapter 6.

5.2 KEY STEPS IN DESIGNING AND IMPLEMENTING A MONITORING SYSTEM

Organizations interested in launching an AirBeat-type project should begin by contacting the agency in their state or region that is responsible for air quality monitoring. As described in Chapter 3 of this handbook, every state in the United States is required to operate a network of stations for measuring concentrations of common pollutants in ambient air. Monitoring for these pollutants is conducted in every large city and in numerous other locations. No matter where your organization is located, your best option for developing reliable ozone and particulate data within a reasonable budget is to tap into the existing monitoring infrastructure(s) in your area. Using the AirBeat model, you should try to develop a partnership with the air quality agency in your region or state. Such agencies have the resources and expertise needed to develop and operate reliable monitoring systems, as well as insight into the availability of other environmental monitoring resources.

The following subsections provide an overview of the key steps in designing and implementing an ambient air monitoring system for ozone and fine particulate matter. The information presented here is geared toward the development of monitoring systems that are consistent with EPA's standards for ozone and $PM_{2.5}$ monitoring networks. The information is meant to help program managers and others understand the monitoring process; it is not meant to be a substitute for the knowledge and expertise offered by senior technical experts.

5.2.1 QUALITY ASSURANCE PLANNING

Planning for quality assurance activities and preparation of a Quality Assurance Project Plan (QAPP) are central to the success of any environmental data collection operation. The QAPP details how quality assurance (QA)[7] and quality control (QC)[8] will be implemented for the complete duration of the project. All projects involving the generation or acquisition and use of environmental measurements data must be planned and documented prior to the start of data collection.

In a single document, the QAPP provides an overview of the entire project, describes the need for the measurements, and defines QA/QC activities to be applied to the project, with enough detail to provide a clear description of every aspect of the project.

The critical functions to be addressed in the QAPP are:

- *Project Background and Management.* This section of the QAPP should provide background information and define the problem to be addressed and the general goals of the project. It should also describe project organization (e.g., staffing responsibilities), quality objectives and acceptance criteria for measurement data, special training and/or certification requirements, and plans for documentation and record keeping.

[7] Quality assurance is defined as an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

[8] Quality control is defined as the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality.

- *Technical Approach.* This section of the QAPP should address the design and implementation of the project's measurement systems. The point is to ensure that appropriate approaches/methods are employed for performing measurements, data handling, and QC, and that these approaches/methods are thoroughly documented. The section should also detail what measurements are expected, what the applicable technical quality standards and/or criteria are, what the project schedule is, and what the reporting requirements are.
- *Assessment/Oversight.* This section of the QAPP should describe what QA/QC steps will be taken to ensure the effectiveness of the project and that all project facets are conducted according to plan. Facets to cover include: (1) experimental design, (2) representativeness of the data, (3) instrument operation and data acquisition, (4) calibration check procedures, (5) data quality indicators, (6) systems and performance audits, and (7) peer review.
- *Data Validation and Usability.* The QAPP should also describe what steps will be taken to ensure that the individual data elements conform to the criteria specified in the project's Data Quality Objectives.

Identifying Data Quality Objectives (DQOs) is one of the first steps in preparing a QAPP. DQOs are qualitative and quantitative statements, developed using the EPA DQO Process, that clarify study objectives and specify tolerable levels of potential errors. DQOs establish the quality and quantity of data needed to support program decisions. An example of a DQO used by the AirBeat project for its real-time data set is: "Precision and accuracy of better than 10% for ozone and continuous $PM_{2.5}$". The project's QA plan included detailed procedures for determining whether or not this DQO was being met.

For more information on QAPPs, see the document *EPA Requirements for Quality Assurance Project Plans,* available online at *http://www.epa.gov/quality/qs-docs/r5-final.pdf.* EPA's *Guidance for the Data Quality Objectives Process* can be found at *http://www.epa.gov/quality/qs-docs/g4-final.pdf.*

Quality Assurance Project Plans

A QAPP should demonstrate that:

- **Technical and quality objectives for the project have been identified and addressed.**
- **Intended measurement approaches are appropriate for achieving project objectives.**
- **Assessment procedures are sufficient to confirm that the project's Data Quality Objectives will be met.**
- **Any limitations on the use of the data have been identified and documented.**

5.2.1.1 AIRBEAT'S QUALITY ASSURANCE PLANNING

At the outset of AirBeat, two of the project's partner organizations—MA DEP and the Harvard School of Public Health—already had well-established QA programs in place. As the operator of a statewide ambient air monitoring network, MA DEP is required to have an EPA-approved QA program. Likewise, Harvard had developed a QA program that was evaluated by EPA for earlier monitoring efforts.

Rather than create a new QAPP to encompass the entire AirBeat project, MA DEP and Harvard were able to draw upon their existing QA plans. These plans included QA procedures for many of the measurement methods run at the Dudley Square monitoring station. AirBeat's senior technical experts developed a separate QA narrative to cover the operation of measurement methods run specifically for the AirBeat project. These included the continuous monitoring for $PM_{2.5}$, black carbon soot, and ozone.

The QA narrative, which is presented at the end of this chapter, provides background information about the monitoring effort, defines DQOs and the procedures for determining whether or not DQOs are being met, describes guidelines for assessing data completeness, and identifies procedures for detecting equipment failures.

5.2.2 SITING A MONITORING STATION

To ensure that measurement data collected during any monitoring effort are appropriate for their intended use, monitoring stations must be located to provide, to the extent practical, the most unbiased and accurate representation of the area being characterized. The selection of an appropriate location for a given ambient air monitoring application is dependent on:

- Project-specific DQOs.
- Method-specific specifications and recommendations.
- Monitoring site type (i.e., criteria pollutants, ozone precursors, air toxics, special application) and scale issues (i.e., macro, micro).
- Practical limitations.

Let's look at each of these considerations in turn.

5.2.2.1 PROJECT-SPECIFIC DATA QUALITY OBJECTIVES

The first step in appropriately siting a monitoring station is understanding the project-specific DQOs associated with the monitoring effort being planned. The DQO process is described in Section 5.2.1.

5.2.2.2 METHOD-SPECIFIC REQUIREMENTS

Most monitoring methods contain specifications and recommendations for siting the associated monitoring instrumentation and any ancillary equipment. The siting specifications and recommendations can be quite different from one monitoring method to another. If multiple monitoring methods are proposed for one site location, the siting specifications of each proposed method must be compared to determine compatibility. If conflicts exist in the siting specifications for different monitoring methods, prioritization of the targeted pollutants must be conducted. After the pollutants of interest have been prioritized, the siting specifications corresponding to the highest priority pollutant should be applied to the site location identification process, with the potential effect on lower priority targeted pollutants documented.

5.2.2.3 MONITORING SITE TYPE AND SCALE ISSUES

As with the specific monitoring method requirements, the monitoring site types have individual specifications and recommendations for locating a site. Examples of four primary site types are:

- Criteria pollutants—monitoring performed at locations of highest impact in areas where adherence to National Ambient Air Quality Standards (NAAQS) must be documented.
- Ozone precursors—monitoring performed around areas where the NAAQS for ozone have been exceeded.
- Air toxics—monitoring performed at locations determined to represent a snap-shot of an area or the potential for health risk.
- Special application—monitoring performed at a location potentially impacted by a specific source(s) for either regulatory or non-regulatory purposes.

Macro- and micro-scale siting issues must also be considered. Macro-scale issues include:

- Will the site typically be downwind of the sources of air pollution?
- Will the local air parcel represent the monitoring goals?
- Is cross contamination from other emission sources an issue?

Micro-scale issues include:

- Can all method-specific siting criteria be met, and if not, what will be the effect on the quality of the data generated?
- Are power and/or other required utilities accessible?
- Is there adequate space for the platform/shelter?
- Is the site free of air flow obstructions?
- Is security an issue and if so, can it be managed?
- Is the safety of field staff at an acceptable level?

5.2.2.4 PRACTICAL LIMITATIONS

Even after detailed and careful determination of where a site should ideally be located, practical limitations may impact the ability to meet the ideal. Practical limitations include:

- Availability of, and access to, property.
- Access to power and/or telephone service.
- Security and/or liability issues.

In cases where practical limitations prevent positioning a monitoring site at the location considered ideal, there are two alternatives: 1) the site may be positioned as close to the ideal location as possible if serious impacts to the data will not result; or 2) another appropriate location will have to be identified.

5.2.2.5 SITING THE AIRBEAT MONITORING STATION

Prior to the initiation of the AirBeat project, the environmental group Alternatives for Community & Environment had lobbied MA DEP to set up a monitoring site in what ACE considered to be an air pollution "Hot Spot" in Roxbury. Roxbury is a heavily urbanized neighborhood in the heart of Boston that is impacted by local bus and truck sources, and ACE relayed to MA DEP the community concern about exposure to diesel exhaust.

In response to these community concerns, MA DEP closed down a monitoring site located in the nearby town of Chelsea in order to initiate monitoring in Roxbury. In the process of developing DQOs for the planned Roxbury monitoring station, MA DEP determined that respirable particulate, or $PM_{2.5}$, was the highest priority targeted pollutant. Consequently, selection of an appropriate location for a Roxbury monitoring site was made based on siting considerations consistent with a top priority of performing representative $PM_{2.5}$ measurements in an inner city neighborhood environment. Roxbury presented itself as an ideal monitoring site location because:

- Historically, Roxbury has documented high rates of asthma and other respiratory illnesses that raised widespread concern about the local air quality.
- Diesel-powered vehicles have been shown to be major contributors to $PM_{2.5}$ emissions, and there are more than 15 bus and truck depots housing more than 1,150 diesel-powered vehicles within the Dudley Square area of Roxbury.

After evaluating adherence to the project DQOs and all of the siting specifications and recommendations associated with the proposed monitoring methods, a suitable site location was identified in the Dudley Square area of Roxbury, in an unused portion of a Boston Edison Electrical Substation yard. MA DEP secured permission from the Boston Edison Company to use the substation yard and locate a monitoring shelter, instrumentation, and ancillary equipment on their property. To ensure safety and security, MA DEP contracted to have a chain link fence installed to segregate the monitoring area from the area where active electrical transformers were located, and to provide security for the monitoring equipment and personnel during the study. After the fencing was installed, the monitoring shelter was erected at the site. Applicable location/siting specifications for each of the monitoring methods were documented in the method-specific Standard Operating Procedures (SOPs) prepared by MA DEP and HSPH prior to the onset of monitoring (see Section 5.2.5).

The final siting of the Dudley Square station meets EPA's guidance for $PM_{2.5}$ monitoring, which calls for measurements to be conducted in locations where there is both a likelihood of observing high $PM_{2.5}$ concentrations and also a potentially large affected population. For ground-level ozone, the Dudley Square station is considered a "neighborhood-scale site," producing measurements that are representative of "conditions throughout some reasonably homogenous urban subregion, with dimensions of a few kilometers." (This definition is from EPA's standards for monitoring networks as published in the Code of Federal Regulations: 40 CFR Part 58, National Primary and Secondary Ambient Air Quality Standards, accessible online at *http://www.epa.gov/ttn/amtic/40cfr58.html.*)

The Dudley Square monitoring station.

While the ozone data from the Dudley Square station accurately represent the concentrations that Roxbury residents are exposed to, the data are not representative of the ozone exposures of people who live outside of Boston's urban center—particularly those people who live downwind from the city, with its many pollution sources. To counteract this, the AirBeat Web site also includes regional ozone maps, which provide site visitors with information on ozone levels in the greater Boston area (the maps are downloaded from EPA's AirNow Website at *http://www.epa.gov/airnow*).

5.2.3 SELECTING MONITORING INSTRUMENTATION AND/OR EQUIPMENT

Many air pollutants can be measured using multiple, but unique, types of instrumentation and/or equipment. It is important that the correct approach most suited to the specific needs of an individual monitoring effort be selected. The selection process is keyed to the monitoring methods determined to be appropriate during development of the project DQOs. Specific selection issues that should be considered are:

- Measurement of the correct parameters.
- Required quantity and quality of the data.
- Ability to measure on the correct time scale.
- Compatibility with the site design (outdoor or indoor environment).
- Compatibility with other equipment (for example, interfacing continuous emissions monitors and meteorological instrumentation with a data acquisition system).
- Any regulatory-driven requirements.

In the case of criteria pollutants, including ozone and particulate matter, EPA has designated a number of "reference methods" or "equivalent methods" for measuring ambient pollutant concentrations. EPA has approved each of these methods for use in state or local air quality surveillance systems. Where determination of compliance with primary and secondary air quality standards is required, instrumentation must be certified by EPA to be a reference method or equivalent method. The equivalency designation provides that each separate instrumental approach may be directly substituted for the corresponding reference method, and the data obtained are acceptable for any use allowed by the reference method.

The following is an overview of the basic types of equipment needed to perform continuous air monitoring:

- Extraction equipment—used to extract a sample of a pollutant from the atmosphere for analysis.
- Analyzers—measure the pollution concentration in a sample of ambient air. Where possible, analyzers should meet the reference method or equivalent method requirements specified by EPA to help ensure that air quality measurements are accurate.
- Calibration units—determine the relationship between the observed and the true values of a measured parameter. *Accuracy* is the extent to which measurements represent their corresponding actual values, and *precision* is a measurement of the variability observed over repeated analyses. The accuracy and precision of data derived from air monitoring instruments depend on sound instrument calibration procedures.
- Data loggers—computerized systems that can control and record data generated from several instruments at a monitoring site. With a data logger, you can interact with software using either a keyboard or an interactive, command-oriented interface. Data loggers perform numerous functions: reviewing collected data, producing printed reports, controlling the analyzer and other instruments, setting up instrument operating parameters, performing diagnostic checks, setting up external events and alarms, and defining external storage.

Data can be downloaded from the data loggers to an off-site computer through a modem connection. In addition to the off-site computer and modem, data acquisition and processing software and a data storage module are needed to make the data available for further processing. See Chapter 6 for more information on data management, processing, and delivery.

5.2.3.1 INSTRUMENTATION SELECTED FOR THE DUDLEY SQUARE MONITORING STATION

Table 5-1 provides a list of the specific instruments and equipment used at the Dudley Square monitoring station. With a few notable exceptions, most of the instrumentation installed at the station was selected by MA DEP. Because the Dudley Square station is part of a statewide SLAMS network and generates data that are used for determining compliance with federal air quality standards, MA DEP relied on instruments that have been designated by EPA as reference or equivalent methods. These include instruments for making continuous measurements of ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide. Because EPA regulations currently do not allow for continuous $PM_{2.5}$ monitors to be used for compliance monitoring, MA DEP installed a Thermo Andersen RAAS2.5-300 Sequential Sampler at the site to measure 24-hour $PM_{2.5}$ concentrations. These 24-hour measurements are used for determining compliance with the 24-hour National Ambient Air Quality Standard for $PM_{2.5}$ (see Section 3.4.2).

Of the compliance monitors listed in the first section of Table 5-1, AirBeat uses only data from the continuous ozone monitor. These ozone data are reported in real time on the AirBeat Web site. The second section of the table lists the instruments used for gathering the real-time $PM_{2.5}$ and black carbon data reported on the site. See Section 5.2.3.2 for more information about these instruments.

When looking through the table, keep in mind that air monitoring technology is a rapidly evolving field. Because much of the instrumentation for the Dudley Square site was selected in the period between 1998 and 1999, it does not necessarily represent the best or most up-to-date instrumentation currently available. If you are interested in launching an AirBeat-type monitoring program and have questions about appropriate instrumentation, contact your state or local air control agency, which will have up-to-date information on the latest EPA-certified measurement methods. Indeed, you should make every effort to engage your state or local air control agency as a partner in your monitoring effort. If you are interested in gathering further information on reference or equivalent methods for measuring criteria pollutants, you can also visit the following Web page, operated by EPA's Ambient Monitoring Technology Information Center: *http://www.epa.gov/ttn/amtic/criteria.html.* The Web page provides lists of EPA-approved instrumentation.

