Ambient Air Monitoring Strategy for State, Local, and Tribal Air Agencies

Office of Air Quality Planning and Standards
Research Triangle Park, NC

December 2008

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PREFACE

This document presents an Ambient Air Monitoring Strategy (AAMS) for State, Local, and Tribal (SLT) air agencies. This document updates the broader, SLT-oriented material from the December 2005 version of the National Ambient Air Monitoring Strategy (NAAMS). The material in this document differs from the material in the December 2005 NAAMS document in a few substantive ways:

The discussion in this document of the history, process, and rationale for various strategic decisions is not as detailed as that in the April 2004 or December 2005 versions of the NAAMS. This document is narrower in scope, focusing primarily on criteria pollutant monitoring and the other more urban-oriented monitoring programs for SLT air agencies.

The U.S. Environmental Protection Agency's (EPA) specific strategy with regard to some monitoring programs remains in a formative stage (e.g., National Ambient Air Quality Standards review outcomes, or monitoring for ammonia). Thus, in those instances, this version of the Strategy may focus more on potential outcomes or broad goals and objectives rather than on specific strategic plans.

Since this document does not cover the full scope of ambient air monitoring programs in which EPA plays a role, EPA expects to develop a larger, fully comprehensive NAAMS in the coming year. The comprehensive NAAMS is intended address overall air quality management in the U.S., including both monitoring and modeling objectives, covering regulatory and non-regulatory, health-based, rural, and ecosystem-level monitoring objectives.

This document, referenced documents, and previous versions of the NAAMS are available at http://www.epa.gov/ttn/amtic. The website will also include the final, full-scale NAAMS document upon release. Note that even after finalizing this particular document and the full-scoped NAAMS, EPA envisions that it will revise these documents as monitoring needs evolve, and EPA adjusts its strategy to address emerging air quality topics, technological advances, and other implementation issues.

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EXECUTIVE SUMMARY

Federal, state, local, and tribal air agencies operate and maintain a wide variety of ambient monitoring systems across the United States. Many of these systems now serve multiple environmental objectives, even though they may have been sited originally for one specific purpose. Over time, regardless of whether the original objective remains or diminishes in importance, air quality management developments continue to warrant rethinking of how best to use the existing monitoring systems for current and emerging environmental and air program objectives. The content of this document outlines EPA's present efforts and future plans to maintain and enhance State, Local, and Tribal (SLT) ambient air monitoring and encourage multi-pollutant monitoring activities to meet current and future air quality goals and challenges.

The primary objectives of this strategy are:

- Implement a multi-pollutant monitoring approach that will broaden the understanding of air quality conditions and pollutant interactions, furthering the capability to evaluate air quality models, develop emission control strategies, and support long-term health studies.
- Pursue opportunities for integrating monitoring networks and programs.
- Reconfigure the existing NAAQS compliance networks, mainly the State and Local Air Monitoring Stations (SLAMS), to place emphasis on pollutants for which problems with attainment are more widespread and persistent, such as ozone and $PM_{2.5}$. In part, this emphasis will require shifting resources currently expended on NAAQS attainment problem pollutants that have largely been addressed (such as CO, NO_2, and SO_2). However, EPA recognizes that future NAAQS reviews could result in lower standards, which may in turn change network resource requirements.
- Ensure the quality system and other technical requirements for monitors are appropriate for the intended use of the data and that methods are performance-based in order to provide high-quality data.
- Encourage the use of continuous and high-sensitivity methods and the adoption of the latest digital data acquisition technology and data handling methods in order to provide easy access to timely, high-quality, high-resolution air quality data.

This strategy document describes EPA's overall approach for achieving these objectives. There are a number of situations for which EPA's strategy remains at a formative stage or still in development (e.g., finalizing regulatory monitoring rules for lead). In those situations, this document presents the overall objectives and goals based on the most current and public information.

The focus of this strategy on reconfiguring and integrating existing criteria pollutant-oriented networks in no way diminishes the importance and value added by such networks, nor does this document diminish the importance of regional or rural monitoring, which provides information on trends in atmospheric chemistry, deposition, visibility, and ecosystem-level assessments. In fact, the reconfiguration of SLT-based networks provides an opportunity to explore ways to coordinate regionally based monitoring networks (i.e., the Interagency Monitoring of Protected Visual Environments [IMPROVE] , the Clean Air Status and Trends Network [CASTNET], and the National Atmospheric Deposition Program [NADP], etc.) with SLT NAAQS-oriented networks and the emerging NCore network in the near future. Plans to revise the fully comprehensive ambient air monitoring strategy (known as the National Ambient Air Monitoring Strategy or NAAMS) are underway; the NAAMS will address the various monitoring programs managed by EPA, federal partners, and SLTs.

1. MONITORING NETWORKS AND OBJECTIVES

1.1 INTRODUCTION

The intention of this document is to capture the overarching objectives, approaches, and long-term goals for the primarily urban-oriented ambient air monitoring programs run by state, local, tribal, and federal agencies. This document is also recognized as serving as a reference for State, Local, and Tribal (SLT) air quality monitoring agencies, aiding in the justification and planning of their ambient monitoring efforts above and beyond minimum monitoring requirements spelled out in the Code of Federal Regulations (CFR).

1.2 ROLE OF AMBIENT MONITORING IN AIR QUALITY MANAGEMENT

Ambient air monitoring systems are a critical part of the nation's air quality management infrastructure. Environmental management officials and other environmental professionals use the ambient air monitoring data for a wide variety of purposes in managing air quality. Air quality management involves a cycle of setting standards and objectives, designing and implementing control strategies, assessing the results of those control strategies, and measuring progress. Ambient monitoring data have many uses throughout this process, such as research on the health effects of air pollution; developing and determining compliance with the National Ambient Air Quality Standards (NAAQS); characterizing air quality and trends; estimating health related exposure risks; developing and evaluating emission control strategies; evaluating source-receptor relationships; providing data for input to run and evaluate models; and measuring overall progress of air pollution control programs. Ambient air monitoring data provide accountability for emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors. The data form the basis for air quality forecasting and other public air quality reports and also can provide valuable information about broader ecosystem impacts.

Federal, state, local, and tribal air monitoring agencies have a long history of providing high-quality, credible environmental data. Monitoring agencies have primary responsibility for air monitoring networks that produce data used to demonstrate which areas in the United States attain the NAAQS. Many monitoring agencies maintain additional monitoring resources to assess local air quality issues such as air toxics. In addition, the federal government operates or supports several networks, such as atmospheric deposition and visibility monitoring networks, which provide data on specific issues, particularly focused on providing information on ambient conditions in regionally representative areas. Regional air quality issues, such as transport, can be better characterized by evaluating both urban-oriented criteria pollutant monitoring with regionally oriented, non-criteria pollutant monitoring. In addition, both types of monitoring are designed to provide information for accountability of national and regional emission reduction programs, model development and evaluation, and geographical distribution of pollutants. Although certain objectives of this strategy overlap with regional/rural monitoring, the full range of objectives for EPA's Office of Air and Radiation (OAR) and partnering federal agencies are not covered. The full spectrum of ambient air monitoring objectives will be addressed in a forthcoming version of the National Ambient Air Monitoring Strategy (NAAMS).

The overarching challenge for SLT and federal agencies charged with ambient air monitoring is to maintain and improve upon the existing, valued ambient air monitoring networks despite level or possibly declining funding. Monitoring networks are subject to continual changes in SLT, federal, and research priorities and objectives. New and revised NAAQS, changing air quality (e.g., significantly reduced concentrations of some criteria pollutants, better characterization of impacts from international transport), and an influx of scientific findings and technological advancements, challenge the response capability of the nation's networks.

Another continuing challenge in air quality management in which ambient monitoring plays a vital role is in understanding the complex nature of air pollution formation and providing information to develop effective control strategies. To respond to these challenges, EPA and its partners often need integrated measurements and strategies. The single-pollutant measurement approach, commonly administered in SLT networks, is not an optimal design for integrated air quality management approaches. In addition, as many air quality control solutions move toward large-scale regional, multi-pollutant control strategies, there is an increasing need for coordinating various urban oriented networks with the regional/rural monitoring networks, given that the changes in regional background atmospheric conditions critical to understanding how to reduce urban air pollution are typically observed at the regional/rural monitoring stations. At the same time, ambient air networks need a certain degree of stability so that EPA and others have consistent, long-term data to detect long-term air pollution trends and support long-term health effects research.

1.3 OVERVIEW OF SLT AMBIENT AIR MONITORING NETWORKS

1.3.1 NAAQS Monitoring

Since the 1970s, State and Local Ambient Monitoring Stations (SLAMS) have represented the backbone of all criteria pollutant (sulfur dioxide [SO_2], nitrogen dioxide [NO_2], carbon monoxide [CO], ozone [O_3], lead [Pb], particulate matter [PM] with an aerodynamic diameter less than 2.5 µm [$PM_{2.5}$], PM with an aerodynamic diameter less than 10 µm [PM_{10}], and formerly Total Suspended Particulate [TSP]) monitoring across the nation. At one point, over 5,000 monitors at approximately 3,000 sites were maintained as part of the SLAMS network. These stations use Federal Reference Methods (FRMs) or Federal Equivalent Methods (FEMs) for direct comparison to the NAAQS, which lead to determining whether areas are designated in attainment or non-attainment of a standard. EPA established a suite of regulations that specifies the design and measurement requirements for these networks which can be found in publications dating from the 1970's: 40 CFR Part 50, Part 53, and Part 58. On October, 17th, 2006, EPA finalized its revisions to the Ambient Air Monitoring Regulations located in 40 CFR Parts 53 and 58 (http://www.epa.gov/ttn/amtic/40cfr53.html). This revised monitoring rule is the foundation for much of the strategic plans laid out in this document.

Given the long history of collecting data from SLAMS and the changing nature of NAAQS attainment and control strategy issues, rethinking the design of SLAMS is one of the central topics of this Strategy. Figure 1-1 illustrates the size, nature, and changes to the NAAQS networks since the 1970's. In the early 1980s, O_3, CO, SO_2, NO_2, Pb, and TSP networks were well established. During this time, PM_{10} monitors were being added to SLAMS in advance of the eventual PM_{10} NAAQS, promulgated in 1987. PM monitoring operations were further expanded to include $PM_{2.5}$ monitors, starting in 1999, to assess attainment with the $PM_{2.5}$ NAAQS, promulgated in 1997. The $PM_{2.5}$ and PM_{10} networks consist of ambient air monitoring sites that make mass concentration measurements. As of the end of 2007, there were approximately 947 FRM/FEM filter-based monitors and 591 continuous measurement monitors making $PM_{2.5}$ mass measurements.[1] Further, there were approximately 943 PM_{10} monitors, 1216 O_3 analyzers, 389 CO analyzers, 519 SO_2 analyzers, 422 NO_2 (a.k.a. NO_x) analyzers, 172 Pb (TSP method) monitors, and 104 TSP monitors, although TSP sites have not been required since promulgation of the PM_{10} standard in 1987.

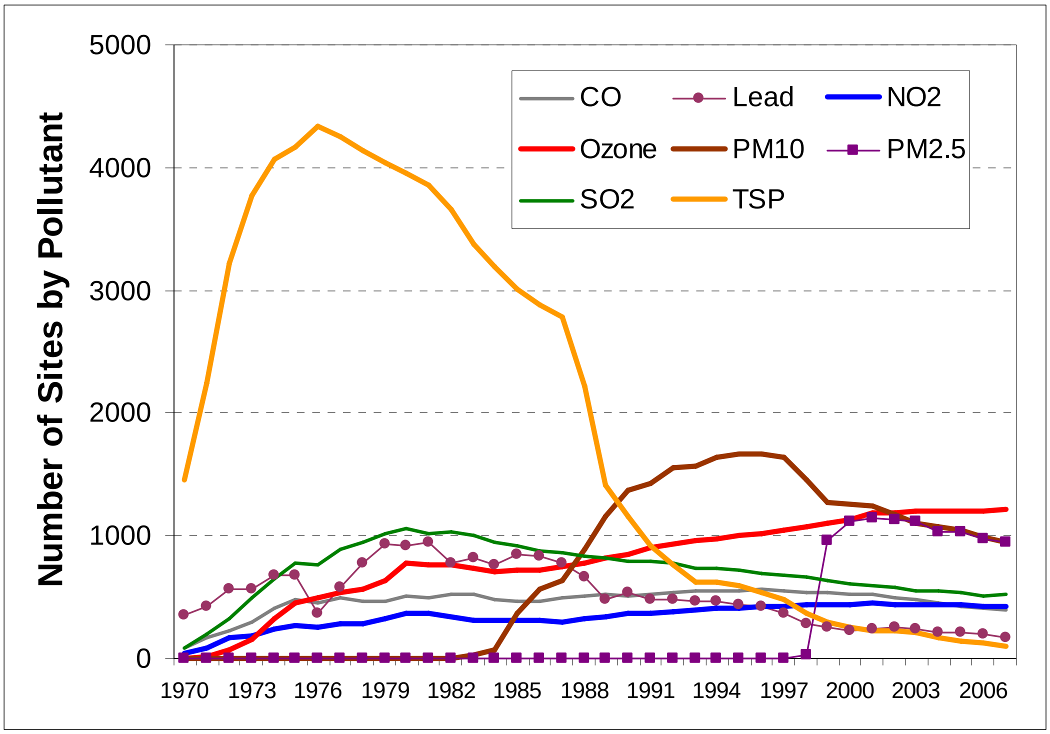

Figure 1-1. Change in Number of Monitors in the Criteria Pollutant Networks from 1970 to 2007.

Dramatic, and mostly positive, changes in air quality have been observed over the past two decades, despite increasing population, vehicle usage, and economic growth. Most criteria

[1] The $PM_{2.5}$ continuous monitoring network is the only criteria pollutant reported and forecasted nationally on a year-round basis as part of the Air Quality Index (AQI); see <http://www.airnow.gov>.

pollutant measurements read well below national standards as shown in Figure 1-2. Control measures adopted under the federal Clean Air Act (CAA) and state and local laws have generally solved the widespread, elevated levels of lead and gaseous criteria pollutants as measured against the NAAQS levels in existence through 2005. However, current and future public health problems with $PM_{2.5}$, ozone, and air toxics continue to challenge air programs, and changes to NAAQS levels of individual pollutants, such as $PM_{2.5}$ and ozone, are forcing a reassessment of how well particular control measures are working.

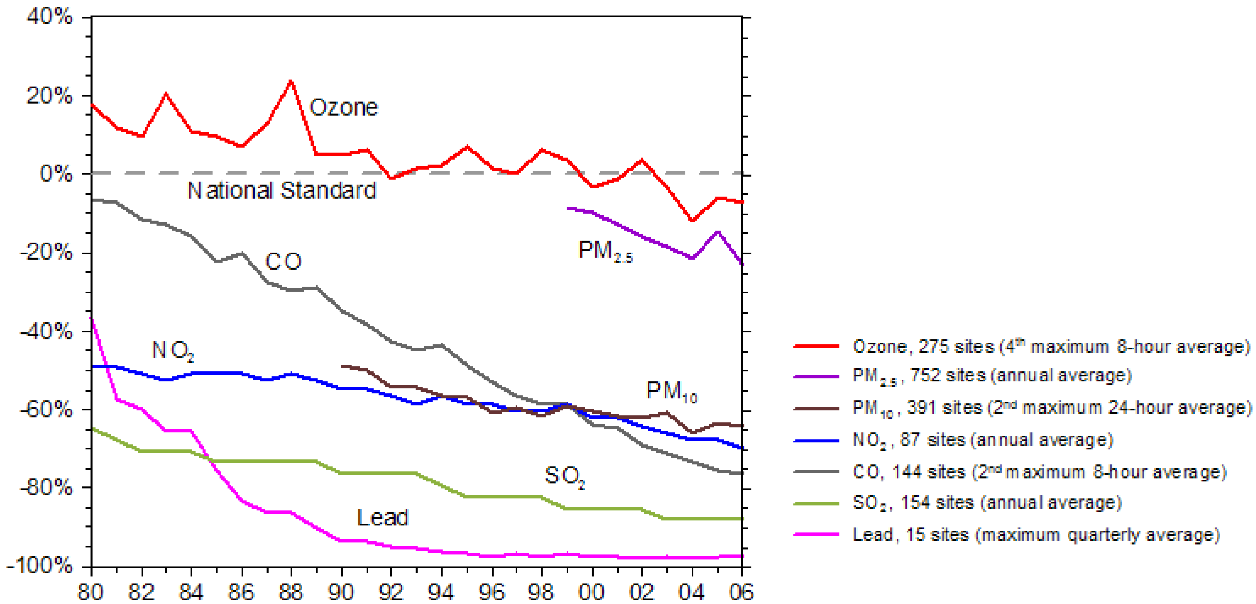

Figure 1-2. Comparison of National Levels of the Six Principal Pollutants to National Air Quality Standards, 1980 – 2006. National levels are average across all sites with complete data for the time period. (Source: Latest Findings on National Air Quality: Status and Trends through 2006, http://www.epa.gov/airtrends/2007/report/trends_report_full.pdf)

1.3.2 Photochemical Assessment Monitoring Stations (PAMS)

In addition to the SLAMS networks, the Photochemical Assessment Monitoring Station (PAMS) network was developed and implemented in the mid-1990s to measure ozone precursors (volatile organic compounds [VOCs], nitrogen oxides [NO_x], and reactive nitrogen species [NO_y]) and surface and upper-air meteorological measurements. The PAMS network consists of 78 sites in 23 areas (circa 2006) that had been classified as serious ozone nonattainment areas at any point in time. Implementation of the PAMS program was a major addition to state and local networks, introducing continuous research-grade (at the time) measurement technologies to produce hourly data for over 50 VOCs[2] during the ozone season.

[2] PAMS target VOCs are listed here: http://www.epa.gov/oar/oaqps/pams/general.html (Target Parameters)

The PAMS sites provide reasonably comprehensive data pertinent to ozone air pollution in non-attainment areas classified as serious, severe, or extreme. There are four types of PAMS sites. The site type is based on its location relative to the emissions and transport pathways in an area and is defined as follows:

- Type 1 – located to provide upwind and background characterization of ozone and precursors being transported into an area.
- Type 2 – located to document the maximum ozone precursor emissions impact. These sites are typically located downwind of a central business district and operate on the most intensive PAMS monitoring schedule.
- Type 3 – located to measure the maximum ozone concentration and typically situated farther downwind than the Type 2 sites.
- Type 4 – located downwind of the non-attainment areas to assess the extreme downwind conditions. In some parts of the country, a Type 4 PAMS site may also be defined as a Type 1 site for another non-attainment area well downwind.