Table 5-1. Monitoring Instrumentation and Equipment Used at Dudley Square Site

	Instruments Used for Compliance Monitoring
Ozone (O_3)	Advanced Pollution Instrumentation (API) 400 O_3 Analyzer (EPA Reference Method Number EQOA-0992-087)
Fine Particulate Matter ($PM_{2.5}$)	Thermo Andersen RAAS2.5-300 Sequential Sampler (EPA Reference Method Number RFPS-0598-0120)
Nitrogen Dioxide (NO_2)	TECO 42C NO_2 Analyzer (EPA Reference Method Number RFNA-1289-074)
Sulfur Dioxide (SO_2)	TECO 43C SO_2 Analyzer (EPA Equivalent Method Number EQSA-0486-060)
Carbon Monoxide (CO)	API 300 CO Analyzer (EPA Reference Method Number RFCA-1093-093)
Calibration System	Dasibi Model 5008 Multipoint Gas Phase Titration Calibration System with a Dasibi Model 5011 Zero Air Unit (Meets EPA monitoring requirements as defined in 40 CFR Part 53) with Protocol 1 Certified Gas Cylinders
Calibration System	TECO Model 146 Multipoint Gas Phase Titration Calibration System with a TECO Model 111 Zero Air Unit (Meets EPA monitoring requirements as defined in 40 CFR Part 53) with Protocol 1 Certified Gas Cylinders
Instruments Used for AirBeat-Specific Measurements	
Black Carbon Soot	AE-21 Dual Channel Aethalometer, Magee Scientific, Inc.
$PM_{2.5}$	Met One Instrumentation 1020 Beta Attenuation Mass Monitor
$PM_{2.5}$	Tapered Element Oscillating Microbalance (TEOM), Rupprecht & Patashnick Co., Inc.
$PM_{2.5}$	Andersen Continuous Ambient Mass Monitor (CAMM)
Haze	Hazecam Automatic Camera Visibility Monitoring System, Air Resources, Inc.
Meteorological Monitors	
Meteorological Parameters	Met One Instrumentation Meteorological Station for Wind Speed, Wind Direction, Temperature, Barometric Pressure, Relative Humidity and Solar Radiation (Meets EPA monitoring requirements as defined in 40 CFR Part 53)
Data Acquisition System	
Datalogger	Environmental Systems Corporation (ESC) Model 8816 DSM Data Acquisition Unit
Computer	HP Brio Desktop
Modems	Zoom Telephonics Models 14.4K and V34 plus
Data Software	ESC E-DAS Digi-trend Software for Windows

5.2.3.2 RESEARCH INSTRUMENTATION APPLIED AT THE AIRBEAT MONITORING SITE

As mentioned in Section 5.1, the AirBeat team chose to test two innovative methods for air quality monitoring at the Dudley Square site: the Continuous Ambient Mass Monitor (CAMM), a new tool for measuring $PM_{2.5}$ concentrations in ambient air, and the Aethalometer, which measures concentrations of black carbon as a surrogate for diesel emissions.

The CAMM is a new technology that was made commercially available by Andersen Instruments in the summer of 2000. The AirBeat team tested the CAMM side by side with another, more-established PM monitor: the Tapered Element Oscillating Microbalance (TEOM). (The TEOM is usually used for PM_{10} measurements, but can be adapted for $PM_{2.5}$ monitoring by placing an impactor inlet upstream to remove particles larger than 2.5 micrometers.) These comparative tests showed that the CAMM produced representative data. In March 2001, the TEOM was turned off, and for the following year the CAMM was used to generate the $PM_{2.5}$ data that were posted to the AirBeat Web site and updated on an hourly basis. In spring of 2002, problems emerged with the CAMM unit and it could not be repaired by the manufacturer in a timely manner. The CAMM was replaced by a Met One Instrumentation Beta Attenuation Mass Monitor, which is still in use.

To supplement the core air pollution measurements of ozone and $PM_{2.5}$, AirBeat also measures aerosol black carbon and UV-absorbing carbon using the Aethalometer, a real-time optical absorption monitoring instrument. Measurements of black carbon are of interest because black carbon is a surrogate for elemental carbon; mass of black carbon as reported by the Aethalometer agrees well with integrated elemental carbon mass samples. Hourly data from the Aethalometer are available on the AirBeat Web site. In urban areas, the predominant source of black carbon is from diesel fuel used in buses, trucks, and construction equipment. Although black carbon is a component of $PM_{2.5}$ (around 10 percent by mass, typically), its temporal variation can be quite different, usually peaking during morning rush hour. Real-time measurements of black carbon are thus required to evaluate the temporal variation and provide useful information on potential health effects to residents of the area.

> **Tip!**
>
> **The technology used to continuously monitor fine particles is constantly evolving and being improved. The experience of the AirBeat project—which used three different technologies within a two-and-a-half-year period—demonstrates this point. Any organization planning a new AirBeat-type project should do its homework before deciding upon a particular type of monitor.**

5.2.4 INSTALLING AND MAINTAINING MONITORING EQUIPMENT

The key to effective installation of instrumentation and equipment at a site is to plan ahead of time a layout allowing the best use of the interior and exterior space available so that field personnel can operate the site in an efficient and safe manner. When planning the site layout, particular consideration must be given to adherence to any/all siting requirements (i.e., specified distances around and between collections systems, height from ground level of sample collection intakes, acceptable instrumentation temperature ranges, etc.). Equipment must be situated so that field technicians have the space to conveniently conduct operation and repair activities, without disturbing the function of other instrumentation and equipment. It is essential to plan for adequate electrical power with outlets located in close proximity to the equipment.

Safety must also be a primary consideration when planning a site layout. Placement of instrumentation and equipment must minimize the potential for personal injury. Injury can be the result of physical, electrical, chemical, or environmental hazards. All applicable occupational health and safety standards must be met.

After the instrumentation is installed and operating, a maintenance plan should be developed to ensure continued operation. The maintenance plan may be a separate document, or planning for instrument maintenance may be a part of the Standard Operating Procedures (SOPs) written for the monitoring program (see Section 5.2.5 for information on SOPs). Procedures and schedules must be established for activities intended to reduce the potential for missing data due to monitoring instrumentation, equipment, or station malfunctions or problems.

Computers and monitoring equipment inside the secure shelter at the Dudley Square station.

There are two approaches to maintenance that must be addressed—preventive and corrective. Preventive maintenance involves conducting planned service activities prior to, and in an effort to avoid, failures. Based on manufacturers' recommendations, historical information on previous application of the equipment, and sound knowledge, the following determinations must be made:

- What are the components that must be replaced at specific intervals and what are the intervals?
- What are the components that can receive servicing to extend their lifetime, and what is the service and interval for service?

A schedule reflecting required service activities must be developed, and service must be conducted accordingly. When developing the schedule, make sure to consider the timing of service activities so that data collection won't be disrupted (affecting data capture completeness).

Because of their complexity, electro-mechanical devices occasionally fail. Given this fact, the primary purpose of corrective maintenance planning is to establish procedures that ensure that unscheduled repairs are completed as rapidly as possible. An integral facet of efficient corrective maintenance is possessing a store of appropriate replacement parts. Based on input from the manufacturer, a list of replacement parts for each monitoring or critical ancillary device should be developed. The list should be detailed and present items by part description, vendor, part number, cost, and approximate delivery time required. Parts determined to have the highest potential for failure, or that have a long delivery time, should be obtained and stored until required.

A maintenance checklist presenting the date of service, equipment identification information, service performed, person performing the service, and any associated notes should be prepared at the time of each servicing activity, for both preventive and corrective maintenance actions.

5.2.4.1 AIRBEAT'S MAINTENANCE ACTIVITIES

AirBeat defined the specific procedures for maintaining monitoring instrumentation—and the appropriate frequency of maintenance—in the SOPs that were developed for each instrument. During the EMPACT grant period (1999 to 2001), quality checks for AirBeat included twice-a-week station visits, with routine inspection of all systems at each visit. Monitors were calibrated quarterly, with flow or precision checks performed bi-weekly. At least one internal performance audit was conducted on all monitors during the grant period. Since 2001, all instruments at the Dudley Square station have been maintained by MA DEP.

5.2.5 OPERATING THE MONITORING EQUIPMENT

To ensure that representative data and a high data capture rate are achieved, each piece of monitoring equipment must be operated in strict accordance with an in-depth operating protocol. Although general operating instructions are typically provided by the manufacturer, and general operational guidelines and performance specifications are available for EPA-approved methods, these instructions and guidelines do not provide the level of detail needed to facilitate standardized operation of monitoring equipment. To achieve the appropriate level of detail and standardization, and to consequently ensure that the monitoring equipment provides high quality data, Standard Operating Procedures must be prepared for each specific measurement method/approach conducted.

EPA has published a document that provides guidance for preparing SOPs, available at *http://www.epa.gov/quality1/qs-docs/g6-final.pdf.* Where monitoring data will be used for determining compliance with federal air quality standards, SOPs should be prepared according to this guidance and should address specific topics as follows:

- Introduction and background information.
- Location and siting criteria applied.
- Calibration procedures, standards, acceptance criteria, and schedule.
- Quality control procedures, standards and checks, acceptance criteria, and schedule.
- Data reduction, validation procedures, reporting, and schedule.

5.2.5.1 OPERATION OF THE AIRBEAT MONITORING EQUIPMENT

The monitoring conducted at the Dudley Square monitoring station during the EMPACT grant period was performed in accordance with well-prepared SOPs as presented in Table 5-2.

As the table shows, most of the SOPs were documents prepared by MA DEP for operating instrumentation in the agency's SLAMS network. These SOPs were prepared according to EPA guidance. Each document is very long and highly detailed.

The Harvard School of Public Health developed the SOPs for the Aethalometer, TEOM, and CAMM. These are shorter, less formal documents. Given that the data from these instruments were not used by MA DEP for determining the commonwealth's compliance with federal air quality standards, it was not necessary for Harvard to follow the official EPA guidance for developing SOPs. The SOP for the Aethalometer is presented as a sample at the end of this chapter.

Table 5-2. SOPs for the Dudley Square Monitoring Equipment

Instrument Type	Pollutant	Prepared By
Aethalometer	Black Carbon Soot	HSPH
Tapered Element Oscillating Balance Monitor	$PM_{2.5}$	HSPH
Continuous Ambient Mass Monitor	$PM_{2.5}$	HSPH
Continuous Emission Monitor	Carbon Monoxide	MA DEP
Equivalent Continuous Emission Monitor	Ozone	MA DEP
Continuous Emission Monitor	Oxides of Nitrogen	MA DEP
Semi-continuous Beta Attenuation Mass Monitor	$PM_{2.5}$	MA DEP
Meteorological Monitoring System	Wind Speed, Wind Direction, Relative Humidity, Temperature, Solar Radiation, Barometric Pressure	MA DEP

5.3 FOR MORE INFORMATION

EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5, EPA/240/B-01/003)
http://www.epa.gov/quality/qs-docs/r5-final.pdf

Guidance for the Data Quality Objectives Process (EPA QA/G-4, EPA/600/R-96/055)
http://www.epa.gov/quality/qs-docs/g4-final.pdf

EPA Guidance on Technical Audits and Related Assessments for Environmental Data Operations (EPA QA/G-7, EPA/600R-99/080)
http://www.epa.gov/quality/qs-docs/g7-final.pdf

Network Design for State and Local Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS). Code of Federal Regulations. Title 40, Part 58, Subpart E, Appendix D.

Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Part 1 (EPA-454/R-98-004)
http://www.epa.gov/ttn/amtic/files/ambient/qaqc/redbook.pdf

Technical Assistance Document for Sampling and Analysis of Ozone Precursors (EPA/600-R-98/161)
http://www.epa.gov/ttn/amtic/pams.html

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (EPA/625/R-96/010b) *http://www.epa.gov/ttn/amtic/airtox.html*

Designated EPA Reference and Equivalent Methods for Criteria Pollutants
http://www.epa.gov/ttn/amtic/criteria.html

Equivalent Reference Method Designation Procedures and Program. Code of Federal Regulations. Title 40, Part 53.

Guidance for Preparing Standard Operating Procedures (SOPs) (EPA QA/G-6, EPA/240/B-01/004)
http://www.epa.gov/quality1/qs-docs/g6-final.pdf

AirBeat Quality Assurance Narrative Statement

MA DEP and HSPH, the two organizations responsible for making the environmental measurements, both have been collecting air pollution data for over 25 years and have established QA programs in place. MA DEP's QA program is required by the U.S. EPA for their SLAMS program, and the HSPH QA program has been required and evaluated by the U.S. EPA as part of recent cooperative agreements with that agency. This QA narrative covers the operation of measurement methods run specifically for this EMPACT project (hourly means for real-time $PM_{2.5}$, black carbon soot, and ozone) and the real-time data processing and validation for those methods that is done specifically for use in this EMPACT project. It does not cover the non-EMPACT integrated methods being run at the same site or the data processing and validation of "official" MA DEP data streams for real-time $PM_{2.5}$, black carbon soot, and ozone, since the MA DEP has existing QA programs in place for those efforts, and those data will not be directly used by this project. Although continuous $PM_{2.5}$ and BC are relatively new methods and not yet commonly used for routine ambient monitoring, HSPH has been running both of these methods in several studies since 1990, including a 3-year study in Boston. The experience gained from this previous work with these methods will be applied to both the operational and data validation aspects of EMPACT, and will insure generation of complete and high quality data for this project.

Data Quality Objectives for the real-time (hourly) data set will include precision (coefficient of variation) and accuracy of better than 10% for ozone and continuous $PM_{2.5}$. For ozone, this is determined by repeated calibrations and internal audits; for continuous $PM_{2.5}$ by external flow checks, mass transducer calibrations, and comparison to integrated 24-hour samples (TEOM). For the Aethalometer assessment of precision and accuracy is limited to flow checks, since there are no other practical techniques for precision and accuracy for this method. Traditional techniques of replicate sampling used for integrated PM sampling methods can not be readily used for any of these continuous methods, since that would require multiple samplers.

Station visits will occur at least twice a week; routine inspection of all systems will be performed at each visit. Monitors will be calibrated quarterly, with flow or precision checks performed bi-weekly. The TEOM $PM_{2.5}$ impactor will be cleaned twice a week, per EPA requirements. TEOM and Aethalometer leak checks will be performed at least quarterly. Standard Operating Procedures (SOPs) for all of these methods have been developed for previous studies and will be adapted for use in this project. All ozone, flow, and mass calibration standards used are NIST traceable. At least one internal and if possible, one external performance audit will be conducted on all monitors during the EMPACT monitoring period.

Completeness will be assessed on an hourly basis; a valid hour requires 75% of the interval (45 minutes) to be valid; a valid day requires 18 valid hours (75%). Since this is a short-term pilot program, seasonal or yearly completeness criteria are not used; however we expect to achieve an overall daily data capture and public reporting rate of 95% or higher after the system is fully functional. There is no sample custody for these continuous methods other than data management, which is discussed elsewhere in this proposal. The sampling and analytical methods are discussed in the proposal's Approach section.

Although as noted in the proposal the data for this project will not be the final validated data set that will be submitted to AIRS by the MA DEP, it is still important that the preliminary real-time data distributed to the public via EMPACT be of known quality. Therefore it is important for this project that instrument failures are detected automatically to prevent grossly invalid data from being publically presented. This will be accomplished by utilizing built-in status flags on the instruments and by real-time data screening for outliers, impossible values, 'stuck values', rates of change, excessive short-term (1 minute interval) noise, etc. All instruments will be configured to allow observation of negative values for screening purposes. These data processing issues, along with other real-time data handling QA processes, are addressed in the attached Information Management Plan. As a final independent check of the EMPACT data management process, a subset of the "official" MA DEP hourly data set will be compared with archived EMPACT data on an ongoing basis as the MA DEP validated data becomes available on a quarterly basis, approximately 1 to 3 months after collection. Any significant discrepancies will be investigated. The validated MA DEP data for these monitors will be made available via the EMPACT Web site on a quarterly basis when it is submitted to the U.S. EPA AIRS database.

AirBeat
Roxbury Air Monitoring

Operating Protocol for BC with Magee Scientific AE-21 Aethalometer™

G. Allen, HSPH, Rev. 1, September 20, 1999

This protocol is for Black Carbon (BC) soot measurements using the Magee Scientific AE-21 dual channel Aethalometer™ with a 4-lpm Harvard Impactor (HI) $PM_{2.5}$ inlet at the Roxbury MA DEP site. The instrument is run with tape-saver mode off and flow reported at 20E C.

Any times that data are not valid while the system is "on-line" should be noted in the site computer log, along with any comments or notes. If at all possible, avoid doing any procedure that causes loss of data during periods with BC concentrations higher than about 5 µg/m3.