1.3.3 PM Speciation

As part of the $PM_{2.5}$ NAAQS review completed in 1997, EPA established a $PM_{2.5}$ Chemical Speciation Network (CSN) consisting of 54 Speciation Trends Network (STN) sites for routine speciation monitoring in primarily urban areas to provide nationally consistent data for the assessment of trends and to provide a long-term record of the characterization of $PM_{2.5}$ in the United States. The initial STN monitoring began with a pilot of 13 sites in February 2000. In addition to the STN, EPA also implemented a network of about 200 supplemental speciation sites for multiple monitoring objectives, including support for development of modeling tools and the application of source apportionment modeling for control strategy development in support of NAAQS; support for health effects and exposure research studies assessment of the effectiveness of emission reductions strategies through the characterization of air quality; support for programs aimed at improving environmental welfare; and state implementation plan (SIP) development. The STN and supplemental speciation monitoring sites are referred to as the CSN.

In 2005, EPA conducted an assessment specifically focused on the $PM_{2.5}$ speciation monitoring network. In consultation with the National Association of Clean Air Agencies (NACAA), formerly STAPPA/ALAPCO, EPA evaluated CSN sites to determine which ones might be shut down so as to provide resources for future monitoring needs. EPA ranked the sites according to their overall information value. The ranking was based on several factors, including whether the site was in a non-attainment area and whether other sites were nearby. There was general agreement that many of the sites should be shut down when FY 2005 funding ran out. Other sites were identified as high value sites, particularly with regard to the $PM_{2.5}$ NAAQS program. EPA evaluated each of these sites when FY 2006 Regional funding allocations for continued operation and maintenance were developed. In doing so, EPA balanced filter-based $PM_{2.5}$ speciation against other uses of $PM_{2.5}$ funding, such as FRM site operations, filter analysis, and startup of additional precursor gas sites and continuous speciation sites.

As of May 2008, the $PM_{2.5}$ CSN consisted of approximately 53 STN sites and about 160 SLAMS supplemental sites. These sites collect aerosol samples over 24 hours every third day or every sixth day on filters that are analyzed for $PM_{2.5}$ mass, trace elements (Al through Pb), major ions (sulfates, nitrates, and ammonium), and organic and elemental carbon fractions. During the summer of 2008, the CSN transitioned to a new method of sampling and analyzing for carbon that is consistent with Interagency Monitoring of Protected Visual Environments (IMPROVE) network methodology.

The IMPROVE program was established in 1985 to aid the creation of federal and state implementation plans for the protection of visibility in Class 1 areas (155 national parks and wilderness areas) as stipulated in the 1977 amendments to the CAA and further supports goals set forth in the 1999 Regional Haze rule (documentation available at http://www.epa.gov/visibility/actions.html). The IMPROVE program provides $PM_{2.5}$ speciation data, like the CSN, and also includes some toxic metals analysis. IMPROVE is a cooperative measurement effort managed by a steering committee composed of representatives from federal, regional, and state organizations. The IMPROVE network presently comprises 110 regionally representative monitoring sites, 7 sites operated collaboratively with the Clean Air Status and Trends Network (CASTNET), and 34 sites within the CSN operating according to IMPROVE protocols.

1.3.4 Air Toxics

In 1999, EPA began designing a national ambient air toxics monitoring program. The initial step in this process was a concept paper developed by a committee comprised of representatives from EPA and SLT agencies. The broad program objectives delineated therein were well-received by the EPA Clean Air Scientific Advisory Committee (CASAC) subcommittee. Historical air toxics ambient monitoring data were then compiled and assessed, and a 10-city pilot study was designed and executed. The information derived from these efforts, combined with that of the 1996 National Air Toxics Assessment (NATA), led to an initial network design and National Air Toxics Ambient Monitoring Strategy (located at http://www.epa.gov/ttn/amtic/files/ambient/airtox/atstrat804.pdf). As a result, EPA has developed a national air toxics program that increases the role of ambient monitoring in support of efforts to reduce human exposure and health risks from air toxics. The primary objectives of ambient air toxics monitoring are to (1) discern trends and account for program progress by measuring key air toxics in representative locations to provide a basic measure of air quality differences across cities and regions and over time in specific areas; (2) support exposure assessments by providing ambient concentration levels for comparison with personal measurements; and (3) provide basic grounding for models used for exposure assessments, development of emission control strategies, and related assessments of program effectiveness.

Unlike NAAQS pollutants, the CAA does not require ambient monitoring for air toxics (also known as Hazardous Air Pollutants [HAPs]). Because the primary focus of the air toxics program to date has been on reducing HAP emissions by application of available control technology for industrial sources and more stringent mobile source emission standards, the success of the program so far has been measured more often by the level of emissions reductions achieved rather than measured changes in air quality. EPA has used air dispersion modeling to estimate the impact of HAP emissions on ambient air concentrations of air toxics and, ultimately, on human health through the NATA. The most recent assessment was conducted with the 1999 emissions inventory and can be found at http://www.epa.gov/ttn/atw/nata1999/. Currently, the NATA is being updated using 2002 data, with a tentative release in late 2008.

EPA has an active national air toxics monitoring program that includes three distinct monitoring efforts:

- National Air Toxics Trends Stations (NATTS);
- community-scale projects to assess conditions at the local level; and
- existing state and local program monitoring.

The NATTS network provides long-term monitoring data for certain priority HAPs[3] across representative areas of the country in order to establish overall trends for these pollutants. In 2007, EPA piloted the inclusion of polycyclic aromatic hydrocarbons (PAHs) at 5 NATTS, with full network implementation of PAH monitoring occurring in 2008. The initial 23 NATTS were established during 2003-2005; two NATTS were added in 2007 and two more in 2008 for a total of 27 sites.

Initial ambient air toxics monitoring pilot studies showed that significant variations in pollutant concentrations occur across a city that cannot be characterized by a single monitoring site. Thus, EPA has incorporated into its air toxics program support for competitively awarded community-scale projects. Selected projects are well-developed in terms of basis, objectives, approach, and expected outcomes, and typically include several monitoring sites operated for one to two years.

In 2003/2004, EPA selected and awarded 17 community-scale project proposals from 49 proposals; these grant awards totaled approximately $6.2 million. In 2005/2006, EPA selected and awarded 19 community-scale projects from 56 proposals; these grant awards totaled approximately $6.6 million. In 2006/2007, EPA selected and awarded 20 community-scale projects from 60 proposals; these grant awards totaled approximately $6.8 million. EPA works with monitoring agencies to define the goals and priorities for this monitoring program element. Under this Strategy, EPA anticipates continued funding for these types of local-scale projects, and a continued dialogue with stakeholders, including SLT monitoring agencies, on the appropriate priorities for these efforts.

1.3.5 RadNet

Currently, RadNet is the nation's only comprehensive radiation monitoring network, with more than 200 sampling stations located throughout the United States. The network is multi-media and provides broad geographical coverage as well as coverage of many major population

[3] See http://www.epa.gov/ttnamti1/files/ambient/airtox/2007-workshop/05_100207_jones.pdf for minimum measurement requirements.

centers, and often relies on voluntary participation by SLTs for field operations. For air monitoring, RadNet samples twice a week at 59 locations. In addition to RadNet, there are other radiation monitoring programs in the United States. The Department of Homeland Security's (DHS) Environmental Measurements Laboratory operates the Surface Air Sampling Program (SASP). This global air particulate monitoring network comprises approximately 41 active sampling stations worldwide. In addition, DHS operates a global precipitation monitoring network with 45 U.S. sampling locations.

RadNet remains the only comprehensive national environmental ambient radiation monitoring network that focuses on major population centers and broad geographical areas.

EPA has an ongoing implementation plan to enhance RadNet, with a focus on homeland security concerns. The planned approach to enhancing RadNet is currently being reviewed by EPA's Science Advisory Board. After the approach and implementation plan are finalized, those elements will be incorporated into this overall Strategy.

1.3.6 Tribal Monitoring

In the 1990 CAA, Congress recognized EPA's obligation to work with the Tribes in addressing air quality on Tribal lands. Promulgation of the Tribal Authority Rule (TAR) in 1998 provided Tribes with the framework to begin assessing air quality on Tribal lands. Tribal nations generally are seeking to expand ambient air monitoring efforts, and the substantial need for Tribal air monitoring support is generally recognized. At the same time, nothing in this Strategy imposes requirements on Tribal monitoring or mandates linkages of Tribal air monitoring with national networks.

Currently, there are well over 100 Tribal air quality programs in various stages of development across the United States. This is a dramatic increase from only nine programs in 1995. Many of these Tribes currently report data to EPA's Air Quality System (AQS) from about 120 monitors on Tribal lands for several types of pollutants, including $PM_{2.5}$, PM_{10}, ozone, NO_x, and SO_2. Tribes also operate sites as part of the CASTNET and NADP networks, and there are currently 11 Tribal IMPROVE protocol sites operating in six EPA regions. These numbers may increase as Tribes continue to build the capacity to assess air quality on their respective lands. However, the maintenance and growth of air quality monitoring also will remain linked to the availability of Tribal grant funds to support these activities.

EPA's Tribal air policy emphasizes that, as sovereign governments, Tribes set their own air program goals and determine how monitoring is to be used in achieving these goals. Thus, EPA's role for Tribal air programs is to help the Tribes understand their air quality problems and to establish and meet their air quality goals, rather than to set goals or timetables for the Tribes.

The national networks clearly can benefit from Tribal participation by gaining additional monitoring sites in those areas where Tribes participate in the national network. Tribes share a spectrum of technical issues with states, since pollutant transport and meteorology ignore political boundaries. Accordingly, any measurement contribution from Tribal efforts should be viewed as an asset to a larger integrated national need for air quality measurements, and Tribes should perceive some level of ownership of air quality data collected in non-Tribal lands that has relevance to Tribal air quality issues. Tribal participation can benefit all parties as opportunities exist for Tribes to operate NCore multi-pollutant sites, likely more-so in rural areas where significant spatial gaps in monitoring remain. Under this Strategy, Tribes will be given consideration for hosting sites of national interest, and the associated funding.

2. DEVELOPING THE "AAMS FOR SLT" OBJECTIVES

2.1 INITIAL STRATEGY DEVELOPMENT

In the early 1990s, a National Monitoring Steering Committee (NMSC) was developed to provide oversight and guidance to ambient monitoring, and eventually develop a national monitoring strategy. The NMSC included representatives from SLTs, EPA's Office of Air Quality Planning and Standards (OAQPS), Office of Research and Development (ORD), and Regional Offices. The NMSC structure included relevant EPA offices and its major air monitoring grantees with a manageable subset of clients in order to increase the probability of progress. With input from the NMSC, EPA later released a series of draft Strategy materials, dating from 2004 forward (found at http://www.epa.gov/ttn/amtic/monitor.html).

During this time span, EPA has been conducting national assessments of the criteria pollutant monitoring networks. An assessment was conducted in 2000[4] to catalyze subsequent regional level assessments. The key findings of the national assessment of criteria pollutant networks are as follows:

- **Investment Needs**. New monitoring efforts are needed to support new air quality challenges, including new monitoring technology for criteria pollutants, precursor species, and air toxics. Newer technology, especially continuous measurement methods for pollutants, such as fine particles, are needed to provide more complete, reliable, and timely air quality information, and to relieve the burden of manual sampling. Air toxics have emerged as a top public health concern in many parts of the country, and as a result, a primarily urban focused national air toxics monitoring network has been established under special funding.
- **Divestment Opportunities**. To make more efficient use of existing monitoring resources and to help pay (and justify additional resources) for new monitoring initiatives, opportunities exist to reduce current monitoring network sizes. Two areas of potential divestment were suggested. First, many historical criteria pollutant monitoring networks have achieved their objectives and demonstrated that national (and, in most cases, regional) air quality problems for certain pollutants—PM_{10}, SO_2, NO_2, CO, and Pb—no longer exist. It is very important to note that these statements are made under the premise of using the existing NAAQS. Therefore, a substantial reduction in the number of monitors for these pollutants should be considered, although considerations need to be made to retain a certain number of trace level/high-sensitivity monitors, especially for SO_2 and CO, because of their utility as tracers for certain sources of emissions, for model performance evaluation, and for exposure assessment. Second, many sites monitor only one (or a few) pollutants. To the extent possible, sites should be combined to form multi-pollutant monitoring stations. Any resource savings from such divestments must remain in the monitoring program for identified investment needs.

[4] Documentation of assessment findings can be found at http://www.epa.gov/ttn/amtic/netamap.html

It should be noted that the type of network assessment used here produces recommendations on removing or relocating samplers based largely on technical merit. In some instances, these recommendations may be in conflict with existing policy or other needs. For example, a recommendation that an ozone monitor be discontinued in a "nonattainment" county due to redundancy of neighboring sampling sites raises interesting policy/technical issues. These and other issues require attention in concert with technical recommendations developed through assessments. It should not be assumed that policy should override a technical recommendation, nor should technical approach override existing policy. Rather, reasonable solutions can be achieved on a case-by-case basis.

- **Importance of Regional Input**. The national analyses were intended to provide broad directional information about potential network changes. Regional/local analyses are a critical complement to the national analyses and are necessary to develop specific monitoring site recommendations.

Consistent with these overall design and management principles, the initial members of the NMSC recommended several key ideas that should be a foundation for an ambient monitoring strategy. The implementation of these concepts will allow for more efficient collection and universal use of air quality data and greater flexibility in monitoring efforts to meet the challenges of the 21st Century in ways that meet both national and local monitoring needs. The key recommendations follow:

- The networks need to produce data more closely aligned with current challenges by
  - including a greater level of multi-pollutant monitoring sites in representative urban (and regionally representative) areas across the nation;
  - expanding use of advanced, continuously operating instruments and new information transfer technologies;
  - integrating emerging HAP measurements into mainstream monitoring networks; and
  - supporting advanced health and atmospheric research where appropriate.
- A new national, urban-based monitoring network design, such as that for the National Core monitoring network (NCore), should accommodate these recommendations and the major demands of air monitoring networks, such as
  - determining trends;
  - reporting to the public;
  - assessing the effectiveness of emission reduction strategies;
  - assessing source-receptor relationships;
  - providing data for health assessments and NAAQS review; and
  - determining attainment and nonattainment status.

- Existing monitoring regulations require modification and promulgation by EPA to accommodate recommended network changes.
- Flexibility must be maintained or increased for monitoring agencies to address local and area-specific issues including, for example, environmental justice concerns, episodic PM and ozone events, and "local" or hot spot air toxics concerns.
- Periodic assessments of air monitoring networks must be performed to determine if the existing network structure is optimally meeting national and local objectives. The current national review of the networks indicates that many criteria pollutant measurements (e.g., NO_x, SO_2, CO, PM_{10}) provide only limited value, which presents opportunities to realign air monitoring resources in more relevant areas. Such assessments and network decisions are best addressed through regional to local level evaluations.
- The network modifications should be conducted within current resource allocations used to support monitoring (e.g., with respect to staffing). However, modest investments in new equipment need to be made to upgrade monitoring systems to meet new priorities and accommodate advanced technologies.
- Recommendations for network changes should engage the general public and health research organizations.

2.2 RECOMMENDATIONS ON AIR QUALITY MANAGEMENT

EPA engages multiple external stakeholders in order to better assess many of the key air quality management challenges it faces. A major recent document providing feedback on air quality management to EPA is the National Academy of Sciences (NAS) report: Air Quality Management in United States (2004).[5] This report provides valuable input and recommendations on how best to address current and future air quality management challenges, which EPA has taken steps to address, including

- meeting new standards for ozone, PM, and regional haze;
- understanding and addressing the human health risks from exposure to air toxics;
- responding to evidence that there may be no identifiable threshold exposure below which harmful effects cease to occur for some pollutants;
- mitigating pollution effects that may disproportionately occur in minority and low-income communities;
- understanding and protecting ecosystems affected by air pollution;
- understanding and addressing multi-state and international transport of pollutants; and
- adapting the air quality management system to address a changing climate.

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[5] <http://www.nap.edu/catalog.php?record_id=10728>

Among the NAS recommendations to address air quality management challenges are enhancing assessments of air quality and health, ecosystem monitoring, and exposure assessment. Therefore, EPA saw confirmation in its effort to pursue the concept of reconfiguring existing air quality monitoring networks and management as a way to reflect progress made in reducing many forms of air pollution and incorporate new scientific findings and technologies to address the remaining challenges. This Strategy outlines the approaches to aid in implementing those recommendations by coordinating ambient monitoring efforts and looking for ways to strengthen, update, and link existing monitoring systems.

The maintenance of effective ambient monitoring networks involves no single EPA office or other entity, but a wide range of groups. These groups can have different objectives for ambient monitoring, different funding, and other constraints. If progress is to be made in meeting the rising and apparent air quality management challenges, all stakeholders will need to adhere to certain operating principles including creating and enhancing partnerships, allowing flexibility between national and local needs, effectively interfacing with the scientific community, making plans with zero sum resource assumptions, and recognizing needs for data analysis and interpretation.

2.3 STRATEGY OBJECTIVES

This Strategy has a number of elements, not all of which apply to all forms of ambient air monitoring. The major impetus behind this effort is EPA's recognition that the monitoring historically undertaken to determine NAAQS compliance needs to be reconfigured and updated to meet air quality management challenges in the United States. At the same time, EPA recognizes that other ambient monitoring networks and programs, including some that are just now being developed, play a vital role in responding to those challenges as well, and that continued maintenance and, in places, enhancement of those networks is an important element of a national monitoring strategy. Finally, EPA also realizes that while these various monitoring programs may have been developed initially to provide data for different objectives, there are synergies and needs among objectives that provide opportunities to integrate some of these systems.

Therefore, based on information gathered from various criteria pollutant monitoring network assessments, the NMSC, the NAS' Air Quality Management in United States 2004 report, and input from various state and local air agencies (e.g., NACAA), the EPA has developed the following strategy objectives for current and future ambient air monitoring and management:

- Implement a multi-pollutant monitoring approach that will broaden the understanding of air quality conditions and pollutant interactions, further the capability to evaluate air quality models, develop emission control strategies, and support long-term health studies.
- Pursue opportunities for integrating monitoring networks and programs.
- Reconfigure the existing NAAQS compliance networks, such as SLAMS, to place emphasis on pollutants for which problems with attainment are more widespread and

persistent, such as ozone and $PM_{2.5}$. In part, this emphasis will require shifting resources currently expended on NAAQS attainment problem pollutants that have largely been addressed (such as CO, NO_2, and SO_2). However, EPA recognizes that future NAAQS reviews could result in lower standards, which may in turn change network resource requirements.

- Ensure the quality system and other technical requirements for monitors are appropriate for the intended use of the data and that methods are performance-based in order to provide high-quality data.
- Encourage the use of continuous and high-sensitivity methods and the adoption of the latest digital data acquisition technology and data handling methods in order to provide easy access to timely, high-quality, high-resolution air quality data.