Once Each Week:

1. Check the system date and time on the Aethalometer display and on the data logger PC. The Aethalometer time should be within 5 minutes of the PC's time. Times should always be EST (subtract 1 hour from daylight time). If the time is reset, record the time error before changing the time, and the date and time you changed the time. The Aethalometer must be "stopped" to change the time, but does not need to be taken "off-line" from the data acquisition system, since the -5 volt output in this state automatically flags the data as void in the data logger. A security code must be entered to stop the Aethalometer and perform certain other system operating tasks; the default code is 111 and should not be changed. If there is a clear trend in the system time error (for example, a system typically gains 2 minutes each week), set the time somewhat off in the opposite direction of the trend to reduce the need for frequent system time changes. For the fast clock example given above, set it 4 or 5 minutes slow each clock reset.
2. Check the sample flow on the Aethalometer display and record it in the log. It should be 4.0 ±0.3 lpm. Adjust with the valve on the pump if necessary, and record the after adjustment value in the log sheet.
3. Check the Aethalometer display for normal operation (reasonable readings, no error messages, etc).
4. Change both impactor plates on the roof inlet. Plates can be reused at least 5 times by field cleaning before being throughly cleaned in the lab. Wipe the deposit off the plates with a Kimwipe, apply one drop of mineral oil on each plate, and blot dry after 30 seconds to remove any excess oil.
5. Check the filter tape supply. Change it if the thickness of the roll is less than 1/8" thick. Re-tension the tape roll take-up spool if needed. Inspect the used filter tape spots that are visible for distinct and uniform borders between the exposed and unexposed areas. If obvious poor seals are noted, contact HSPH.

Once Each Month:

1. While the Aethalometer is in its normal run mode, perform an external flow check. Do not stop data collection on the Aethalometer to do this test, since that can change the flows. The "tape-saver" function must be off to perform this flow check procedure.

1a. Measure the sample flow at the inlet of the fine mass impactor using a BIOS flow meter, dry test meter, rotameter, or other calibrated volumetric (e.g, not STP) flow measurement device with a range of 3 to 5 lpm. Wet flow devices are not recommended since they can not be used below freezing, and have a RH dependent error due to water vapor. The external flow meter must be at ambient temperature for readings to be valid. A STP flow device can be used if the temperature is 20E C; in this case skip the next step.

– more –

1b. Record the flow from the Aethalometer display (a Sierra MFM with STP at 70E F). Correct the external volumetric flow measurement to a standard condition of 20E C and 29.92" Hg as follows:

$$\text{STP flow} = \text{actual flow} \; * \; \frac{293}{273 + \text{ambient T in degrees C}} \; * \; \frac{\text{Station BP (in inches)}}{29.92}$$

For this site (Roxbury), station pressure can be the pressure reported from Logan Airport, since the site elevation is less than 30 meters above sea level.

1c. Calculate the % error of the Aethalometer flow compared to the external flow standard. % error = 100 x (Aethalometer display - external STP flow) / external STP flow If the flow difference is more than 10%, contact HSPH.

2. Leak check the Aethalometer by disconnecting the inlet hose at the rear of the instrument and blocking the inlet on the back. Record the flow on the flowmeter display after 30 seconds; it should be less than 1.5 lpm. Reconnect the sample line.

3. Change the Aethalometer data disk. The Aethalometer does not need to be interrupted to do this as long as the change is done during the first three minutes of any five minute measurement cycle [based on the Aethalometer's internal clock]. Before changing the disk, start by labeling a new disk with the site and start date/time (local standard time). Remove the old data disk and insert the new disk. Immediately put the write protect tab on the old disk, and record the end date/time (EST) on the disk label. Return the disk to HSPH.

Once Each 6 Months:

Perform an optical strip check according to the manual. Also verify that the concentration reported by the data logger agrees with the Aethalometer display within 200 ng while the optical strip is in place. Record the results of both these in the comment section of the instrument log.

6 DATA MANAGEMENT

This chapter presents general information about managing, processing, and delivering data generated from an air pollution monitoring effort. Section 6.1 provides an introduction to data management and suggests ways of reducing the costs and technical challenges involved. Section 6.2 offers an overview of AirBeat's data management efforts, focusing on the functions of the project's Data Management Center, where all project data are collected, managed, and archived. Sections 6.3 and 6.4 discuss the hardware and software components used to operate the Data Management Center. Finally, Sections 6.5 and 6.6 describe the creation of AirBeat's Web site and telephone hotline.

Sections 6.1 and 6.2 are meant to provide a plain English overview of data management for programs managers and others who may have limited experience with information technology (IT). The other sections are more technical in nature, and are designed for IT specialists who may be charged with creating a data management system for an air pollution monitoring and outreach program.

6.1 INTRODUCTION TO DATA MANAGEMENT

In an environmental monitoring project such as AirBeat, data management is the process of collecting data generated by monitoring instruments, validating and standardizing the data, storing the data in a database, and then translating the data into formats that can be communicated to the public. Today, most data management systems are automated systems operated by complex configurations of computer hardware and software. Building such systems requires the expertise of experienced information technology specialists.

The scale of your project's data management needs, and the resources required for this project phase, will depend on a number of factors. Will your project be providing real-time data? How many types of data will you be reporting? Will your project be responsible for assuring the quality of the data, or will QA procedures be conducted by the agency or organization that owns and operates the monitoring sites?

As indicated in Section 4.5 of this handbook ("Estimating Program Costs"), data management turned out to be one of the most costly and technically challenging components of the AirBeat project. This was true for several reasons. One key factor was AirBeat's decision to build a data management system that could collect, process, validate, and deliver data in real time. The Massachusetts Department of Environmental Protection (MA DEP), the agency that owns and operates the AirBeat monitoring station as well as 41 others in the commonwealth, has its own program for collecting, processing, and validating air quality data. However, at the inception of AirBeat in 1998, MA DEP did not have the capabilities for managing and delivering data in real time. This meant that the AirBeat project was required to build its own real-time data management system from scratch—a costly proposition.

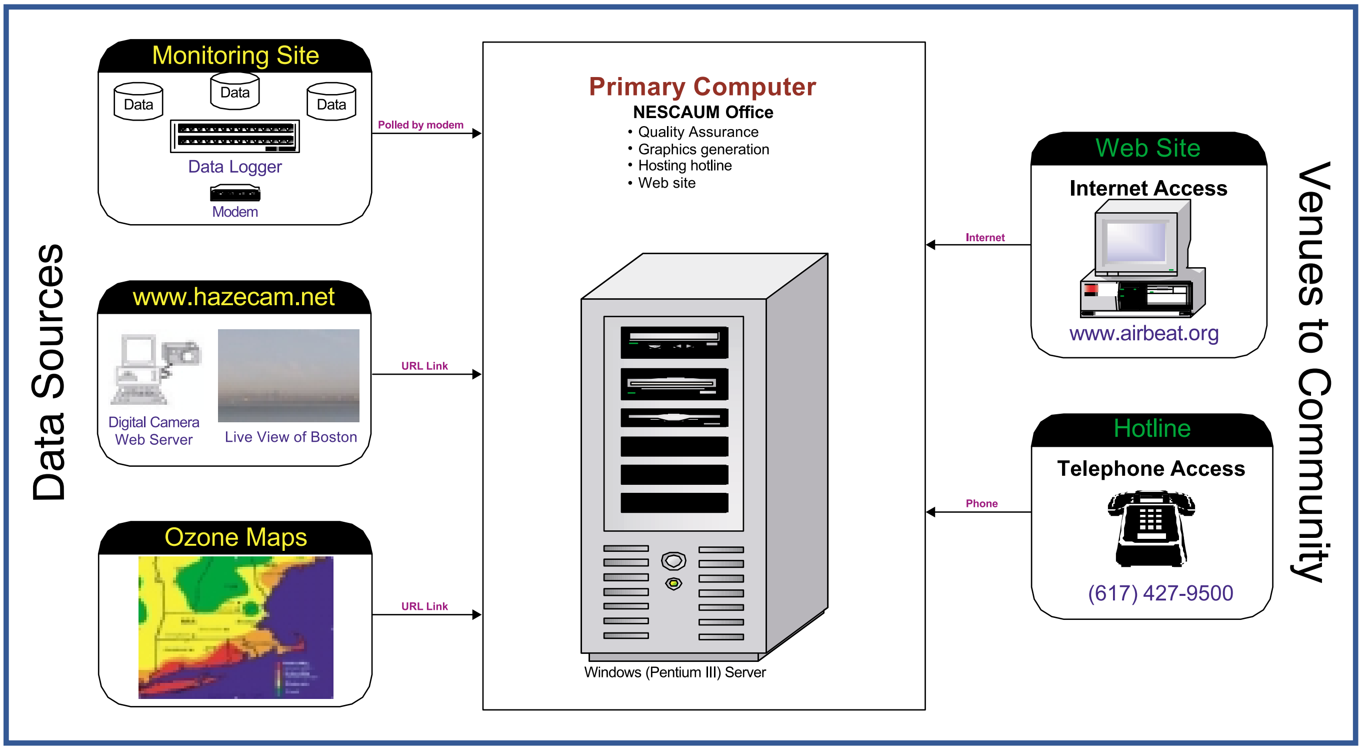
> **Tip!**
>
> **Find out if your state or local air control agency has the data management capabilities to provide the public with real-time data from its monitoring network. If so, you might be able to arrange with the agency to download pre-processed data (rather than raw data) from the agency's network, thereby avoiding the costs of building a separate data management system.**

It's worth noting that there are ways of structuring an air pollution monitoring and outreach program that can reduce the costs and challenges involved with data management. Today, many state and local air control agencies have the data management capabilities to provide the public with real-time data from their monitoring networks (MA DEP intends to develop this capability in the coming years).

An AirBeat-type program getting underway today might be able to arrange with its state or local air control agency to download pre-processed data (rather than raw data) from the agency's network, thereby avoiding the costs of building a separate data management system. A model for this type of cost-efficient program is the St. Louis Regional Clean Air Partnership, described in *Appendix C.*

In reality, no two projects will have precisely the same data management needs or systems. This chapter describes the AirBeat project's data management system as a case study, meant to illustrate some of the considerations that go into building a real-time system for managing and processing environmental information. The chapter also describes the work that went into creating the AirBeat Web site and telephone hotline, two key tools for delivering air pollution data to the public.

Design Diagram for AirBeat Data Management System



6.2 Overview of AirBeat's Data Management Efforts

All data for the AirBeat project were and are being collected, managed, and archived at a single Data Management Center, which puts the data into a standard electronic format and performs quality checks prior to making the data available to the public.

The AirBeat Data Management Center (DMC) is shown schematically in the diagram above. As the diagram shows, the DMC collects data from multiple sources. Types of data include monitoring data downloaded from the data logger at the AirBeat monitoring site, hazecam images downloaded from a digital camera Web server, and ozone maps downloaded from EPA's AirNow Web site *(http://www.epa.gov/airnow).* In addition, some data on weather parameters originate from the National Weather Service and the National Oceanic and Atmospheric Administration.

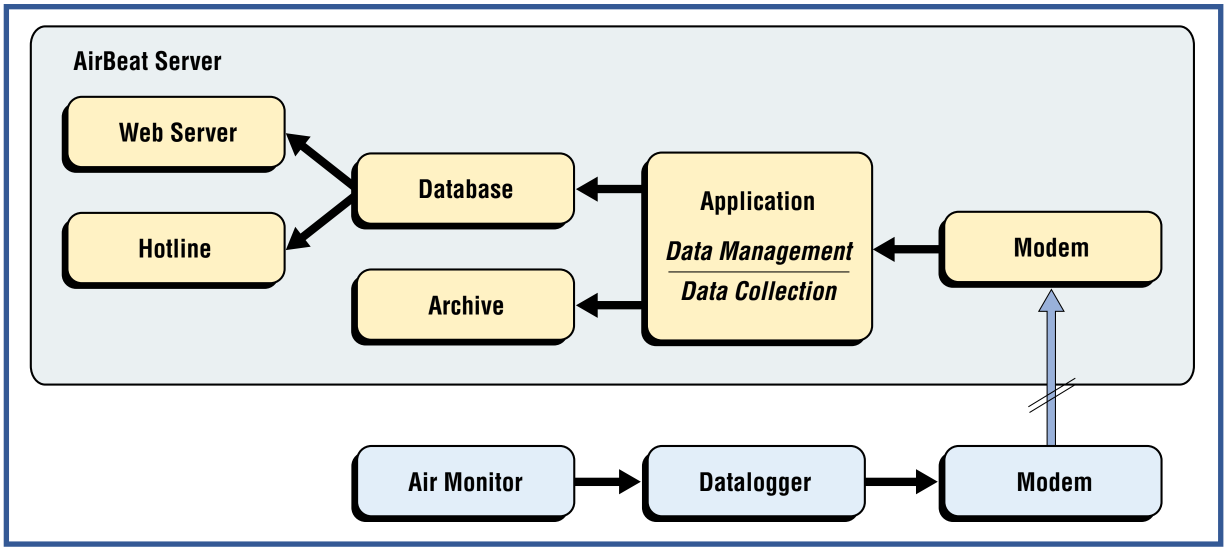
Once the data are processed and validated, they are communicated to the public via various venues. AirBeat had planned to implement multiple communication venues to optimize communication with the public, including a toll-free telephone hotline, an e-mail and fax listserver, an AirBeat Web site, and an information kiosk to be located in the Roxbury community. Due to budget constraints, only the hotline and the AirBeat Web site were implemented during the period of the EMPACT grant (1999 to 2001). (Roxbury high school students also developed an innovative flag system for communicating air quality data to the public—this is described in Chapter 7.)

Though the DMC handles a variety of data streams from different sources, its key function is processing the data from the AirBeat monitoring site in Dudley Square. This involves collecting the data, assuring its quality, storing the data in a standardized format, and translating the data into other formats for communication to the public. A further breakdown of the steps in this process is as follows:

- Download an ASCII text file from the Dudley Square air monitoring station. Each file contains the measured levels of each air pollutant for the previous hour, along with weather parameters. The files are available over a standard telephone line (modem-to-modem) and must be automatically retrieved every hour.
- Validate data file completeness and integrity.
- Transfer file contents to a database.
- Flag data that do not meet pre-defined quality control limits (as defined by MA DEP and the Harvard School of Public Health).
- Calculate Air Quality Index values for quality-assured data (see Chapter 3 for information on the AQI).
- Copy quality-assured data and indices into database tables for use by graphics, Web, and voice-response software programs.
- Generate and record logs to monitor system operation.
- Alert system administrator when certain errors occur.

All of the specifications cited above are achieved by some combination of hardware, commercially available software packages, information available from the Internet, and code written in Visual Basic®. These are described in more detail in the following section. An overall picture of the Data Management Center data flow is shown in the flow chart below.

AirBeat Data Flow



Lessons Learned: Including an IT Specialist on the Project Team

At the outset of the AirBeat project, none of the partner organizations had an information technology specialist on staff who could take on the technically challenging task of creating and operating the project's Data Management Center. As a result, the AirBeat project team decided to hire a contractor to lead this effort. In selecting the contractor, the team hoped to give preference to a local (preferably Roxbury-based) contractor who would be able to meet and interact with the AirBeat team regularly.

In the execution of the project, the selected contractor (a small local business) was unable to complete the work in a satisfactory manner. The initial version of the data management software created by the contractor was full of bugs. Because of a lack of responsiveness in addressing these problems, the contractor was removed from the project after approximately one year, leaving the AirBeat project in a difficult position: with the data management hardware installed and operational but with only part of the software in place and operational. Also, documentation to support the operation of the Data Management Center was minimal. (The contractor had been asked to document all data formats, scripts, parameter definitions, and directory structures to maximize transferability and sustainability of the project.)

NESCAUM hired an Information Technology specialist, who discarded most of the computer programs written by the original contractor. New source code was written to link commercial software packages and to manage data input. The resulting Data Management Center operated smoothly, but the AirBeat team had learned a lesson in the process: *For any project requiring collection of environmental monitoring data, it is helpful to include a qualified and experienced IT specialist on the project team who can oversee the data management operation on a daily basis and ensure that the work is being performed correctly and documented thoroughly.* Incorporating this IT specialist on the project management team is highly desirable.

If a contractor is going to be used, consider the pros and cons of using a small local business versus a larger, more established company. Reasons to select a small local business include offering positive support to the community and benefitting from a small business's personal connections to the community. However, considerable difficulties can arise if the business moves or closes before the completion of the work. Larger businesses, on the other hand, offer stability and perhaps a larger skill set (or more areas of expertise), but typically don't have the same types of community connections.

The bottom line is: include an IT specialist on your project team if at all possible.

6.3 HARDWARE COMPONENTS USED TO OPERATE THE DATA MANAGEMENT CENTER

To operate its Data Management Center, AirBeat uses a Dell Dimension 450 MHZ computer with a 13.6 GB hard drive and a US Robotics 28.8K external modem. These hardware components were selected and purchased in the 1998/1999 time frame. The components have served AirBeat well, and continue to be used today. However, the components are not listed in this handbook as recommendations for the use of other AirBeat-type programs. Because of the rapid evolution of hardware in the field of information technology, most computer systems that could be purchased today would outperform the system described above. For example, a search of the US Robotics Web site or a general search for modems will show that the 28.8K external modem is no longer readily available: most equipment manufacturers now feature 56K modems of various types. AirBeat originally intended to use an internal modem to download data from the Dudley Square monitoring site. However, AirBeat's original contractors reported problems using the internal modem that was supplied as part of the computer system and therefore went to an external modem. Since the external modem was performing acceptably when responsibility for the Data Management Center shifted to the NESCAUM IT specialist, no changes were made.

The computer system purchased for AirBeat was originally obtained with 128 MB of memory, but the computer memory was upgraded for performance reasons to 384 MB. At the present time, the system could be upgraded further if required. The hard drive purchased for this computer system has a capacity of 13.6 GB. After 2 to 3 years of utilization of this hard drive in the operation of AirBeat, less than half of this capacity (around 6 GB) is being used, and not entirely for material related to AirBeat. The hard drive is still more than sufficient, and could be upgraded if required.

Tip!

When selecting hardware for your data management system, carefully consider how your memory needs might evolve over the lifetime of your project.

6.4 SOFTWARE COMPONENTS USED TO OPERATE THE DATA MANAGEMENT CENTER

The software tools used to perform the functions required of the Data Management Center are summarized in the table below. Some of these components are discussed in detail following the table.

Table 6-1. Software Components of the DMC

Package	Function
Microsoft SQL Server	Stores data and metadata
Microsoft Access 97	Database to support the telephone hotline
Visual Basic® 6.0	Application programming language
SaxComm Objects	Terminal emulation: connects to the data logger at the monitoring site and captures monitoring data
Microsoft IIS 3 (Windows NT 4.0 Operating System)	Used to create and operate the AirBeat Web site
Graphics Server	Creates graphs on the Web site
Dialogic Software (with accompanying Dialogic IVR Board)	Presents air quality information via telephone hotline

Visual Basic® 6.0

The single software package selection that determined most of the subsequent choices of other available packages was the choice of Visual Basic® 6.0 (VB) as the application programming language. VB is Microsoft Windows-specific, so there were no other options for the hardware system selected. The original contractors selected VB because they were most familiar with it, not necessarily because VB was the best technical choice. VB is used for three things: 1) to import ASCII data from the data logger at the monitoring site to a text-based data file residing on the production server, 2) to import data from the data file to the MS Access® data model, and 3) to verify the quality and integrity of the information by processing the data through a rules algorithm defined by the AirBeat project team. VB performs the following functions:

- Reading a text file
- Listing a directory
- Creating a log file
- Reading and writing large files
- Reading and writing binary data
- Watching file system changes

NESCAUM considered switching the AirBeat Data Management Center from the Windows-based Visual Basic® to freely available software. Cost-effective alternatives to VB that NESCAUM considered include Tcl, a freely available scripting language available for multiple operating systems, including Windows and Linux. Tcl is a language that provides the building blocks for custom applications. NESCAUM also considered Perl (possibly in combination with Tcl), since Perl is a language especially suited for manipulating strings, and a major portion of the programming effort required string manipulation. Perl could also produce Web server scripts as well as ASP, the Windows-specific program. Numerous books and manuals describing Tcl and Perl are available online through O'Reilly Bookstores: *http://www.OREILLY.com.*

To make the switch away from Visual Basic®, AirBeat would have incurred a significant cost in re-programming. Ultimately, it was not deemed practical for AirBeat to change after the original choices had been made. For organizations interested in starting an AirBeat-type program, the bottom line is: carefully evaluate the capabilities and associated costs of any software package before committing to a purchase. Consider freely available alternatives, and remember that software is a rapidly evolving field.

SaxComm Objects

Another commercial software package, SaxComm Objects, was used by the AirBeat project for terminal emulation—that is, connecting to the data logger at the monitoring site and capturing the monitoring data. This software performs a screen capture of the text screens containing the data generated by the data logger. SaxComm Objects is used to dial up to a text-based service, with the specific benefit of being able to embed in another application.

To utilize the commercial software for data transfer, the IT specialist on the AirBeat project team wrote Visual Basic® code to run a timer that invokes SaxComm Objects every hour, sending the software the phone number to dial and the commands to send to the site data loggers, as well as telling the software how to handle the screen capture file. The returned file that is transferred is a text file containing a table with all of the monitoring data; a representative file is found at *ftp://airbeat.org/upload/roxbury/bookmark1.txt.*

Lessons Learned: Use of a Digital Camera—Hazecam

CAMNET is an organization initiated by NESCAUM to raise public awareness about the effects of air pollution on visibility. This function is accomplished, in part, through a network of real-time visibility cameras located at scenic urban and rural locations. CAMNET pictures are updated every 15 minutes. In addition, real-time air pollution and meteorological data are provided to help distinguish natural from man-made causes of poor visibility and to provide health-relevant data to the public on current air pollution levels. Air pollution and meteorological data are updated every hour.

AirBeat's Data Management Center downloads hazecam images from a digital camera sited by NESCAUM, MA DEP, and the EPA Regional office to provide real-time images of the Boston skyline. The digital camera is part of a turn-key system supplied at a cost of $6,000 to $7,000 by Air Resource Specialists, Inc. *(http://www.air-resource.com).* The system includes the following components:

- A high resolution digital camera with zoom lens and integrated scripting.
- A custom-designed controller.
- A Personal Digital Assistant (PDA) palm computer interface.
- A battery-backed power system (AC or solar power).
- A lockable environmental enclosure.

Air Resource Specialists hosts and operates a digital camera network over most of the northeast United States, and digital images from the Boston area are supplied to the network *(http://www.hazecam.net)* as well as the AirBeat Web site. The camera is positioned appropriately to take timed pictures of the Boston skyline, showing haze, fog, or a clear day. In operation, the computer is programmed to tell the digital camera to take a picture at the specified time intervals. The digital image is downloaded from the camera to the hard drive of the computer and sent by modem to Air Resource. Air Resource edits the digital image, as required, and then sends the edited image to subscribing Web sites.

The digital camera image is central to the AirBeat Web site and provides a prime illustration of the guiding principle for a project such as AirBeat: make full use of all available resources. A major investment of time and capital resources would be required to purchase a digital camera system and program the system to send images at regular time intervals to the AirBeat Web site. Accepting a digital image sent from Air Resource and putting this image on the AirBeat Web site is a relatively small cost.

A hazecam image of the Boston skyline, taken on a relatively clear day, with low pollutant levels.

6.5 CREATING THE AIRBEAT WEB SITE

The work of creating a Web site for disseminating air quality data is best done by a qualified and experienced IT specialist. As mentioned earlier in this chapter, it is helpful to include an IT specialist on your project team. If a contractor must be used for your Web-development efforts, look for a contractor with extensive experience in HTML coding, basic scripting skills, and some experience working with Web-enabled databases. The contractor should also have familiarity with Web accessibility guidelines and demonstrated experience at creating attractive and user-friendly Web pages.

The AirBeat Web site *(http://www.airbeat.org)* was created by several contractors, who worked on the site in succession. The Web site has two primary functions: to provide public access to AirBeat's real-time air pollution data and other air quality information, and to promote AirBeat's outreach goals by presenting an array of online educational materials and providing links to other sources of information. Section 7.2.1 of this handbook discusses these functions in more detail and provides visual examples of the ways that air quality information is presented on the Web site.

To create the Web site, AirBeat's contractors paired the existing hardware with Microsoft Internet Information Server (IIS) 3, available as a part of Windows NT 4.0 Server. IIS is a standard Web and File Transfer Protocol (FTP) server, with built-in Web page generation scripting. For information on a more recent version of this software, see *http://www.microsoft.com/windows2000/technologies/web/default.asp.*

Adobe Photoshop was used for designing and creating graphics for the Web site. The html pages were written using a text editor, rather than a specific software package. The scripted (dynamic) parts of the Web site were done using Active Server Page (ASP) scripts, a part of the Web server software (Microsoft IIS 3). Programming was done in the Microsoft Visual Studio Environment, a software package that includes Visual Basic®.

The graphs on the Web site, which continue to be updated hourly, are created with Graphics Server *(http://www.graphicsserver.com).* Graphics Server is a very powerful graphics production program that has its interface in Visual Basic®. Graphics Server adds interactive graphs to the numerical data that are being put into the Web site, using multiple platforms, multiple hosts, multiple interfaces, and an extensive range of graphs, charts, and statistical functions. The data features of Graphics Server allow charting of up to 128,000 dynamic data points in a single graph and can even plot incoming data in real time. See Section 7.2 for examples of the types of graphs generated on the Web site.

The AirBeat Web site is operational and available to the public. Maintenance and improvements to the system have continued since the end of the EMPACT grant period (1999 to 2001), and the Web site continues to operate at the NESCAUM office. The Data Management Center can integrate data into the Web site from Internet resources (for example, ozone maps are integrated from EPA's AirNow Web site: *http://www.epa.gov/airnow*). The Web site also provides links to other organizations' Web pages.

6.6 CREATING THE TELEPHONE HOTLINE

AirBeat's telephone hotline (617-427-9500) was created so that Roxbury residents without Internet access can still obtain timely information about air quality. The hotline reports current pollutant concentrations and also reports the highest concentrations for the current day and the peak concentrations from the previous day. In addition, the hotline message interprets these data from a public health standpoint and recommends actions that sensitive individuals can take to reduce exposures.

The hotline is supported by a Dialogic IVR Board with accompanying software. (Information about Dialogic equipment can be found at *http://www.voiceinternational.com/*.) The AirBeat team used Insight IVR®, developed by Micro Delta Corporation, as the application generator to build an Interactive Voice

Response application. The Insight IVR® Package software was used in conjunction with the Dialogic voice processing board to create and maintain the AirBeat hotline. To foster community involvement in the hotline, high school students in the Roxbury area pre-recorded air quality messages so that the hotline-supporting hardware and software could select the appropriate pre-recorded segments to describe air quality on an hourly basis.

Microsoft Access 97 *(http://www.microsoft.com/office/access)* is used as the database to support the hotline. The only purpose of the Access database is to replicate some of the data in the SQL database for the hotline to use. The Access database is required to solve a deficiency in the hotline software; replacement of the hotline software would result in a cost savings by making use of the Access database unnecessary.

AirBeat has had some problems with the hotline system (for example, there were problems in getting the system to use two telephone lines when it should be capable of using four). However, the system was operational for much of the EMPACT grant period, and continues to operate in automated fashion.

Lessons Learned: Tracking Usage of the Hotline

The AirBeat team considers the hotline a key venue for communicating air quality data to the public. It is especially important given that few Roxbury residents have the ability to connect to the Internet and thus access the AirBeat Web site.

A point of frustration for the AirBeat team has been their inability to track usage of the hotline. The creation of the hotline was a fairly costly and challenging process, and the team would like to be able to monitor its use in order to assess the return on their investment.

Hotline systems can be purchased that include usage tracking features. New AirBeat-type programs should consider investing the extra resources from the start to buy a system that has these features.

7 EDUCATION AND OUTREACH

This chapter provides information on setting up and running an education and outreach component of an air pollution monitoring program. Section 7.1 provides tips on developing an outreach plan for your program, with a focus on defining goals, key messages, and target audiences. Section 7.2 describes a variety of outreach tools that can be used, and provides examples of outreach materials developed by the AirBeat project. Finally, Section 7.3 describes the challenge of evaluating the success of your education and outreach program.

The information in this chapter is designed primarily for managers who are implementing air quality monitoring programs, as well as for education and outreach workers who are responsible for communicating about these programs.

7.1 DEVELOPING AN OUTREACH PLAN

AirBeat represents a step forward for air quality monitoring, a field that has evolved gradually for over 50 years. Scientists in the United States started developing air pollution monitoring devices in the 1940s, 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. AirBeat, and other programs like it, are the descendants of that early system. The goals of today's programs are essentially the same as 50 years ago: to gather accurate, timely data on air pollution and to communicate these data to the public in ways that can reduce harmful human exposures. The difference is that today's technologies allow air monitoring programs to collect more nuanced data and to communicate with the public in much more sophisticated ways. In the case of AirBeat, the goal is to deliver data directly to residents in a way that can affect their daily decision-making.

Communication is at the heart of AirBeat's mission, so an effective education and outreach program is key to the project's success. During the EMPACT grant period (1999 to 2001), AirBeat's education and outreach program was run primarily by Alternatives for Community & Environment (ACE), a non-profit organization that has worked closely with the Roxbury community on environmental justice issues since 1993. ACE has strong ties with other community and activist organizations in Roxbury, and has significant experience working to educate the public about environmental and health issues. ACE also has a flourishing internship and leadership development program for 14- to 18-year-olds, and the organization's interns played a key role in AirBeat's education and outreach efforts, as described in the box on the next page. Other AirBeat partners contributed outreach work as well, especially Northeast States for Coordinated Air Use Management (NESCAUM), which coordinated the development of two of the project's key outreach tools—the AirBeat Web site and the telephone hotline system.

The first step to creating an effective education and outreach program of your own is to develop an outreach plan. This plan will provide a blueprint for action. It does not have to be lengthy or complicated, but it should define four things: What are your outreach goals? Who are the target audiences? What are the key messages and types of information that you want to deliver? And what outreach tools will you use to reach these audiences? Let's look at each of these questions in turn.

Lessons Learned: Involving Youth Interns in Community Outreach Efforts

ACE, the Roxbury-based organization that spearheads AirBeat's outreach efforts, runs a youth program called the Roxbury Environmental Empowerment Project (REEP). REEP has trained more than 300 Roxbury youth on environmental justice and leadership issues through an in-class curriculum, an after-school internship program, and community workshops.

ACE interns played an integral part in AirBeat's community outreach efforts. Their accomplishments included:

- Designing a community survey on air pollution that they administered to approximately 80 Roxbury residents in 1999. The survey assessed residents' understanding of air pollution issues and helped AirBeat determine the best methods for delivering air quality information to the target community.
- Developing and distributing a "Roxbury Air Quality Fact Sheet," which describes pollution sources and health effects and summarizes what the AirBeat monitoring has indicated about pollutant levels in Dudley Square.
- Delivering a presentation at a Boston city hearing on the connection between traffic congestion and air pollution.
- Helping to create and operate an innovative air quality flag warning system for communicating AirBeat data to the local community. See Section 7.2.3 for more information about the system.

Involvement in the AirBeat effort provided a valuable learning experience for the ACE interns. The interns were treated as part of the AirBeat team and attended the project's monthly organizational meetings. The interns contributed to the meetings and presented information about their accomplishments. Through their participation, the youths understand how to use and interpret air quality data and take action on pollution issues.

The youths' participation has also benefitted the project itself. For the technical members of the AirBeat team, the interns provided a human face for the target population. In addition, the interns were among the best ambassadors for the program. Acting as "youth experts" on air pollution issues, they were able to share their knowledge with the community, educating their peers and neighbors about how to use real-time air quality data to improve their lives.

Two former interns recently co-authored (along with ACE staff members) an article about AirBeat that was published in the journal *Environmental Health Perspectives* (volume 110, supplement 2, April 2002).

7.1.1 WHAT ARE YOUR OUTREACH GOALS?

Defining your outreach goals is the first step in developing an education and outreach plan. Outreach goals should be clear, simple, action-oriented statements about what you hope to accomplish through outreach. Here are six goal statements for outreach that the AirBeat team included in their original project proposal:

1. Develop multiple communication venues to ensure widespread access to environmental information and to appeal to the various communication preferences among end users.
2. Promote access to, awareness of, and use of the real-time air pollution data through an active outreach and education campaign.
3. Develop contextual material to assist understanding and interpretation of the real-time data, including its limitations.
4. Affect and improve daily decisions to reduce the harmful effects of air pollutants.
5. Bolster the community's effectiveness in shaping local policies for transportation, development, and construction projects that affect air pollution.
6. Evaluate, document, and disseminate results for further benefits in other EMPACT cities.

Where possible, outreach goals should be measurable. This will help you when it comes time to evaluate the success of your program (see Section 7.3). In fact, for each goal, you might want to identify some specific measures that you can use to define success. For example, some measures that could be used for goal #2 above are:

- Attract 10,000 visitors per year to your Web site.
- Deliver a presentation or class on air pollution and health effects at each school in your target community.
- Conduct direct outreach (e.g., via face-to-face visit or phone call) to the managers of all health care facilities in your target community.

7.1.2 WHO ARE YOUR TARGET AUDIENCES?

The second step in developing an outreach plan is to clearly identify the target audience or audiences for your outreach effort. As illustrated in the examples in Section 7.1.1, specific outreach goals and measures often have defined target audiences. You might want to refine and add to your goals and measures after you have specifically considered which audiences you want to reach.