In the process of fulfilling these objectives, future monitoring networks will have to evolve from the current air monitoring networks to address existing measurement and technological gaps and needs that have accumulated over the years. This Strategy emphasizes the establishment of multi-pollutant sites including important pollutants previously not included in SLAMS, such as ammonia and NO_y. It is also very important to note that multi-pollutant monitoring sites are a supplement to traditional NAAQS sites and will heavily leverage into existing networks, allowing the multi-pollutant sites to meet a number of important needs. The multi-pollutant approach also calls on the implementation of newer, higher sensitivity gas analyzers for all the criteria gases except ozone, and increased use of continuous PM methods. These steps will lead to multi-pollutant sites that will measure particles ($PM_{2.5}$, speciated $PM_{2.5}$, $PM_{10-2.5}$, speciated $PM_{10-2.5}$), gases (ozone, SO_2, CO, nitrogen oxides [NO_x/NO_y]), and basic meteorology.

3. MULTI-POLLUTANT MONITORING

The modified ambient network outlined in this Strategy is part reconfiguration and part enhancement of existing networks, i.e. SLAMS. The reconfiguration of the SLAMS and other networks reflects upon their multifaceted roles. While these networks are the critical tool in assessing NAAQS attainment, they also complement other applications, such as intensive field campaigns to understand atmospheric process dynamics, or to assess human exposure. To produce a more integrated and multi-pollutant approach to air monitoring, this Strategy outlines changes in nomenclature for existing networks, the proposed reconfiguration of the allocation of monitoring sites within the networks, and introduces the multi-pollutant site network known as the National Core monitoring network (NCore). The introduction of NCore not only complements changes to existing network configurations, but folds in new measurements to foster a multi-pollutant measurement approach. These new measurement methods may replace existing hardware and methods that either do not have the measurement sensitivity to handle current atmospheric concentrations or have reached a point of strongly diminished value.

NCore sites may be characterized as a type of SLAMS site, essentially forming a subset of multi-pollutant sites within the SLAMS network. EPA expects each state to have at least one NCore multi-pollutant monitoring site, with multiple sites in more populous states and areas with nonattainment issues. EPA will collaborate on site selection with states individually and through multistate organizations. The objective is to locate sites in broadly representative urban (about 50 sites) and rural or regional (about 20 sites) locations throughout the country to help characterize urban- and regional-scale patterns of air pollution. In many cases, SLTs will likely upgrade existing SLAMS locations, and where possible, monitoring agencies are encouraged to collocate NCore sites with PAMS sites already measuring ozone precursors, NATTS sites measuring air toxics, or possibly Clean Air Status and Trends Network (CASTNET) sites measuring ozone for the regional and rural component. By combining these monitoring programs at a single location, stakeholders can maximize the multi-pollutant information available. This approach not only leverages existing resources but notably enhances the foundation for future health studies and NAAQS revisions.

The change to a multi-pollutant approach provides an opportunity to take new directions in monitoring and to begin to fill measurement and technological gaps that have accumulated in the networks. The EPA recognizes that there are both national and local objectives in monitoring that require different design approaches despite the best attempts at leveraging resources and maximizing versatility of monitoring stations. The multi-pollutant approach is a step forward in addressing national needs to make the most of available data by emphasizing:

- timely reporting of data to the public by supporting AIRNow, air quality forecasting, and other public reporting mechanisms;
- support for development of emission strategies through air quality model evaluation and other observational methods;
- accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors;

- support for long-term health assessments that contribute to ongoing reviews of the NAAQS;
- compliance through establishing nonattainment/attainment areas through comparison with the NAAQS;
- support of scientific studies ranging across technological, health, and atmospheric process disciplines; and
- support of ecosystem assessments, recognizing that national air quality networks benefit ecosystem assessments and, in turn, benefit from data specifically designed to address ecosystem analyses.

In the multi-pollutant framework, all the multi-pollutant monitoring objectives are equally valued at each site, which is a departure from an historical emphasis on NAAQS attainment compliance for individual pollutants at certain SLAMS sites. This is not meant to imply that EPA is committing to a research-grade network, as the measurements generally are produced through routine operations conducted by most monitoring organizations. The underlying philosophy adopted in the multi-pollutant monitoring approach is that regulatory assessments are strengthened through a more comprehensive measurement approach that is well integrated with scientific applications. In turn, science and research efforts become more focused and effective because of the integration with the regulatory program perspective.

Finally, monitoring agencies may find that NCore may become a main trunk of information upon which the necessary branching of specific monitoring needs can be grafted in the future. The network design assumes that pollutant measurements inherently serve multiple data needs and, therefore, that network efficiencies are enhanced through collocating measurements. However, there is a balance to be found between designing for a specific data objective and taking a more holistic design approach that risks a dilution of attention toward a specific need. Such caution must be acknowledged in communicating the limitations of a nationally designed network and recognizing the equal importance of local and other program-specific monitoring efforts that branch off from the core design.

3.1 NCORE SYSTEM DESIGN

In shifting to the multi-pollutant framework, EPA and its partners will seek to continue to assess existing monitoring; reduce monitoring where no longer needed to assure NAAQS attainment or to meet other policy needs (such as trends analysis); and move to continuous monitoring where possible. The regulatory changes promulgated October 17th, 2006 (40 CFR Parts 53 and 58) provide the regulatory framework necessary to restructure the existing SLAMS networks, harmonize quality assurance (QA) requirements, and provide additional changes necessary to implement elements of this Strategy.

There are several basic design attributes for the NCore sites:

- **Multi-Pollutant Measurement Sites**. From an emissions source perspective, multiple pollutants or their precursors are released simultaneously (e.g., a combustion plume with nitrogen, carbon, hydrocarbon, mercury, sulfur gases, and PM). Meteorological processes that shape pollutant movement, atmospheric transformations, and removal act on all pollutants. Numerous chemical/physical interactions underlie the dynamics of particle and ozone formation and the adherence of air toxics on surfaces of particles.

The overwhelming programmatic and scientific interactions across pollutants demand a movement toward integrated air quality management. Collocated air monitoring will benefit health assessments, emissions strategy development, and monitoring. Health studies with access to multi-pollutant data will be better positioned to identify confounding effects of different pollutants, particularly when a variety of concentration, composition, and population types are included. Air quality modelers will be able to perform more robust evaluations by checking performance on several variables to ensure the model produces results for correct reasons and not through compensating errors. Just as emission sources are characterized by a multiple pollutant releases, related source apportionment models yield more conclusive results from use of multi-pollutant measurements. Multi-pollutant measurements also streamline monitoring operations and offer increased diagnostic capabilities to improve instrument performance.

In addition, in moving aggressively to integrate continuous PM (mass and potentially speciation) monitors in the network, it is important to retain a number of collocated filter and continuous instruments, as the relationships between these methods are subject to future changes brought on by modifications of aerosol composition. For example, assuming proportionally greater sulfur reductions than nitrogen reductions, nitrate will replace sulfate as the major inorganic component, and aerosol sampling losses because of volatility may increase at different rates depending on instrument type.

As it is not possible with constrained resources to measure everything everywhere, a natural conflict arises between the relative value of spatial richness and multiple parameters at fewer locations. This Strategy assumes that there is a geometric increase in value gained from combining measurements at a single location, rather than spreading out single measurements in a dense spatial network.

- **Emphasis on Continuously Operating Instruments**. Continuous systems allow immediate data delivery through state-of-the science telemetry transfer, support reporting mechanisms such as AIRNow, and provide critical support for a variety of public health and monitoring agencies charged with informing the public about air quality. Continuous data add considerable insight to health assessments and address a variety of averaging times, source apportionment studies that relate impacts to direct emission sources, and air quality models that need to perform adequately over a variety of time scales to increase confidence in projected emissions control scenarios.

- **Establish “Representative” Locations**. Sites should represent urban (large and medium-size cities) areas. Siting criteria must be specific and defined for each site classification. National-level health assessments and air quality model evaluations require data representative of broad urban (e.g., 4 to 50 km) and regional/rural (> 50 km) spatial scales. Long-term epidemiological studies that support review of NAAQS benefit from a variety of airshed characteristics across different population regimes. The basic urban air monitoring networks must include sites in locations that allow EPA to develop a representative report card on air quality across the nation, a report that can delineate differences among geographic and climatological regions. Although "high" concentration levels will characterize many urban areas, it is important to include cities that also experience less elevated pollution levels or differing mixtures of pollutants for more statistically robust assessments.

These various design attributes differ from historical approaches that emphasized maximum concentration locations, often dependent on a particular pollutant. Those perspectives remain valid from a local perspective and need to be addressed through elements of local, single pollutant-focused measurement sites, as well as through local discretionary monitoring conducted outside the scope of the basic urban monitoring networks.

Also, while the NCore multi-pollutant design is based, in part, on supporting long-term epidemiological studies, an effective communications mechanism is still needed to increase support to health effects community. Recent efforts by the Health Effects Institute (HEI) have incorporated the national networks as part of its ongoing agenda. EPA and HEI should continue to pursue opportunities for integration. More specifically, EPA (and SLTs as appropriate) should engage active researchers in the health effects community and have a substantive meeting addressing important locations (e.g., those cities with planned long-term studies) to help prioritize NCore sites and comment on the parameter list.

3.2 NCORE NETWORK

The approximate total number of NCore multi-pollutant sites (~75), as well as the list of required pollutant measurements, reflects a modest recommendation for balancing total network growth while introducing manageable network realignment. Site locations will be based on design criteria that also balance technical needs with practical considerations, such as leveraging established sites and maintaining geographic equity. Sites will adhere to a site allocation process described in Section 3.4. The network is likely to be phased in over several years after promulgation of the applicable regulatory revisions to be fully implemented by January 1, 2011.

The minimum required NCore measurements (Table 3-1) include PM in the form of filter-based and continuous $PM_{2.5}$ mass, filter based $PM_{2.5}$ speciation, filter-based $PM_{10-2.5}$ mass (a.k.a. PM_{coarse} or PM_c), filter-based $PM_{10-2.5}$ speciation; gaseous O_3, CO, SO_2, NO, NO_y; and meteorological measurements including temperature, relative humidity (RH), wind speed, and wind direction. $PM_{10-2.5}$ measurements have been included as part of multi-pollutant measurements to support health studies and emission strategy development. In addition, integrated ammonia and nitric acid sampling will be investigated for inclusion at NCore sites; however, the methods, sampling frequency, and implementation details for these two gases remain under consideration at this time, and are further discussed in Chapter 7 of this document.

Although these parameters include all the criteria pollutants except Pb and NO_2, the parameters are not chosen solely for compliance purposes. Instead, they represent a robust set of indicators that support multiple objectives including accountability, health assessments, and emissions strategy development (e.g., air quality model evaluation, source apportionment, and numerous observational model applications).

Table 3-1. Required NCore Parameter List.

Measurements	Comments
$PM_{2.5}$ FRM mass	Typically 24-hr average every 3rd day
Continuous $PM_{2.5}$ mass	1-hr reporting interval for all continuous species
$PM_{2.5}$ speciation	Organic and elemental carbon, major ions, and trace metals (24 hr average; every 3rd day)
$PM_{10-2.5}$ mass	Supporting research related to potential future $PM_{10-2.5}$ standard
$PM_{10-2.5}$ speciation	Analytes to likely include elemental analysis and possibly major ions. Operations would be integrated/collocated with $PM_{2.5}$ speciation.
Ozone (O_3)	Continuing use of continuous FEM analyzers
Carbon monoxide (CO)	Using high sensitivity analyzers
Sulfur dioxide (SO_2)	Using high sensitivity analyzers
Nitrogen oxide (NO)	Using high sensitivity analyzers
Total reactive nitrogen (NO_y)	Using high sensitivity analyzers
Surface meteorology	Wind speed and direction, temperature, RH

Monitoring for most of these parameters will be conducted using near continuous monitors, with reporting at 1-hr intervals or less. The continuous PM measurements are not required to be made by FEM monitors, although the first FEM continuous monitor was recently (Spring 2008) approved by EPA. As a peripheral benefit, the presence of collocated integrated and in-situ continuous aerosol measurement methods will provide a continuing reference check for the performance of continuous instruments and will address some of the network collocation requirements needed to assess Approved Regional Method (ARM) applicability for a particular continuous method (see Section 7). Collocation with FRMs is an important component of the $PM_{2.5}$ continuous implementation strategy, as the relationship between FRMs and continuous monitors drives the integration of these systems. These relationships will vary in time and place as a function of aerosol composition (e.g., gradual evolution of a more volatile aerosol in the East as carbon and nitrate fractions increase relative to the more stable sulfate fraction).

The minimum required NCore multi-pollutant measurements reflect a balance across a constrained resource pool, available monitoring technologies, and desired measurements. Consideration should be given to introducing additional measurements at selected sites in the future. Examples of nationally important new measurements that support multiple objectives include ammonia, nitric acid, true NO_2, and continuous measurements of particle size distributions. As multi-pollutant stations, EPA and its partners should over-design these sites in terms of space and power consumption with the expectation of additional future measurements. Such over-design also will encourage collaboration between research scientists and government agencies, because the NCore sites should be able to accommodate periodic visits from health and atmospheric scientists who may conduct specialized intensive sampling.

3.3 NCORE MEASUREMENT METHODS

In order to make the measurements required at NCore multi-pollutant sites, the implementation of some advanced continuous and semi-continuous measurement technologies is needed. With the exception of high sensitivity CO, SO_2, and NO_y analyzers, these measurements can be made using methods that are currently available in 40 CFR Part 50, http://www.epa.gov/ttn/amtic/40cfr50.html, and in the QA Handbook, http://www.epa.gov/ttn/amtic/qabook.html. High sensitivity CO, SO_2, and NO_y monitoring required the development of additional technical guidance to allow implementation of continuous monitoring using newer, more sensitive instruments. High sensitivity analyzer Standard Operating Procedures (SOPs), training material and presentations, and a Technical Assistance Document (TAD) are available on the web at http://www.epa.gov/ttn/amtic/precur.html. The method-specific discussion and implementation approach for the required NCore monitoring methods are covered in Chapter 7.

3.4 NCORE SITING

The siting goal for NCore multi-pollutant sites is to produce representative measurements at stations to serve multiple objectives. Urban siting criteria can take one of two forms:

- Collective
  - Consist of approximately 75 locations that are predominantly urban.
  - Represent a cross section of urban cities that emphasizes major areas with a population greater than 1 million.
  - Include a mix of large (0.5 to 1.0 million) and medium (0.25 to 0.5 million) cities with geographically and pollutant diverse locations suitable as reference sites for long-term epidemiological studies.
- Individual
  - Include “representative” locations in the urban scale, 4-50 km, which are not impacted by unique local sources; this is important for using the data in air quality model development and validation.
  - Leverage existing sites where practical, such as the speciation, air toxics, PAMS, and CASTNET trends sites.
  - Maintain consistency with collective criteria (i.e., does the selected site add holistic network value?).
  - Consider logistical practicality.

3.4.1 Site Allocation Process

Many of the proposed NCore sites (shown in Figure 3-1) are based largely on historical and political considerations (e.g., one NCore site per state) that involves the distribution of monitoring resources based on a combination of population and geography, which in broad terms is consistent with several technical design aspects. Technical guidance sets a framework for assessing the development of NCore multi-pollutant sites, while an allocation scheme provides a process for facilitating implementation. The allocation must be flexible enough to ensure that sites have meaningful value and redundancies are avoided. Examples of suspected shortcomings in the allocation scheme that may need to be reconciled include multiple Florida locations with generally moderate air quality due to marine influences, and possible redundant locations along the East Coast and Midwest. To ensure that the collective national siting criteria are followed, NCore sites will require approval by the EPA Administrator or an agency entity delegated authority.

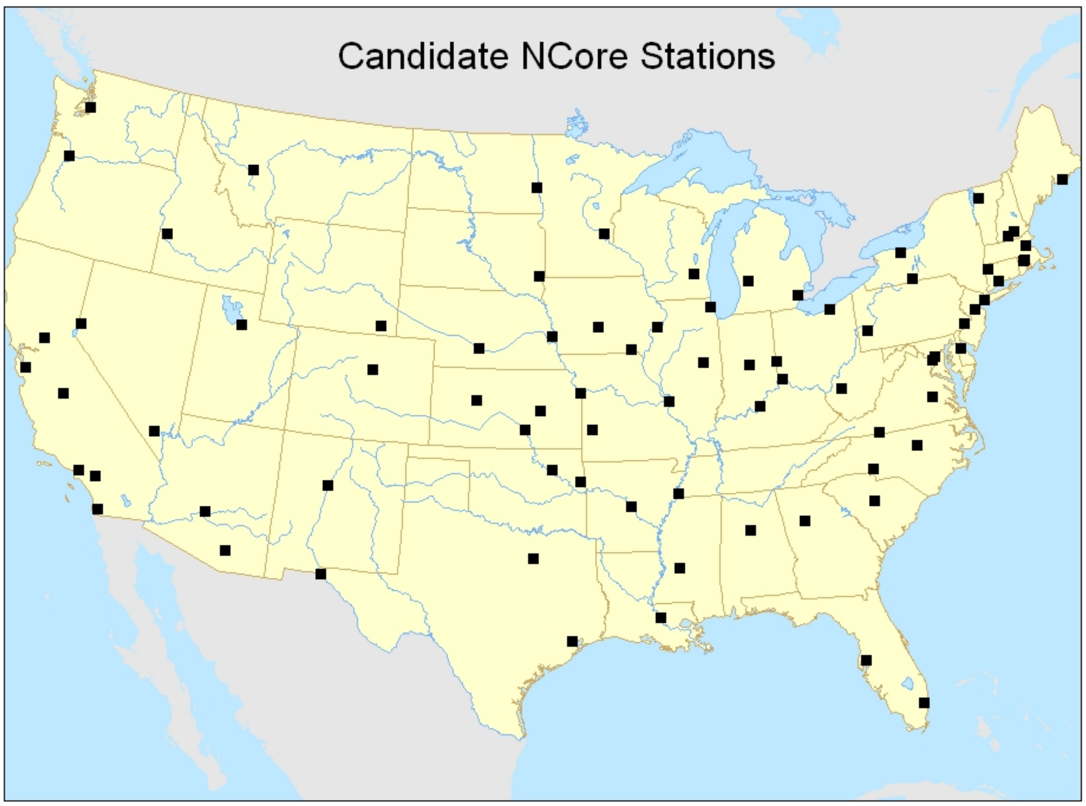

Figure 3-1. Proposed NCore Sites as of June 2008.

3.4.2 Process for Input to Decide Specific Site Locations

The number of sites and their distribution is only an approximation that requires added input and consideration to reach decisions on actual site locations. Site locations will be influenced by a combination of logistics associated with SLT capabilities and existing infrastructures, and input from monitoring agencies and the health effects/exposure, atmospheric sciences, and ecosystem assessment communities. OAQPS and the EPA Regional Offices will serve largely as facilitators for this siting effort. Regional Offices will work with their SLT air monitoring agencies and Regional Planning Organizations (RPOs) to provide initial suggestions based on logistics and design considerations with which the states and Regional Offices are most familiar. EPA OAQPS will solicit input from the research community through a combination of existing committee and organization structures, workshops and meetings. There likely will be some iteration and negotiation involved in this outreach effort. The multi-year phased approach for implementation will enable the necessary outreach and adjustments to start the NCore multi-pollutant approach on the right track. SLTs and other stakeholders are encouraged to submit information on proposed NCore sites, including site macro data and pictures, to OAQPS for inclusion on the NCore page within EPA's Technology Transfer Network (TTN) – Ambient Monitoring Technology Information Center (AMTIC) website located at http://www.epa.gov/ttn/amtic/ncore/index.html.