The AirBeat team included the following statement about their target audience in their project proposal:

> *The target audience for this project is the residents of Roxbury and those students and workers who spend a significant portion of their day outdoors in the neighborhood. Within this group, we will target those who suffer from asthma and other respiratory diseases, and those who are in a position to improve their care, such as school nurses and day care and health care providers.*

As the statement illustrates, it is typical to have a number of sub-audiences within a target audience. (AirBeat's sub-audiences include adult residents, adult residents who suffer from asthma, children who suffer from asthma, nurses and other health care providers, and day care providers.) Each audience will have its own specialized interests, and before you can begin tailoring messages for your different audiences, you will need to develop a profile of their situations, interests, and concerns. This profile will help you identify the most effective ways of reaching the audience. For each target audience, consider:

- What is their current level of knowledge about air pollution and health effects (particularly asthma)?
- What do you want them to know about air pollution and health effects? What actions would you like them to take?
- What information is likely to be of greatest interest to the audience? What information will they likely want to know once they develop some awareness of air pollution issues?
- How much time are they likely to give to receiving and assimilating the information?
- How does this group generally receive information?
- What professional, recreational, and domestic activities does this group typically engage in that might provide avenues for distributing outreach products? Are there any organizations or centers that represent or serve the audience and might be avenues for disseminating your outreach products?
- What are the language needs of each target audience? Do all audiences speak English, or will you need to conduct outreach in other languages as well? Often the community residents most in need of air quality information do not speak or read English.

Profiling an audience essentially involves putting yourself "in your audience's shoes." Ways to do this include consulting with individuals or organizations who represent or are members of the audience, consulting with colleagues who have successfully developed other outreach products for the audience, and using your imagination.

The AirBeat team profiled its audience by means of a survey developed by three of ACE's youth interns. The survey, which was distributed to Roxbury residents, evaluated the respondents' knowledge of air pollution issues and health effects and asked residents how they preferred to receive information on these issues. The interns collected 80 survey forms in all and then created a report presenting the results. A copy of the survey questions and results is available on the AirBeat Web site: *http://www.airbeat.org* (click on "Student Projects" in the main menu).

The survey revealed some interesting trends:

- Roughly one-quarter of the respondents had asthma, and half lived with someone who has asthma.
- Two-thirds of the respondents did not know what particulate matter is, and over half could not name other types of air pollutants.
- Only 10 percent of the respondents knew that AirBeat had set up an air monitoring station in Roxbury.
- Television and newspapers were far and away the most popular media for receiving information on air pollution issues.

7.1.3 WHAT ARE THE KEY MESSAGES AND TYPES OF INFORMATION THAT YOU WANT TO DELIVER?

The next step in planning is to think about what you want to communicate. In particular at this stage, think about the key points, or "messages," you want to communicate. Messages are the "bottom line" information you want your audience to walk away with, even if they forget the details.

A message is usually phrased as a brief (often one-sentence) statement. For example:

- Air pollutants such as ground-level ozone, fine particulate matter, and black carbon soot can exacerbate asthma symptoms and trigger asthma attacks.
- The AirBeat Web site and telephone hotline system can provide you with easy access to real-time information about air pollution levels in Roxbury.
- Reducing your exposures to air pollution and other asthma triggers can help you manage your asthma symptoms.
- Cars, trucks, buses, factories, power plants, and construction activities are some of the primary sources of air pollutants such as particulate matter.

Outreach products often will have multiple related messages. Consider what messages you want to deliver to each target audience group, and in what level of detail. As stated above, you will want to tailor different messages for different audiences.

Let's look at how this can be done. For instance, let's say that you are writing a press release for distribution to local newspapers, announcing the launch of your program. Your audience, the average reader of these publications, has relatively little knowledge about air pollution and its health effects. What should be the focus of your press release? Probably you will want to concentrate on a few simple messages: that the United States is experiencing an epidemic of asthma that is most severe among lower income and minority children; that air pollutants such as ground-level ozone and particulate matter have been linked to asthma and other respiratory illnesses; that your program has begun an effort to monitor levels of these pollutants locally and deliver real-time data to community residents; and that people with asthma can use this information to avoid harmful exposures. An example of a similar press release, distributed by the AirBeat team in November 1999, is included at the end of this chapter.

On the other hand, if you were conducting outreach to nurses and other health care providers, you would spend less time describing the asthma epidemic that is affecting children in the United States (after all, no one is more aware of this epidemic than health care professionals). Instead, you would probably focus on communicating in detail about the connections between outdoor air pollution and asthma and other respiratory illnesses. Health care professionals receive a great deal of information and training regarding the role that allergens and irritants in indoor air can play in triggering asthma attacks. Most professionals are also aware that pollutants in the outdoor environment can trigger attacks. Your goal is to reinforce this awareness and to describe how real-time air quality data can help people reduce their exposures to air pollution.

You could do this indirectly (for example, by sending fact sheets or other educational information to health care centers), but a more effective method would be to conduct direct, face-to-face outreach to health care providers. If possible, you want to establish an ongoing relationship with the health centers in your target community, making the health care providers aware of your monitoring program and of the availability of your real-time data. (See Section 7.2.9 to read about the AirBeat project's approach to direct outreach.) Your hope is that the health care providers will act as a conduit, passing on this information to their patients who suffer from asthma. After all, these patients are the people who most badly need the information your program is gathering.

7.1.4 WHAT OUTREACH TOOLS WILL YOU USE?

As the above examples illustrate, one of the key challenges of conducting outreach and education, besides tailoring your message for the intended audience, is choosing the best outreach tool or approach for delivering your message. There are many different types of outreach: print, audiovisual, electronic, events, and novelty items. The table below provides some examples.

	Outreach Products	
Print	Advertisements Brochures Editorials Educational curricula Fact sheets	Newsletters Newspaper and magazine articles Posters Press releases Question-and-answer sheets
Audiovisual	Cable television programs Exhibits and kiosks	Videos Public service announcements (radio)
Electronic	E-mail messages Fax services	Subscriber list servers Web pages
Events	Briefings Community days Fairs and festivals Media interviews	One-on-one meetings Press conferences Public meetings Speeches
Novelty Items	Banners Bumper stickers Buttons Coloring books	Frisbee discs Magnets Mouse pads

It's up to you to select the most appropriate products to meet your goals within your resource and time constraints. Questions to consider when selecting products include:

- How much information does your audience really need to have? How much does your audience need to know now? The simplest, most straightforward product generally is most effective.

- Is the product likely to appeal to the target audience? How much time will it take to interact with the product? Is the audience likely to make that time?
- How easy and cost-effective will the product be to distribute or, in the case of an event, organize?
- How many people is this product likely to reach? For an event, how many people are likely to attend?
- What time frame is needed to develop and distribute the product?
- How much will it cost to develop the product? Do you have access to the talent and resources needed for development?
- What other related products are already available? Can you build on existing products?
- When will the material be out of date? (You probably will want to spend fewer resources on products with shorter lifetimes.)
- Would it be effective to have distinct phases of products over time? For example, a first phase of products designed to raise awareness, followed at a later date by a second phase of products to encourage changes in behavior.
- How newsworthy is the information? Information with inherent news value may be rapidly and widely disseminated by the media.

The key here is to make good use of the resources available to you. In the best of all worlds, you would have the time and budget to personally visit every health center, day-care center, and school in your target community and to craft customized press releases for every type of publication and every audience. But it is unlikely that you will have the resources to do everything you'd like to do. The goal, then, is to pick your spots wisely. Reach as many people as you can, but also focus on those audiences that are most receptive to—and most in need of—your information.

7.2 EDUCATION AND OUTREACH TOOLS

This section describes a variety of outreach tools used by the AirBeat project. Examples of specific outreach materials developed by AirBeat can be found at the end of the chapter.

7.2.1 AIRBEAT WEB SITE

The technology of the Internet is nearly ideal for the purposes of an AirBeat-type project. It allows the project to present air quality data in multiple formats and to regularly update the data through automated delivery systems that require only a minimal level of human oversight. In addition, Web sites can be highly effective educational tools.

The AirBeat Web site *(http://www.airbeat.org)* is a key tool used by the project for delivering air quality data to Roxbury residents. Visitors to the site can access a variety of information on air quality conditions, including:

- Summary information on current air quality conditions, people at risk, and recommended actions, presented on the AirBeat homepage in an easy-to-read chart.
- Detailed data on current and recent pollution levels, presented in bar and line graphs (see examples on pages 7-8 and 7-9).
- Animated ozone movies, showing the progression of regional ozone levels over the course of a day.
- Static maps showing region-wide ozone forecasts for the upcoming day.
- Digital photographs of the Boston skyline, taken by a hazecam located 12 miles northeast of the city (see page 6-7 for more information on hazecam images).

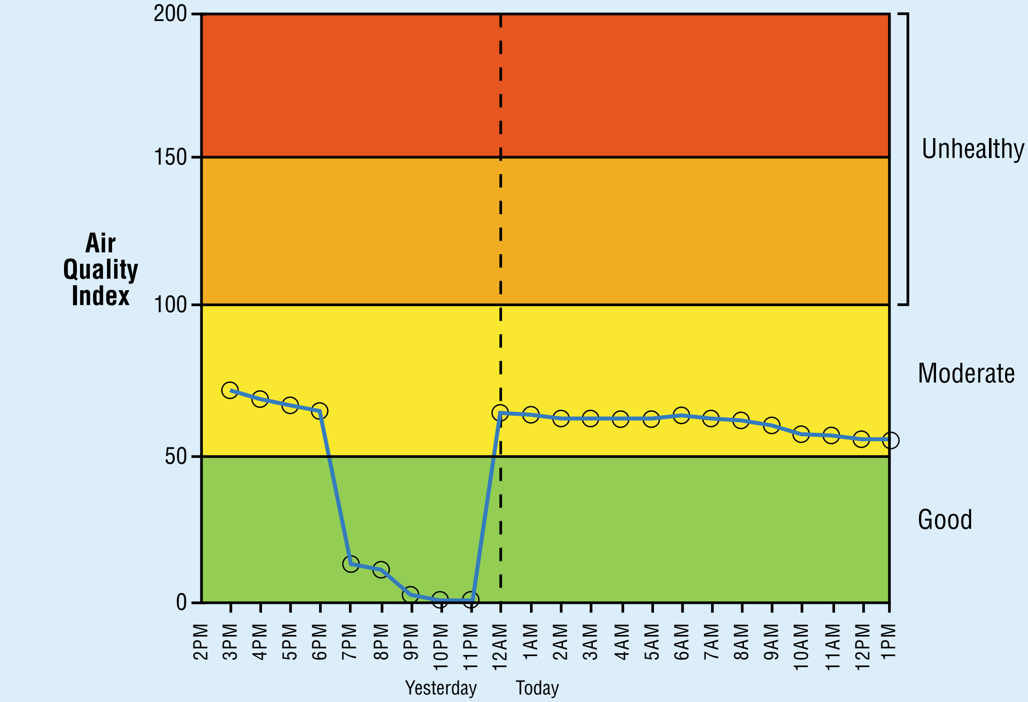
Why present air quality data in so many different formats? The AirBeat team designed the Web site to be interactive. The goal was (and is) to engage visitors, encourage their interest in air pollution issues, and then provide them with educational materials that put the air quality data in an understandable context. The AirBeat team wanted Web site visitors to come away with a better understanding of air pollution sources and health effects, along with an improved awareness about actions they can take to protect their health, reduce air pollution, and get involved with local efforts to improve air quality.

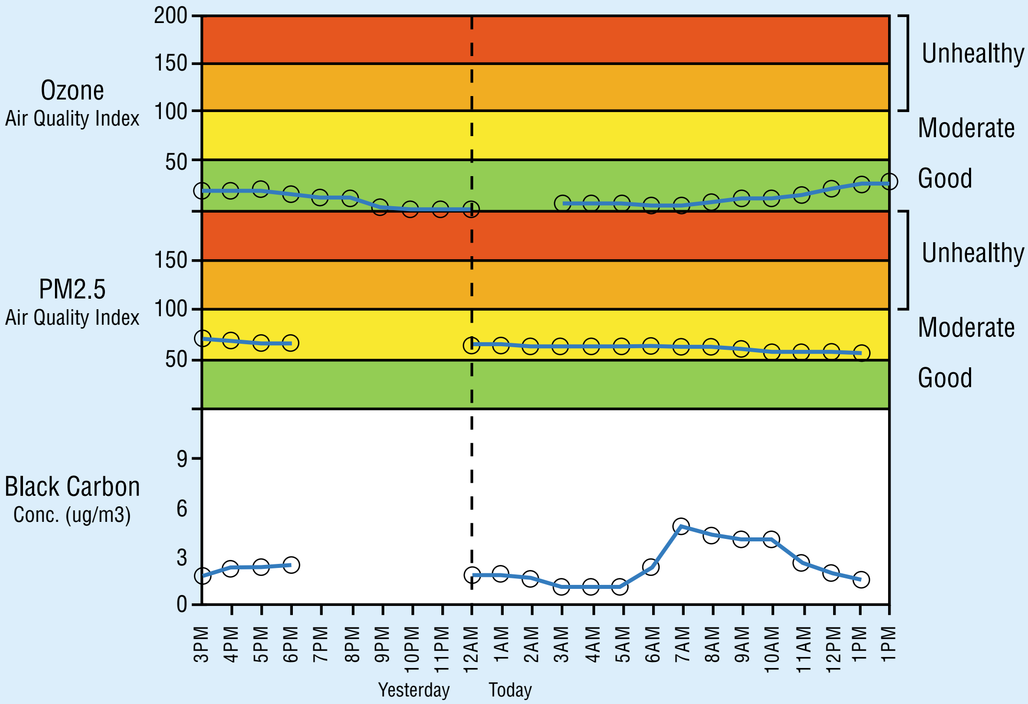
To promote these goals, the AirBeat team placed an array of outreach and educational materials on the Web site, which has continued to operate since the end of the EMPACT grant period. There are also numerous links, so that visitors can quickly move back and forth between the monitoring data and the contextual information, answering questions as they arise. Two of these educational pieces are provided as hard copy inserts at the end of this chapter. Others can be found online (go to *http://www.airbeat.org*). If you are developing an AirBeat-type program of your own, you can use these pieces as a model to stimulate ideas for your own outreach language. If you are a member of the public interested in air pollution and health effects, you can read these materials to learn about steps that you can take to reduce pollutant levels and to protect yourself from unhealthy exposures.

Information on the technical aspects of delivering monitoring data via a Web site is provided in Chapter 6.

PRESENTING MONITORING DATA ON THE AIRBEAT WEB SITE

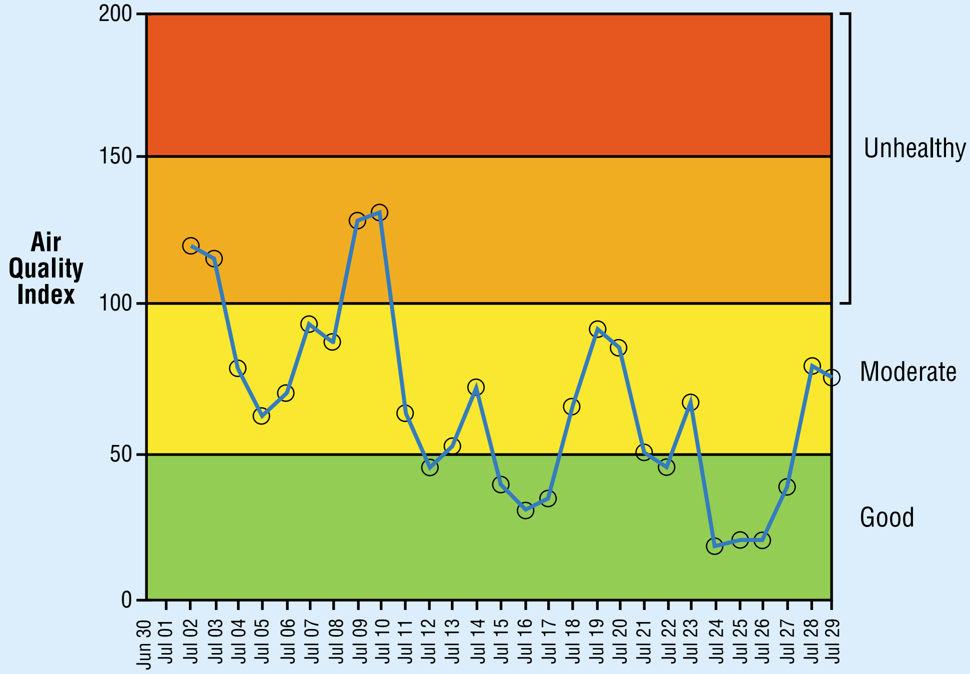
Visitors to the AirBeat Web site can view air pollution data in multiple formats. The two graphs below show air pollution data for a 24-hour period in late July, 2002. The top graph shows changes in the overall Air Quality Index (see Chapter 3 for more information on the AQI). The bottom graph shows changes in specific pollutant levels over roughly the same 24-hour period. Note that data are missing for several hours during the 24-hour period. Technical difficulties that can lead to missing data are a real-world problem that can occur several times per year in AirBeat.

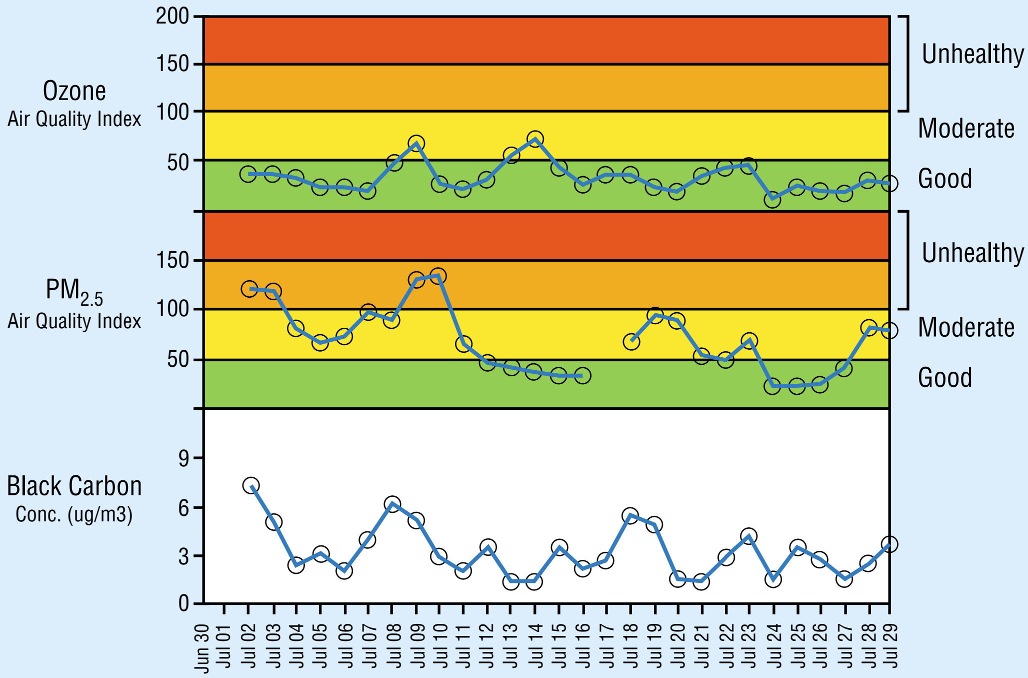




PRESENTING MONITORING DATA ON THE AIRBEAT WEB SITE (CONTINUED)

The two graphs below show air pollution data for a 1-month period from late June to late July, 2002. The top graph shows day-to-day changes in the overall Air Quality Index. The bottom graph shows changes in specific pollutant levels over the same period. As the graphs illustrate, the AQI value for the Roxbury area is generally driven by $PM_{2.5}$ concentrations. An exception to this trend occurred around the middle of July, when $PM_{2.5}$ levels fell and ozone drove the AQI. Note that color-coded health descriptors (good, moderate, unhealthy) are not used for reporting black carbon concentrations because EPA has not established a National Ambient Air Quality Standard for BC.





Other Ideas for Disseminating Real-Time Air Quality Data

One drawback to using Web sites as a tool for disseminating air quality information is that community residents will need Internet access to view the information. In many low-income communities, the percentage of residents with Internet access is quite low. However, public libraries generally provide Internet access, and public schools are increasingly offering it as well. If you are starting an AirBeat-type program, you might want to target librarians and teachers with your educational campaign, so that these professionals can show children and other community residents how to access your program's air quality information online.

AirBeat explored some additional ways of delivering real-time data to the public. The project hopes to implement these ideas in the future:

***Listserv*—using an automated system to distribute air quality alerts via e-mail, fax, or beeper notification to names on a mailing list.**

***I-kiosk*—building a kiosk in Dudley Square or another public location, offering round-the-clock access to the AirBeat Web site for people without an Internet connection.**

***Television and radio reports*—working with local stations to integrate air quality information into regular weather, traffic, or news reports.**

***Appendix C* describes another air quality project—the St. Louis Regional Clean Air Partnership—which has implemented some of these communication venues in its work.**

7.2.2 TELEPHONE HOTLINE

The AirBeat project supplemented its Web site with a telephone hotline (617-427-9500) so that Roxbury residents without Internet access can still obtain timely information about air quality. The hotline, which continues to operate today, reports current pollutant concentrations and also reports the highest concentrations for the current day and the peak concentrations from the previous day. In addition, the hotline message interprets these data from a public health standpoint and recommends actions that sensitive individuals can take to reduce exposures.

The hotline system is fully automated. (See Chapter 6 for information on the technical aspects of setting up and running a telephone hotline.) The voice on the hotline is that of a high school intern from ACE—a voice that is meant to sound friendly and familiar to the local community.

7.2.3 FLAG SYSTEM

On Flag Day, June 14, 2000, students at Greater Egleston Community High School in Roxbury launched a flag system to provide the community with visual notification of air quality. The system uses colored flags that correspond with the colors of the Air Quality Index (AQI) used to report pollutant levels on the AirBeat Web site. A green flag is flown to indicate good air quality; a yellow flag indicates moderate air quality; and a red flag indicates unhealthy pollutant levels.

A yellow flag, hung from the balcony of the ACE offices, indicates moderate air quality.

The flags have been flown at two locations. One set of flags is displayed at the high school and is operated by the students; another set was located at the ACE offices in Dudley Square, two blocks from the AirBeat monitoring station, and was operated by ACE interns and staff. (This location has not been used recently, due to landlord concerns.) Those people who operate the system determine which flag should be displayed by checking the AirBeat Web site for the most recent air quality data.

Lessons Learned: Operating an Air Quality Flag Warning System

The innovative flag system developed by the students of Greater Egleston Community High School is a point of pride for the AirBeat project. The system was one of the first air quality flag warning systems in the nation, and it demonstrated the leadership and commitment shown by Roxbury youth in working on environmental health issues.

While a flag system has great potential as a tool for raising awareness about air quality, the system must be operated in a consistent manner if the community is going to rely on it as a source of accurate, real-time air quality information. Here are two key points to consider when planning and implementing an air quality flag warning system:

1. **Standard operating procedures should be developed to dictate how frequently the air quality should be checked and how frequently the flag should be changed.**
2. **If the flag system is to be operated at a community center or high school, figure out who will operate the system on weekends or when school is not in session. If community members are going to rely on the system for information, they must be able to depend on it.**

7.2.4 PRESS RELEASES

Press releases can be a valuable tool in efforts to get the word out about a community-based air monitoring program. Writing a press release and distributing it to local newspapers, television stations, and other news outlets is a cost-effective way of reaching a large and varied audience. In fact, the survey conducted by ACE interns in the fall of 1999 showed that, among Roxbury residents, television and newspapers were the two most popular media for receiving information on air pollution issues.

ACE led AirBeat's efforts to conduct outreach through the media. ACE staff have contacts and working relationships with individual newspapers and television stations, developed though years of working to generate publicity about environmental justice issues. In addition, ACE staff have the writing, editing, and outreach skills needed for developing stories that will appeal to various news outlets.

ACE issued several AirBeat press releases to the Boston media during the EMPACT grant period, each timed to coincide with a newsworthy event, such as the unveiling of the AirBeat monitoring station or the launch of the flag warning system by Roxbury high school students. These press releases produced excellent results. Media coverage of AirBeat included articles in the Boston Globe, People's Choice, and the Dorchester Community News, and television coverage by a major Boston station and a local cable channel.

Examples of AirBeat's press releases are included at the end of this chapter. These can serve as a model for any AirBeat-type project that is launching its own outreach efforts. In addition, here are a few basic tips to follow for people who have little or no experience with distributing press releases:

- When issuing a press release, send it to as many news outlets as possible. Doing so increases your odds of getting good results and also leverages the work you've already done in writing the release.
- Try to target specific editors, reporters, and newscasters, especially any individuals whom you've contacted in the past. Making personal contact with members of the press can be crucial. The odds of placing a story fall drastically if you just send a press release to a news desk or editorial department, since most news outlets are inundated with dozens (if not hundreds) of press releases daily.
- When sending a press release to a reporter or editor, try preceding it with a phone call or e-mail, meant to kindle interest in the story. Or you could send the press release first, then follow up with an e-mail or phone call. Remember that it pays to be persistent!

What if you don't have a contact at a particular publication? One thing you can do is to read some back issues of the publication, looking for a reporter who has demonstrated some interest in topics related to your project. If the publication is a daily newspaper, it will likely have a beat reporter who focuses primarily on science and/or the environment. Health writers might also be interested in writing about an air quality monitoring program.

7.2.5 FACT SHEETS AND FLYERS

AirBeat developed a number of fact sheets and flyers as part of its public education efforts. Samples are included at the end of this chapter. These materials were handed out to Roxbury residents at community events and workshops, and were also distributed at health centers, public gathering areas, and local businesses. The Internet address of the AirBeat Web site *(www.airbeat.org)* was included in all of the publications as a source of additional information and real-time air quality data.

With the help of program staff, ACE's youth interns developed their own eight-page publication called the "Roxbury Air Quality Fact Sheet," which described the sources and health effects of air pollution and summarized what the AirBeat monitoring has indicated about pollutant levels in the Dudley Square neighborhood of Roxbury.

All of AirBeat's flyers and fact sheets were written in English. ACE considered translating the materials into other languages spoken by Roxbury residents (e.g., Spanish, Creole) but didn't have the budget to do this. If you are developing your own community-based monitoring program, you can assess the need for presenting outreach materials in multiple languages by getting to know the cultures of community residents. Chapter 4 of this handbook provides tips on getting to know your target community.

Communicating About Uncertainty

From the outset of AirBeat, the project team recognized the importance of communicating with users about the limitations of the real-time monitoring data. The team felt that users should be provided with information on data completeness and uncertainty so that the reliability and availability of the data could be trusted. The team decided to place the following statement about data quality on the AirBeat Web site:

"Real-time data on the AirBeat Web site (and hotline) are nearly always accurate. A computer program automatically screens the data for values that are likely to be erroneous. However, before the data can be considered fully 'validated' it must be reviewed by a trained professional for quality assurance purposes. For this reason, AirBeat's real-time data should be considered provisional or preliminary. Nonetheless, these real-time data are generally of good quality and are being shared with the public through this pilot project because of the value it holds for the community."

7.2.6 CURRICULUM MODULE

ACE has developed and teaches an environmental justice curriculum as part of its Roxbury Environmental Empowerment Project. This curriculum is taught to elementary and high school students at several Roxbury schools. After the launch of the Dudley Square monitoring station, ACE began using information from the AirBeat project to enhance its module on air pollution. Lessons were developed on air pollution sources, how the monitoring station works, and how the Air Quality Index is calculated.

Teachers who have used these lessons say that the AirBeat data have helped students understand air pollution in their neighborhood. Students have learned how to graph and manipulate data to compare local air pollution levels with national air quality standards and to understand pollution trends. Students who complete the lessons understand that their neighborhood is a "hot spot" for air pollution and are better prepared to communicate about the problem and work for change.

7.2.7 EVENTS AND TOURS

The AirBeat team organized several events to raise awareness about the AirBeat project and to introduce community members to the air monitoring station that is operating in their neighborhood. For example, ACE organized an event to unveil the station to the public in November 1999. Approximately 75 people attended the event, including several high-profile government officials (such as the regional EPA administrator, the Boston transportation commissioner, and two city councilors). Their presence at the event helped establish immediate credibility for the AirBeat project.

ACE interns present their work at an AirBeat event in Dudley Square.

ACE also routinely gives tours of the monitoring station to student groups, other Roxbury residents, and visitors. The station has become a regular stop on the "Toxics Tour" of Roxbury that ACE conducts. A monitoring technician with the Massachusetts Department of Environmental Protection has trained an ACE intern to lead the tours.

As a result of these tours and events, the monitoring station has become a familiar and accepted component of the neighborhood. Most community members know where the station is, what it does, and why it is important.

7.2.8 WORKSHOPS AND PRESENTATIONS

ACE has incorporated information about the AirBeat project into many of its pre-existing environmental justice programs in Roxbury. For example, ACE has incorporated AirBeat information into its workshops for youth peer groups from community health centers and housing developments. ACE staff have also made presentations at large community events such as the Youth Summit, which attracts roughly 200 youth participants.

All of these pre-existing programs have credibility and well-established constituencies among Roxbury residents. By delivering AirBeat information in the context of these programs, ACE has been able to speed up the process by which community members have become aware of the project and willing to rely on its data.

7.2.9 DIRECT OUTREACH TO NURSES AND OTHER HEALTH CARE PROVIDERS

Nurses and other health care providers are a key target for AirBeat's outreach efforts. These individuals come into regular contact with asthmatic children and others who are susceptible to air pollution. Because of this, and because of their credibility as highly trained professionals, health care providers have a unique opportunity to educate their patients about the connections between air pollution and respiratory illnesses and about the steps that people can take to reduce harmful exposures.

During the EMPACT grant period, AirBeat relied on direct communication when conducting outreach to health care providers. This typically involved visiting health centers and hospitals to talk to providers about the AirBeat project and about the role that outdoor air pollutants can play in exacerbating asthma symptoms and triggering asthma attacks. In addition, ACE interns delivered presentations at several health centers in the Roxbury area. The point of these visits and presentations was to make health care providers aware that their patients can use AirBeat's air quality forecasts and real-time data to reduce their exposures when pollutant levels are high. The AirBeat team tried to establish ongoing relationships with some health centers. In the future, AirBeat hopes to develop a system for delivering air quality data or pollution alerts directly to health centers via fax.

7.3 EVALUATING THE EFFECTIVENESS OF OUTREACH EFFORTS

AirBeat has found no easy or cost-effective way of measuring the success of its education and outreach program. The ultimate goal of the program is to encourage behavior changes by improving residents' ability to make informed decisions to safeguard their health. However, documenting behavior changes on a large scale is beyond the scope and means of the AirBeat project.

The AirBeat team has gathered anecdotal information indicating that some Roxbury residents have used the AirBeat data to improve their daily decisions and reduce their exposures to harmful pollutant levels. For example, an independent consultant who interviewed several Roxbury students as part of an evaluation of the AirBeat project found that the students regularly checked the air quality information on the AirBeat Web site and often reduced their outdoor activities on "bad air days." These students, however, were among those Roxbury youths who were most involved with the project, and were not necessarily representative of the public at large.

Due to the limitations of this type of anecdotal information, the AirBeat team relies on other indicators as a measure of the effectiveness of their outreach efforts. For example:

- The AirBeat team estimates that the project's Web site was online and available about 99 percent of the time during the EMPACT grant period. The air quality data were current (not more than one hour old) roughly 95 percent of the time. The Web site is still operational today.
- In the spring of 2001, the Web site received an average of 42 hits per day.
- Over 300 Roxbury students have visited the Dudley Square monitoring station and received a tour of the station's instrumentation.
- ACE staff incorporated AirBeat information into over 30 public workshops conducted between 1999 and 2001.

If nothing else, these numbers indicate that hundreds (if not thousands) of Roxbury residents have been introduced to the AirBeat project and made aware of the connection between air pollution and health problems.

AirBeat
Roxbury Air Monitoring

Health Effects
(from AirBeat Web site)

AirBeat provides realtime information on the most widespread and harmful air pollutants in the Boston area. These include ground-level ozone (sometimes known as smog) and fine particulate matter (sometimes known as soot). Ozone is a colorless, odorless gas that affects the lungs much like sunburn affects the skin. Fine particulate matter is a mixture of microscopic acids, metals, petroleum byproducts, and diesel soot.

Ground-Level Ozone (O3)	Health Effects (not all of these are noticeable)	Fine Particulate Matter (PM2.5)
✓	Coughing, irritation of the airways, discomfort in the chest or when breathing.	
✓	Premature aging of the lungs.	
✓	Faster or more shallow breathing.	✓
✓	Aggravation of asthma, emphysema, and other respiratory diseases.	✓
✓	Increased risk of respiratory infections.	✓
	Premature death (primarily among the elderly and those with existing heart and lung disease).	✓

Ozone (abbreviated as O_3) and fine particulate matter (abbreviated as $PM_{2.5}$) affect different people in different ways. Moreover, as their concentrations increase, more and more people experience health effects and the effects can become more serious. To simplify matters, the U.S. EPA has developed an Air Quality Index (AQI) that rates the overall quality of the air and the people at greatest risk.