3.4.3 Design Concerns

Because of the limited number (75) of NCore sites, there will inevitably be spatial coverage gaps. This concern is balanced by the expectation that these sites are only minimum recommendations that serve as models for additional network modifications. This concept is similar to the $PM_{2.5}$ speciation program, where the majority of state SIP sites operate similarly to the national trend sites.

The intention in site allocation is to set the basic design goal and allow regional flexibility to choose the most appropriate and practical locations. This type of flexibility is necessary to ensure that the siting decision process takes into account the needs of multiple environmental and monitoring program objectives. For example, long-term epidemiological studies are best served by obtaining data from a cross-section of different cities with varying climates, source configurations, and air quality characteristics. Air quality model evaluations require similar locations, as well as proportionately more information on rural and background locations (along with vertical characterization of the atmosphere, which is beyond the scope of NCore multi-pollutant monitoring). Siting for accountability issues (e.g., emission control programs) benefits from "representative" locations. Often, this factor may favor obtaining information from rural locations more so than urban locations, given the difficulty of separating source signals in urban environments. For example, nitrogen in urban locations is largely dominated by mobile sources, whereas in selected rural locations, such as CASTNET sites, the emission signals from major utility sources are less affected by such area-wide sources.

3.5 EXISTING NETWORK INTEGRATION

Numerous issues related to site selection and measurement needs will arise that will benefit from better communication across networks and organizations. Interaction on ecosystem assessment and atmospheric processes support will be solicited primarily through interactions with the Air Quality Research Subcommittee (AQRS) of Committee for Environment and Natural Resources (CENR). Similar dialogue on health effects and exposure research support will utilize EPA's existing relationship with the HEI. Internally, EPA's health effects, toxicological, and exposure scientists will be actively engaged in siting discussions. Within EPA, a design team consisting of OAQPS and ORD scientists will recommend siting criteria based on technical needs associated with national scale model evaluation and data analysis objectives. Actual siting recommendations will be made by state and local agencies in cooperation with EPA Regional Offices. Approval of these sites will be made by the EPA Administrator or by the OAQPS, which has received delegated authority.

A related factor is that air quality modeling domains continue to increase. Throughout the 1970s and 1980s, localized source-oriented dispersion modeling evolved into broader urban-scale modeling (e.g., Urban Airshed Model [UAM] for ozone) to regional approaches in the 1980s and 1990s (e.g., Regional Oxidant Model [ROM] and a Regional Acid Deposition Model (RADM) to current national-scale approaches (Community Multi-scale Air Quality [CMAQ] model) and eventually to routine applications of continental/global scale models. The movement toward broader spatial-scale models coincides with the increased importance of regional transport on urban conditions. As peak urban air pollution levels decline, slowly increasing background levels impart greater relative influence on air quality. Models need to capture these rural attributes to be successful in showing accurate urban concentrations.

Another opportunity for integration of networks, such as IMPROVE and CASTNET, with the NCore site network, will be to coordinate NCore siting with existing rural monitoring sites. Numerous issues will arise related to site selection and measurement needs that will benefit from better communication across networks and organizations. As part of this Strategy, EPA will seek to engage three disciplines (ecosystems, health, and atmospheric processes) where possible during the NCore siting process. In addition, pollutants such as HNO_3, NH_3, and ozone are constituents for which continued measurement will be necessary at urban and regional-scale locations. Therefore, it is inevitable that various networks will benefit from overlapping measurements and complement each other.

4. MAINTAINING AND UPDATING EXISTING MONITORING NETWORKS

4.1 STATE, LOCAL, AND TRIBAL NAAQS MONITORING

State, local, and tribal monitoring agencies' primary monitoring objectives at SLAMS are to continue to operate sites designed for NAAQS compliance and local issues. Further, these SLAMS will continue to provide high value data that have been critical to ongoing health and trends analysis effort over the past three decades. Therefore, even with the new effort to move to a more multi-pollutant oriented architecture, many of these sites will continue to be single-pollutant sites mainly targeting $PM_{2.5}$, O_3, and Pb. Such sites help define the non-attainment areas and boundaries, monitor in areas with the highest concentrations and the greatest population exposure, provide information in new population growth areas, meet SIP needs, and evaluate local background conditions.

4.2 OZONE

EPA anticipates the number of ozone sites to modestly increase due to the recent strengthening of the ozone NAAQS from 0.08 to 0.075 ppm. It is anticipated that more counties in the United States will require ozone monitoring and that the importance of rural monitoring will increase. During this period of network adjustment, there should be an opportunity to relocate some redundant urban monitors to areas of need, primarily allowing O_3 measurements in smaller urban areas that are currently unmonitored. Also, due to the new standard, in an effort to improve understanding of seasonal O_3 differences and to observe winter-time episodes for certain locales, some monitoring agencies may lengthen their ozone season or even monitor year round at certain sites.

The current ozone SLAMS network, with approximately 1216 sites reporting data for NAAQS compliance, is shown in Figure 4-1. EPA anticipates that by 2009, it will be in a position to supplement existing SLT O_3 data by making the largely rural CASTNET ozone data from approximately 86 sites compliant with 40 CFR Part 58, Appendix A requirements. Essentially, by slightly modifying CASTNET ozone QA, CASTNET data will be compliant and suitable for all objectives including NAAQS attainment.

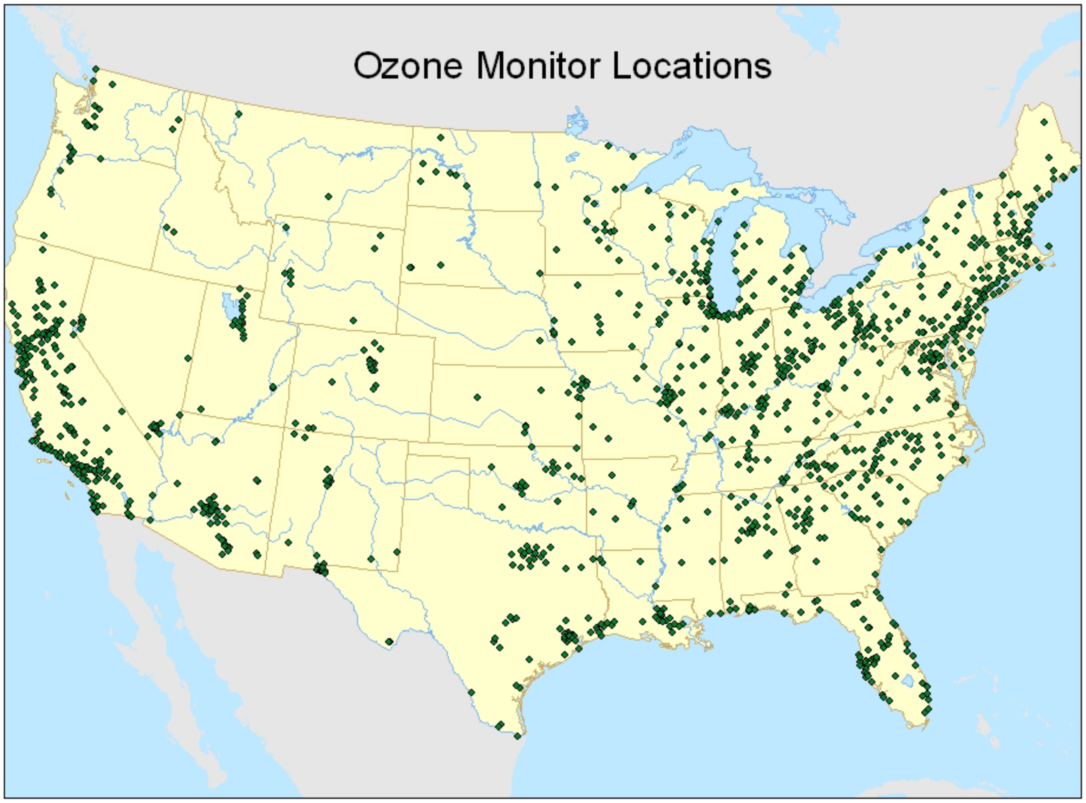

Figure 4-1. Ozone Monitoring Network as of Late 2007.

4.3 $PM_{2.5}$

EPA anticipates that the number of $PM_{2.5}$ sites will, at minimum, remain stable in the near future due to the maintenance of the annual NAAQS of 15 $\mu g/m^3$ and the strengthening of the 1-hr standard from 65 $\mu g/m^3$ to 35 $\mu g/m^3$ in the 2006 rulemaking. As shown in Figure 4-2, there are approximately 947 filter-based $PM_{2.5}$ monitors and 591 continuous $PM_{2.5}$ monitors in operation. Some site relocations or additions are likely as monitoring agencies assess coverage in areas near the 35 $\mu g/m^3$ 24-hr NAAQS. It is anticipated that there will be a continuing shift within the network from filter-based FRM/FEMs to continuous FEMs as additional methods are approved. Details on continuous PM methods, including new FEMs, are covered in Chapter 7.