Much of the $PM_{2.5}$ outside is capable of penetrating indoors, especially if windows are open and no air conditioner is used. Ozone is also capable of penetrating indoors, but not as effectively as $PM_{2.5}$. Regardless of their penetration, it is important to know that the indoor environment presents a whole other set of air pollution issues. Pollutants commonly found indoors include tobacco smoke, insecticides, radon, lead paint, mold, dust, and animal hair. Oftentimes, pollution indoors can be worse than pollution outdoors. This is a serious issue for families coping with asthma. For more information on asthma and its causes, visit our links page.

AirBeat also provides realtime information on a pollutant called black carbon. In urban areas, black carbon is emitted mostly from diesel engines found in trucks, busses, generators, and construction equipment. Black carbon is one of the many components of $PM_{2.5}$, but has the unique ability to absorb toxic gasses and deliver them to the lungs. The specific health effects of black carbon can not be stated with much certainty. However, diesel exhaust as a whole (which contains blackcarbon) is associated with increases in lung cancer and may lead to inflammation of the airways that can cause or worsen asthma.

Ozone, fine particulate matter, and black carbon provide good indicators of the overall air quality in Roxbury and account for much of the risk that residents face from air pollution. However, there is another category of air pollutants commonly known as air toxics. Air toxics are comprised of dozens of different compounds that typically occur in low concentrations. However, as a whole, and over the span of many years, their effects can be significant if concentrations are high enough. These include cancer, damage to the nervous system, and birth defects. Currently, technology is not readily available to report air toxics in realtime. However, monitoring of air toxics is underway in Roxbury, and results will be posted on this Web site when available. In the meantime, you can find out more about air toxics by visiting EPA's air toxics Web site.

Finally, everyone should be careful to avoid too much exposure to the sun, especially children and especially during the summer. Ultraviolet rays (uv) from the sun not only cause sunburn and permanent damage to the skin, but they can lead to cataracts and suppression of the skin's immunity system. To learn more about ultraviolet rays and to get realtime information and uv forecasts, visit EPA's SunWise Web site.

AirBeat
Roxbury Air Monitoring

Actions
(from AirBeat Web site)

Protect your health and the health of your friends and family. This is particularly important if you or your friends and family are considered sensitive individuals.

- Avoid exercise or heavy exertion during hours of high pollution. In the summer, this tends to be during the afternoon of high-pollution days. In the winter, this tends to be in the morning of high-pollution days.
- Try to spend more time in a cool environment, preferable air conditioned, when pollution levels are high.
- Check with the elderly and the other sensitive individuals on a regular basis to make sure they're OK.
- Monitor pollution levels using the AirBeat Web site or the AirBeat hotline (617-427-9500) to determine when the pollution is at its worst and when it returns to healthy conditions.
- Tell a friend, family member, or neighbor about the current levels of air pollution and what they should do.
- Bring any lung disease symptom to a doctor's attention early. Then follow the doctor's advice.
- Make sure medications are readily available (e.g., asthma inhalers, heart medication, etc.).

Help reduce air pollution:

- Avoid smoking indoors or in the presence of children and other non-smokers.
- Avoid driving and filling your gas tank on high pollution days.
- Keep your car well-tuned and the tires properly inflated.
- Try to save energy on high pollution days, but don't shut off your air conditioner or heater to do so.

Get involved with local efforts to improve Boston's air quality:

- Join the Environmental Justice Network or simply register with its email news service.
- Attend local meetings on transportation, air quality, and land use development.
- Contact us to request a tour of the Roxbury air monitoring station.

AirBeat
Roxbury Air Monitoring

Media Release

For Immediate Release:
June 14, 2000

For More Information:
Jodi Sugerman-Brozan,
617-442-3343 x23

Roxbury Youth Launch New Air Quality Flag Warning System: Redefine Flag Day

[Roxbury, MA] Roxbury youth will launch the nation's first air quality flag warning system today at a press conference in Dudley Station at 5:00 pm. The flag warning system will give residents in Dudley and Egleston Squares in Roxbury information about the air quality in their neighborhoods at a glance. Students from Greater Egleston Community High School have been working toward this event for three years with the Roxbury Environmental Empowerment Project (REEP) at Alternatives for Community & Environment (ACE) and AirBeat (coalition members listed below).

"It is about time," said Candy Batista, a student at GECHS. " We've been fighting to breathe easier for for so long, and now everyone will finally know how healthy the air is every day."

"These new air quality flags in Roxbury are just the latest examples of youth leadership to promote health and environmental justice in their community," said Jodi Sugerman-Brozan, REEP co-director. "Neighborhoods like Roxbury have been hardest hit by diseases related to air pollution like asthma."

The warning system relies on the data from a new air quality monitoring system which was installed last year. AirBeat continuously measures and reports levels of three critical air pollutants that affect the health of local residents. AirBeat measures ozone and fine particulate matter, otherwise known as smog and soot. It also measures black carbon soot that is an indicator of how much of the fine particulate matter is coming from diesel vehicles. Hundreds of diesel buses and trucks pass through both Dudley and Egleston Square every day.

Last month, the data from the air monitor became available in real-time on-line at www.airbeat.org. A 24-hour telephone hotline is also planned. GECHS students have designed a system to hang appropriate flags in Dudley and Egleston Squares (red=poor, yellow=moderate, green= good) to warn residents. Today, students will be giving Flag Day new significance by hanging the first warning flag in Dudley Square and explaining the system to community leaders and residents.

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AirBeat
Roxbury Air Monitoring

"I have asthma, and this flag system will let me know whether or not the air is good to breathe," said Mimi Mercado, a student at GECHS. "If I had asthma this flag system would be so important to me," added Roche Burgos, another student at GECHS. "It is a tool that will allow people with asthma and other respiratory disease know when the air quality could be dangerous for them," she continued.

In addition to the students, Mindy S. Lubber, Regional Administrator for the U.S. Environmental Protection Agency's (EPA) New England office will make comments. The AirBeat monitoring project was funded in large part with a $527,000 grant from EPA's Environmental Monitoring for Public Access and Community Tracking program.

"Today's flag raising is a huge step forward in boosting public awareness about the high number of bad air days in Roxbury," said Lubber. "For kids, the elderly and people who like to walk, run or take bike rides, having up-to-date information about air quality – both good and bad – is a huge plus. Even more importantly, we need to do all that we can to improve Roxbury's air quality so that red flag days are eliminated all-together. "Soot levels are a particular concern in this area due to high levels of asthma."

"As a future father, I am going to do all that I can to prevent my child from getting asthma." said Andre Rivera, a GECHS student. "The air monitor and the flags are a first step. They give us the information we need to take action," he continued.

"We have done great work so far," added Frederick George, a GECHS student and REEP intern. "But not it is time to take it to the next level. Now it is time to really reduce the sources of pollution in our neighborhood and lower the asthma rates in Roxbury once and for all."

AirBeat is supported by a grant from the U.S. Environmental Protection Agency's Environmental Monitoring for Public Access and Community Tracking Program. Partners include: Suffolk County Conservation District (lead agency), Alternatives for Community & Environment, MA Dept. of Environmental Protection, Harvard School of Public Health, and Northeast States for Coordinated Air Use Management.

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AirBeat
Roxbury Air Monitoring

For Immediate Release:

November 16, 1999

For More Information:

Penn Loh, 617-442-3343 x24

Roxbury Launches State's First Real-Time Air Monitoring System

[Roxbury, MA] Roxbury residents now have a new tool in their fight for cleaner air. The AIRBEAT monitoring system was unveiled today by a community-university-government partnership. This system, the first of its kind in Massachusetts, continuously measures and reports levels of critical air pollutants that affect the health of residents. Just as easily as checking the weather, residents can check pollution levels via the AIRBEAT telephone hotline and web site.

AIRBEAT addresses the concerns of many Roxbury residents who believe that air pollution may be responsible for high rates of asthma and other illnesses. Roxbury still has the highest rates of asthma hospitalization in Massachusetts – more than 5 times the state average.

"Communities of color like Roxbury have for too long been denied the means to solve critical environmental and health problems. AIRBEAT puts the technology and information in the hands of the people who need it most," said Matthew Goode of the Suffolk County Conservation District, the lead agency in this project. AIRBEAT is a two-year project supported by a $527,000 grant from the US Environmental Protection Agency's (EPA) Environmental Monitoring for Public Access and Community Tracking program.

AIRBEAT measures two air pollutants, ozone and fine particulate matter (PM2.5), otherwise known as smog and soot. The sources of these pollutants include the emissions spewed by motor vehicles, power plants, and factories. Ozone and PM2.5 have been linked to breathing problems, lung damage, asthma, and even premature death.

One community resident Mary White, who has three boys with asthma, said "I need to know how bad the air is before I let my kids go outside. This monitor will give me that information, so we can avoid activities that may cause asthma attacks." Students at Greater Egleston Community High School's Environmental Justice class have already been using the monitoring data. But one student, Fred George, declared "what I really want to see now is what's going to happen to clean up the air and how long it's going to take.

Prior to AIRBEAT, the closest state air monitoring site to Roxbury was located in Kenmore Square. AIRBEAT is not only located in the neighborhood, but also uses new continuous monitoring

-more-

technology for PM2.5. The traditional method of measuring PM2.5 required a laboratory analysis, meaning that results were delayed anywhere from a few days to a few weeks. AIRBEAT's real-time monitors will allow people to relate their own daily experience to actual pollution levels. This information will help residents, researchers, and regulators to better understand the health effects of air pollution.

EPA Regional Administrator John DeVillars stated that "AIRBEAT is an excellent example of giving citizens the information they need to make wise environmental decisions. We need more people making informed choices not just to protect their health from day to day but also to build sustainable and livable communities for the future."

AIRBEAT was created after the Massachusetts Department of Environmental Protection (DEP), in collaboration with several community groups, chose Dudley Square to place one of five PM2.5 monitors for the Boston area in early 1999. According to Edward Kunce, DEP Deputy Commissioner, "This is a precedent-setting project. Not only is the technology cutting edge, but so was the process of collaboration with the community. We hope to use Roxbury as a model for future monitoring efforts."

Penn Loh, Director of Roxbury-based Alternatives for Community & Environment and AIRBEAT partner, stated that "This project is a victory for those of us who have been fighting environmental injustices such as asthma. Thanks to the state, EPA and our other partners, we will now find out what actual pollution levels are in the neighborhood and how they might be made better or worse by new developments and the traffic they might bring."

"The City recognizes the need to address air quality and health impacts. This monitoring effort complements the new Citywide transportation plan, ACCESS BOSTON 2000-2010, which will address the impacts of transportation on the quality of life in our neighborhoods," said Andrea D'Amato, Boston Transportation Commissioner and Chief of Environmental Services.

More than sixty community leaders, youth, and government officials attended the launch event. Other speakers included City Councilor Mickey Roache, Councilor-elect Chuck Turner, John Auerbach (Director of the Boston Public Health Commission), and Roxbury resident Sylvia Hamilton.

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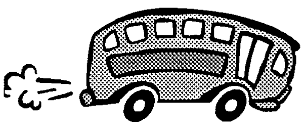
The AIRBEAT partners include: Suffolk County Conservation District (lead agency), Alternatives for Community & Environment, MA Dept. of Environmental Protection, Harvard School of Public Health, and Northeast States for Coordinated Air Use Management. Supported by the US Environmental Protection Agency (EMPACT Program).

AirBeat

Roxbury Air Monitoring

IT'S FINALLY HERE! The Air Monitoring System We've Been Waiting For!



WHAT is it? The only air monitoring station in MA that constantly measures and reports levels of three key air pollutants that affect our health and breathing. This station measures the levels of fine particulate matter (also known as PM2.5 or soot), ozone, (a component of smog), and black carbon. These pollutants are produced by cars, diesel buses and trucks power plants, and other combustion processes.

WHY is it here? We all know Roxbury's asthma hospitalization rates are five times the state average, which means there are people being hospitalized and dying because of the air they breathe. This equipment measures the amount of different pollutes in the air which affects our breathing every day.

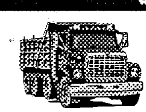
WHERE is it? Harrison Ave. at Zeigler St. (next to auto junkyard and Boston Edison transformers)

WHO brought it here? You did. Because you have voiced your concerns about air pollution and your health at community events, State and Federal environmental agencies began to listen. Alternatives for Community and Environment (ACE) and other organizations represented you and put what you wanted for your community out there.

And the OUTCOME is... Through the information that we receive from the air monitoring system we can be better prepared to deal with air pollution every day and to push for the things our community deserves.

AirBeat

Roxbury Air Monitoring



Look for more to come in Fall 1999. We are developing a telephone hotline and a computer internet web site so that anyone can find out what the air pollution levels are at any time.

For more information go to www.airbeat.org or call 442-3343 x24

AIRBEAT Project Partners: ACE, Harvard School of Public Health, MA Dept. of Environmental Protection, Northeast States for Coordinated Air Use Management, and Suffolk County Conservation District (lead agency). Supported by the US Environmental Protection Agency.

AirBeat
Roxbury Air Monitoring

Questions Commonly Asked about AirBeat Roxbury Air Monitoring

How Does it Work? Data from pollution monitors in Roxbury is sent to a computer at the monitoring station each second. Once each hour, the data is automatically transferred by telephone line to the web site computer at another location and formatted for presentation on the web page. The data are also stored for later use. The haze camera picture is form a network of visibility cameras across New England; the picture is taken every 15 minutes and sent over the Internet to the hazecam web page server in Colorado where it is resized for the web page. It is transferred to the Roxbury web site using the Internet.

Why do Some Days have High Pollution Levels and Others Low Pollution Levels? Some days in Boston can have 20 or 30 times more pollution than others, but the pollution sources do not vary that much. Differences in the weather cause most of the day-to-day and seasonal variation in particle and ozone pollution in the northeastern U.S. When wind speeds are high, locally generated pollution (primarily from cars and trucks) does not build up in the city. Low wind speeds can let pollution build up, especially in the morning during rush hour. In the summer, ozone is higher because the chemical reactions that generate ozone form car and truck exhaust need sunlight and warm temperatures to occur. Ozone is also higher in the mid-day than at night for similar reasons. Weather systems (especially high pressure) "stall" more frequently during the summer. This stagnation lets pollution build up on a regional scale covering several hundred miles. The "Bermuda High" weather systems common in the summer pump air from the heavily industrialized Ohio River valley into the northeast U.S., causing some of the worst air pollution we experience in Boston.

Why Should I Care about the Levels of Pollution in the Air? People with respiratory conditions like asthma should limit their activity on days when ozone or particulate matter are high. Data from the new monitors will allow people to know when air quality might cause or exacerbate health problems.

How Can Communities Use the Data from the Air Monitors? Individuals by themselves can only react to air quality, together we can improve it. Data from the air monitors can help teachers, scientists and community leaders understand and publicize the impact of pollution on Roxbury. The monitoring capacity of this project provides real laboratory data to enhance scientific and environmental education. This project will help to empower residents to be informed participants in political and environmental management decisions.

How Can I Get Information from the Monitors? Any resident, healthcare provider, teacher or student can access data using the AirBeat website (www.airbeat.org) or by calling the Suffolk County Conservation District at 617-451-9141 or Alternatives for Community & Environment at 617-442-3343 x24.

APPENDIX A: THE PASO DEL NORTE ENVIRONMENTAL MONITORING PROJECT

ABOUT THE PROJECT

The Paso del Norte Environmental Monitoring Project addresses the critical issue of data processing and dissemination for a border area between the United States and Mexico known as “El Paso del Norte”. This project provides the public with timely air quality, traffic, and weather information for the Paso del Norte region. Because the region spans the U.S.- Mexico border and is home to a rapidly growing and bilingual population, the project was presented with unique challenges and serves as a prototype for international involvement and cooperation.

Three types of environmental data are collected in the Paso del Norte region: air quality, traffic, and weather. Air quality data for ground-level ozone, carbon monoxide (CO), and particulate matter are used to inform the public about increased air pollution and associated health risks. Traffic information obtained through roadway monitoring is used to inform the public about volume delays, road construction delays, accidents, and other impedances. In addition, traffic data are incorporated into air quality analyses. This synthesis is critical because vehicles, particularly idling vehicles at border crossings, are a major contributor to air quality problems in the region. Weather information is practical both as helpful day-to-day information and as an air pollution indicator.

The Paso del Norte Environmental Monitoring Project aims to improve the dissemination of information through:

- Coordination among various agencies, institutions, organizations, and broadcasters within the Paso del Norte region.
- Development of standards for sharing information and displaying it to the public and decision-makers in the region.
- Establishment of a communications infrastructure for timely environmental information.
- Public outreach programs that improve local understanding of individual actions that can be done to improve the quality of the environment.
- Education of future generations by developing opportunities for students to conduct research and become involved in the improvement of the environment.

PROJECT PARTNERS

The City of El Paso is the lead agency for the Paso del Norte Environmental Monitoring Project. Project partners include the University of Texas at El Paso (UTEP), the Texas Natural Resource Conservation Commission, the El Paso City County Health Management District, the New Mexico Environment Department, and Departamento de Ecologia en Cuidad Juárez, Chihuahua, Mexico.

The support of these agencies and institutions arose from the official support of the Joint Advisory Committee (JAC), a bi-national organization that meets quarterly to review and make recommendations related to projects to improve air quality in the Paso del Norte region. Because the JAC includes representatives from federal, state, and local governments, educational institutions, industry, and others, its endorsement helps ensure cooperation and on-going support from the many entities needed to implement the Paso del Norte project.

MONITORING

Air Quality

Twenty-five existing continuous air monitoring stations (CAMS) are used to collect air quality data: 14 in Texas, six in New Mexico, and five in Mexico. Data are collected every 5 minutes at the monitoring stations. CAMS in the Paso del Norte region are operated by four separate government agencies, serving three states in two countries. Monitoring station calibration occurs every 28 days during the colder months, and span checks are performed once a week.

Traffic
In the El Paso Metropolitan area, 600 existing traffic sensors collect speed and volume data and 34 existing cameras provide video images. Traffic volume information and traffic video images are collected at 5-minute intervals at fixed locations in El Paso and at fixed locations on some of the highways in the area. Volume and speed measurements are summarized on an hourly basis, and data sets and displays are refreshed on the project's Web site every 60 minutes. The project team updates the traffic video images on the Web site every 15 minutes using an automated modem system.

Weather
Wind speed, wind direction, and temperature data are collected at the CAMS in the region and are then transferred and processed with the air quality data. Other weather data from the National Weather Service (NWS) in Santa Teresa, New Mexico, are retrieved at a server at UTEP by means of an ftp connection. Visibility images from NWS satellite links and the UV index forecast from EPA's Sun Wise Program Web site also are transferred to UTEP. These data are processed through a series of algorithms and redisplayed. Current temperature, UV intensity, relative humidity, wind speed, and heat index readings appear in digital form on the Paso del Norte project Web site. Graphs showing changes in various weather parameters also are on the Web site.

DATA MANAGEMENT

Air quality data, traffic volume data, traffic video images, weather data, and static and live images from a Webcam are transferred from monitoring locations, hubs, and Web sites run by multiple agencies. As with other aspects of the Paso del Norte project, communications between agencies is vital to processing the timely environmental data. UTEP collects and processes the data from the different agencies to upload onto the project Web site. Data storage for the Paso del Norte project includes an ftp server and access via interactive searches and select features provided on the project's Internet server. Queries can be performed in the air and traffic databases to identify data sets of interest and download them using anonymous ftp file transfer.

OUTREACH AND EDUCATION

There are five major elements of the Paso del Norte project's outreach program: the project's Web site, Ozone Action Days, the Community Scholars Program, television outreach, and digital information read-outs. The project's Web site *(http://www.ozonemap.org),* which contains all of the collected data and is presented in both English and Spanish, is the primary vehicle for communicating timely information. This Web site also includes a link to Ozone Action Days, a Webpage that describes an ozone action day, provides information on how to protect yourself on such days, and provides recommendations on what not to do (e.g., avoid driving at lunchtime) on an ozone action day. The Community Scholars Program is a grant-funded, non-profit summer internship program designed to foster leadership skills in local high school students by involving them in research on environmental issues. The regional broadcast affiliate, KFOX, broadcasts air quality information and announces ozone action days during their evening broadcasts, and a local television station (Channel 56) and Universidad Autonoma de Cd. Juárez provide daily visualizations of carbon monoxide and ozone levels in Cd. Juárez during the evening news. In addition, digital readouts located in strategic areas are used to provide information on environmental and traffic conditions.

In order to make the data provided in these outreach activities as accessible as possible, the Paso del Norte project uses data visualization tools to graphically depict information. Examples include 3D maps, color-coding, tables and charts, GIS, and live and static images. Graphic representations of environmental data are used on Web sites, in reports and educational materials, and in other outreach and communication initiatives. All of these materials can be viewed in English or in Spanish, and certain formats are downloadable by the public or by local television stations for rebroadcast.

APPENDIX B: THE ST. LOUIS COMMUNITY AIR PROJECT

ABOUT THE PROJECT

The St. Louis Community Air Project (CAP) is a multi-year commitment to better understand the presence of air pollutants in St. Louis and take the necessary steps to improve the air quality. CAP seeks to achieve this goal by involving the community in the development and implementation of the project from start to finish. Through risk education, CAP will enable the public to understand: 1) what pollutants are being monitored, 2) the concept of risk, and 3) how to compare ambient monitoring data to health benchmarks. As a result of CAP, the community will be able to identify pollutants of concern and their sources, as well as develop and implement community-based risk-reduction projects. By identifying the pollutants that represent the greatest health risk, continually monitoring them, and communicating monitoring results directly to the community, CAP seeks to effectively address the air quality issues that are most vital to the public.

There are two key elements of the CAP program: flexible research and community outreach. Unlike many other programs, CAP did not set out to monitor a predetermined set of pollutants. Instead, it began by monitoring a range of 93 different pollutants in order to identify the set of pollutants that posed the most health risk to the local community. It then tailored an ongoing monitoring and research program to address those key pollutants. This flexibility has allowed the program to evolve over time to fit the needs of the community. In addition, the local community has been involved in developing and implementing the CAP program through monthly community partnership meetings. These meetings give community representatives an opportunity to help direct the CAP project, communicate to the project coordinators what resources the community would find most useful, and learn about the most recent findings of the ongoing program research.

Although several project monitoring stations will continue operating indefinitely, the final St. Louis CAP report is expected in October 2003.

PROJECT PARTNERS

CAP is a partnership of the U.S. Environmental Protection Agency, the Missouri Department of Natural Resources (DNR), and the City of Saint Louis, which includes the Saint Louis Association of Community Organizations (SLACO), Washington University in St. Louis, and St. Louis University's School of Public Health, as well as various industry representatives, and health and environmental organizations.

MONITORING

CAP began monitoring air pollutants including carbonyls, VOCs (volatile organic compounds), metals, and semi-volatiles in May 2001. The project utilizes three monitoring stations—one core station and two satellite VOC stations. Multiple monitoring locations allow CAP to monitor VOC pollutants both spatially and temporally to better characterize mobile, industrial, and area source influences. When choosing locations for the project monitoring stations, researchers used the following criteria: vertical placement at either ground level or on the roof of a 1- or 2-story building; enough distance from obstructions to have adequate airflow (using the rule that the distance from an obstruction must be twice the distance between their heights); and a distance of at least 45 feet from smaller residential streets, 100 feet from major roads, and a quarter mile from any freeways.

The data collected at the core monitor indicate that formaldehyde, an EPA-identified health risk, is present in amounts that exceed long-term health benchmarks for both cancer and non-cancer risks. A review of the data also indicates a possibility that peak ambient levels may periodically exceed short-term health benchmarks. Other pollutants of concern include benzene and arsenic.

As a result of the high formaldehyde levels identified by the core monitor, CAP plans to operate two additional formaldehyde stations in the St. Louis area during the summers of 2002 and 2003 to assess both spatial and temporal variations. At a one-time cost of $148,000, Missouri DNR and EPA purchased an optical absorption spectrometer that is capable of monitoring 10 different pollutants, including formaldehyde and benzene in real time (5-minute intervals, rather than the standard 24-hour intervals). This enhanced monitor will be installed and operated by Washington University, and will allow CAP to better characterize short-term exposure risks of formaldehyde. In addition, CAP is sponsoring supplemental formaldehyde research at an existing Missouri DNR station in the rural area outside of St. Louis to determine if the elevated formaldehyde levels are due in part to isoprene emissions given off by oak trees.

DATA MANAGEMENT

CAP does not have a complex data management system because it does not currently provide real-time data and therefore does not have the same volume of data to handle as other research projects. Currently, 24-hour samples from all of the monitoring sites are analyzed, approved by the Missouri DNR, and eventually posted on a public Web page. Data management needs are likely to increase when the new CAP program Web site and real-time monitoring station come online.

OUTREACH AND EDUCATION

From its inception, CAP has involved the local community in the project planning and development process, and has informed the public of air quality measurement results through outreach and education. CAP's outreach and education plan is defined in an official CAP document called the Community Involvement Plan (CIP), which consists of four elements: outreach and education, engagement, results, and resources.

As part of the outreach portion of the CIP, CAP holds monthly partnership meetings with stakeholder organizations, community members, and other interested parties. These meetings, begun in late 2000, have been very successful and draw 30 to 40 participants each month. The meetings provide a forum for participants to help establish air quality health benchmarks, set the CAP agenda, and learn about the latest project findings. Community input gathered during these meetings is a driving force in the ongoing evolution of CAP.

CAP also developed a project Web site to provide the community with access to information and the opportunity to become engaged in local efforts to improve air quality. In 2002, CAP planned to update the Web site to provide sample results from the ambient air (24-hour) monitoring, as well as other relevant health and air quality information. To learn more about the CAP project, please refer to their current Web site at *http://stlouis.missouri.org/stlcap/index.htm.*

APPENDIX C: THE ST. LOUIS REGIONAL CLEAN AIR PARTNERSHIP

ABOUT THE PROJECT

The St. Louis Regional Clean Air Partnership is a public-private partnership formed to raise awareness of regional air quality issues and to encourage activities to reduce emissions of air pollutants. The Partnership promotes a variety of programs to:

- Increase public awareness of air quality issues.
- Increase public participation in emission reduction activities.
- Increase participation of regional institutions in emissions reduction activities.
- Increase responsible decision-making that incorporates air quality considerations.

The Partnership is particularly noteworthy because of its innovative outreach and education campaign. Unlike the other programs described in this document, the Partnership does not perform any pollutant monitoring or data analysis. It simply gathers data published by outside sources and disseminates it to the local community using a program Web site *(www.cleanair-stlouis.com),* e-mails and broadcast faxes, the local television news, and other outlets.

PROJECT PARTNERS

The St. Louis Regional Clean Air Partnership was created in 1995 by the American Lung Association, the St. Louis Regional Commerce and Growth Association, Washington University, and other partners. The Partnership has since grown and now includes the Missouri Department of Natural Resources, the Illinois Environmental Protection Agency, East-West Gateway Coordinating Council, RideFinders, the Missouri and Illinois Departments of Transportation, the Bi-State Development Agency, KMOV-TV, several cultural organizations, and a variety of other local stakeholders.

MONITORING

The Partnership does not independently monitor air quality. It uses ozone data from 16 monitors operated by the City of St. Louis, St. Louis County, Missouri Department of Natural Resources, and the Illinois Environmental Protection Agency.

DATA MANAGEMENT

The Partnership has practically no data management needs because it does not operate monitoring stations or process its own data. Ozone data gathered at the city, county, and state monitors are posted on the Internet by the individual agencies, and the Partnership simply downloads this publicly available data.

OUTREACH AND EDUCATION

There are four main components of the Partnership's outreach and education campaign: the program Web site, televised ozone forecasts, an ozone warning listserv, and the Clean Air Pass.

The Partnership Web site *(www.cleanair-stlouis.com)* provides an air quality forecast, links to information on Partnership initiatives, FAQs, archived ozone data, and links to relevant articles and press releases. Through the Web site, air quality information is available to the public 24 hours a day.

The Partnership works with KMOV-TV, the local CBS affiliate, to produce and publicize a daily air quality forecast. During its initial stages, the Partnership used grant money to purchase a computer model that produces an air quality forecast using data drawn from the local monitoring stations. The Partnership gave the software to KMOV on the condition that it publicize the daily air quality forecast during its local news broadcast. The Partnership trained the station's staff to use the software and input the necessary data, and worked closely with meteorologists at the station to perfect the model. KMOV now produces the daily forecast with no aid from the Partnership at an estimated annual cost of about $350,000 and broadcasts the forecast on all of its local news shows. The Partnership in turn features the forecast in a central location on its Web site.

The daily air quality forecast is designed to be as easy to understand as possible. Air quality is reported using the colors of EPA's Air Quality Index—red for unhealthy, orange for unhealthy for sensitive groups, yellow for moderate, and green for good. Interested persons can sign up for an e-mail alert if the forecast is red or orange. The e-mail alerts are distributed via a listserv, which the Partnership contracts out to a local consultant for a minor fee. Free listserv services are also available through companies such as Topica *(www.topica.com).* The "e-alert" program has received positive feedback from the community, and is an extremely cost-efficient program for the Partnership to run.

The Partnership also works with the Bi-State Development Agency, KMOV-TV, and Schnucks Markets to provide the "Clean Air Pass" program. In order to help control air pollution, the Clean Air Pass allows residents to ride public transportation at a discounted rate during summer months when ground-level ozone levels are at their highest. The 3-month pass (June through August) is available on the Partnership's Web site, at the MetroRide Store, and at most Schnucks Markets.

GLOSSARY

Air Quality Index — A tool developed by EPA to provide people with timely and easy-to-understand information on local air quality and whether it poses a health concern. The Air Quality Index (AQI) provides a simple, uniform system that can be used throughout the country for reporting levels of major pollutants regulated under the Clean Air Act, including ground-level ozone and particulate matter. The AQI converts a measured pollutant concentration to a number on a scale of 0 to 500. The AQI scale is divided into six categories, each corresponding to a different level of health concern. Each category is also associated with a color.

Black carbon — One of the many components of fine particulate matter. Black carbon (BC) is similar to soot and is emitted directly into the air from virtually all combustion activities. It is especially prevalent in diesel exhaust, which tends to be the primary source of black carbon in urban areas.

Clean Air Act — The comprehensive federal law that regulates emissions of air pollutants in the United States. The original Clean Air Act was passed in 1963, but our national air pollution control program is actually based on the 1970 version of the law. The 1990 Clean Air Act Amendments are the most far-reaching revisions of the 1970 law.

Criteria pollutants — A group of very common air pollutants regulated by EPA on the basis of criteria (information on health and/or environmental effects of pollution). Criteria air pollutants are widely distributed all over the country. They include ozone (O_3), particulate matter (PM10), fine particulate matter ($PM_{2.5}$), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2).

Data Quality Objectives — Qualitative and quantitative statements, developed using the EPA Dative Quality Objective (DQO) Process, that clarify the objectives of an environmental data collection effort and specify tolerable levels of potential errors. DQOs establish the quality and quantity of data needed to support program decisions.

NAAQS — NAAQS stands for "National Ambient Air Quality Standards." The Clean Air Act requires EPA to set a primary and secondary NAAQS for each criteria pollutant. *Primary standards* set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. *Secondary standards* set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Ozone — A odorless, colorless gas composed of three atoms of oxygen. Ozone occurs both in the Earth's upper atmosphere, where it forms a protective barrier that shields people from the sun's harmful ultraviolet rays, and at ground level. Ground-level ozone is a major ingredient of smog, and it can harm people's health by damaging their lungs.

Particulate matter A type of air pollution made up of a mixture of solid particles and liquid droplets found in the air. Particulate matter includes dust, soot, and other tiny particles that are released into and move around in the air. Particulates are produced by many sources, including fuel combustion, power plants, industrial processes, construction, operation of fireplaces and wood stoves, and forest fires. The term "fine particulate matter" (known as $PM_{2.5}$) refers to particles less than 2.5 micrometers in diameter. PM_{10} contains particles that are less than 10 micrometers in diameter.

Quality assurance An integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality control The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality.

Real time In this handbook, the term "real time" is used to indicate that data are presented to the public almost as soon as they are collected, with only a slight delay for data processing and quality assurance. AirBeat reports pollutant concentrations as hourly averages, with results generally made available to the public within 15 minutes of the end of the averaging period.

SLAMS SLAMS stands for "State and Local Air Monitoring Stations." A SLAMS system consists of a carefully planned network of fixed monitoring stations which carry out ambient air monitoring for criteria pollutants under the Clean Air Act. EPA uses SLAMS data to determine if an area is meeting the National Ambient Air Quality Standards for criteria pollutants.

SOPs SOP stands for "Standard Operating Procedure." An SOP is a set of written instructions that document a routine or repetitive activity followed by an organization. In an environmental data collection effort, the development and use of SOPs are an integral part of a successful quality system as it provides individuals with the information to perform a job properly, and facilitates consistency in the quality and integrity of the product or end result.

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