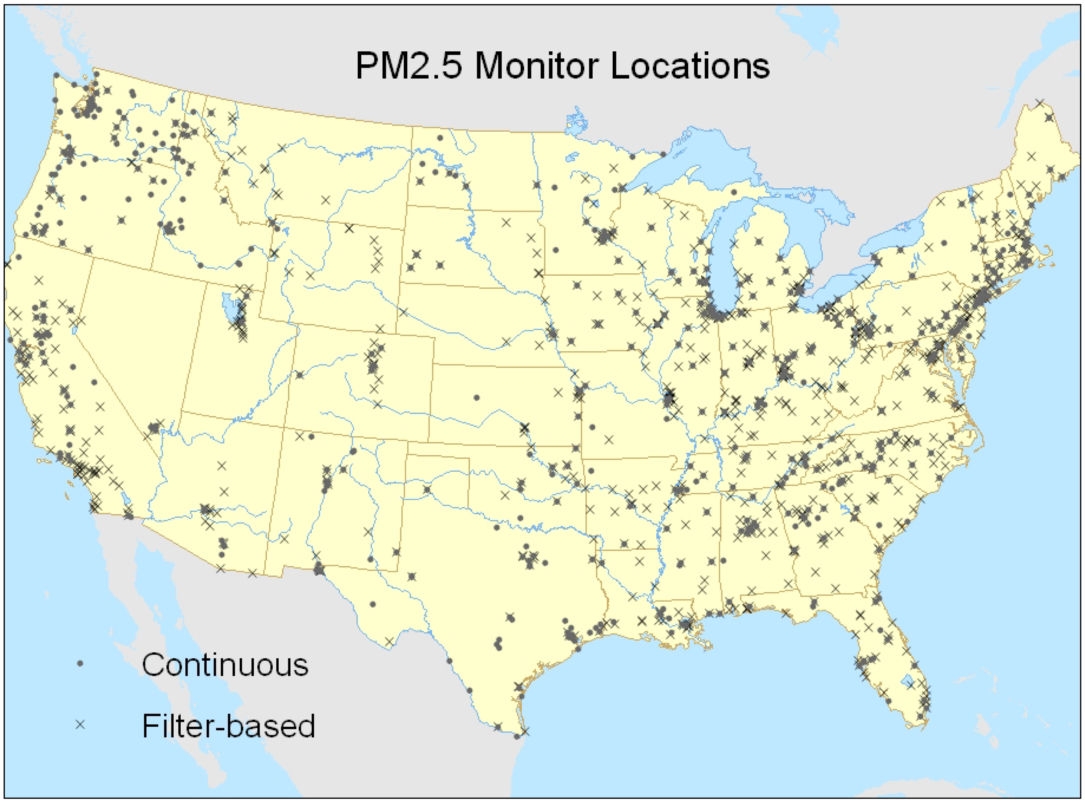

Figure 4-2. $PM_{2.5}$ Monitoring Sites, Including Filter-Based and Continuous Methods, as of Late 2007.

4.4 LEAD

As of 2008, only two areas in the country were classified as non-attainment under the old lead (Pb) NAAQS of 1.5 µg/m^3, using a maximum quarterly average. For this reason, earlier monitoring strategies identified Pb monitoring as a low priority. However, on May 20, 2008 in the Federal Register (73 FR 29184), the EPA proposed to dramatically lower the Pb NAAQS to the range of 0.10 to 0.30 µg/m^3. On October 15th, 2008, the EPA Administrator signed off on a new lead standard, substantially strengthening the primary NAAQS level to 0.15 µg/m^3 measured as TSP, with the secondary standard matching the primary. Documentation and related materials to this new ruling can be found at http://www.epa.gov/air/lead/actions.html. The new rule has a requirement to site lead monitors near sources such as industrial facilities that emit one ton or more per year of lead, to measure maximum concentrations, and in each of the 101 urban areas with more than 500,000 people to gather general population exposure data. Overall, EPA estimates that 236 new or relocated monitoring sites will be necessary to satisfy these new requirements. Approximately half of all newly required monitors are to be operational by January 1, 2010, with the other half of the monitors operational by January 1, 2011. It should be noted that some existing lead monitors will be left in place as part of the network. Further, EPA Regional Administrators may waive the source-oriented monitoring requirements if a state or local air agency can demonstrate that emissions from the source will not contribute to maximum air lead concentrations greater than 50% of the 0.15 µg/m^3 standard (0.075 µg/m^3).

Another change in the rule is the shift in the averaging period and form of the NAAQS. The EPA will use a "rolling" three month period with a maximum (not-to-be-exceeded) form, evaluated over a three year period. The old averaging period and form used calendar quarters, therefore the new averaging period considers each of the 12 three-month periods associated with a given year, not just the four calendar quarters within a year. Currently (2008), the EPA is not establishing classifications for non-attainment areas based on the severity of lead violations. The agency will retain the 1978 lead NAAQS until one year after designations for the new standards, except in current non-attainment areas. In those areas, EPA will retain the 1978 standard until the area submits, and EPA approves, attainment and/or maintenance demonstrations for the new standards, thus ensuring public health protection.
In addition to changes to the NAAQS level and averaging method, a new lead monitoring method was introduced in the form of lead in PM_{10} (Pb- PM_{10}) FRM, which will co-exist with the traditional lead in TSP (Pb-TSP) FRM. The methods are discussed in further detail in Chapter 7 of this document. The monitoring rule allows a state or local monitoring agencies to operate a Pb- PM_{10} FRM in lieu of a Pb-TSP method under the following circumstances:

- To meet the nonsource-oriented monitoring requirements tied to Core Based Statistical Areas (CBSA) population provided that historical monitoring does not indicate Pb-TSP or Pb-PM_{10} concentrations greater than an arithmetic 3-month mean of 0.10 µg/m^3.
- To meet the source-oriented monitoring requirements where Pb concentrations are expected (based on historic data, monitoring data, or other means) to be less than 0.10 µg/m_3 on an arithmetic 3-month mean,
- Where ultra-coarse Pb is expected to be low.

However, monitoring agencies are required to begin monitoring for Pb-TSP within six months of a measured Pb-PM_{10} arithmetic 3-month mean concentration of 0.10 µg/m^3 or more. For example, if a Pb-PM_{10} monitoring site measures an arithmetic 3-month mean concentration of 0.10 µg/m_3 or more for the period March – May 2011, the responsible monitoring agency would be required to install and begin operation of a Pb-TSP monitor at the site no later than December 1, 2011.

4.5 OTHER CRITERIA POLLUTANTS

For other criteria pollutants, this Strategy anticipates reductions in the number of operating sites (see Table 4-1). The disinvestment/reinvestment approach is explained in Section 2.1 of this document. Although certain SLAMS sites may need only to include one pollutant measurement, this Strategy strongly encourages collocating other measurements at these sites when possible.

These SLAMS sites will continue to implement the FRMs and FEMs required for criteria pollutant monitoring and attainment/nonattainment decisions as currently described in 40 CFR, Part 50. No new monitoring technologies or methods are anticipated for CO, SO_2, or NO_2

although the implementation and use of high sensitivity instrumentation is encouraged. Any siting adjustments to SLAMS require Regional Administrator approval. If an SLT is in a position to reinvest criteria pollutant monitoring resources, EPA encourages monitoring agencies to re-allocate their resources for multi-pollutant purposes, although multi-pollutant monitoring is not required. For example, there may be opportunities to collocate ozone and PM monitors without degrading the network information derived from having separate ozone and PM monitoring locations.

Table 4-1. Potential Reductions in Number of Monitors for Various Pollutants. (Note that these potential reductions are liable to change if NAAQS reviews promulgate new, lower standards for any of these pollutants).

Pollutant	Operating Number of Monitors (Approximate)	Long Term Number(Approximate)
PM_{10}	1,072	500 to 750 (until a $PM_{10-2.5}$ standard is created)
Carbon monoxide	445	250
Sulfur dioxide	465	300
Nitrogen dioxide	413	250

In addition to the NAAQS-focused monitoring described above, EPA recognizes the need for a local, flexible component in the Strategy. Specific, local issues will always need to be addressed with air monitoring. Local considerations include, for example, addressing environmental justice concerns, community concerns, local source impacts, political considerations, and a host of other elements that can be important on a local level. EPA will continue to support these efforts. By incorporating flexibility in the overall monitoring structure, both national and local needs can be addressed. In many situations, monitoring conducted for local needs can also be valuable from a national perspective.

4.6 PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

In the PAMS program, changes are being implemented as a result of EPA's finalized revisions to the monitoring requirements promulgated on October 17, 2006 in 40 CFR Parts 53 and 58. The revisions greatly reduce the minimum PAMS requirements. The intent of the revisions is to establish the minimum PAMS network necessary to meet the national objectives of the PAMS program while freeing up resources for states to tailor PAMS networks to suit their specific data needs. Overall, the changes significantly reduce the costs of the minimum PAMS monitoring requirements and allow states to re-invest these savings in area-specific PAMS monitoring activities. The current PAMS network consisting of 78 sites in 23 areas is shown in Figure 4-3.

The specific changes to PAMS as a result of the new monitoring rule are:

- Reduced number of required PAMS sites. There is now a minimum of two sites per area, and at least one of the sites must be Type 2, regardless of population. Further, each area must have enough sites of varied type (e.g. Type 1 or Type 3) in order to have all the PAMS target compounds measured. Note that NO_y is required at Type 1 and Type 3 sites, and is a required target compound for each PAMS area.
- Reduced requirements for speciated VOC measurements. Speciated VOC measurements are only required at Type 2 sites and one other site (either Type 1 or Type 3) per PAMS area.
- Carbonyl compound sampling required only in areas classified as serious or above for the 8-hour ozone standard.
- NO_2/NO_x monitors required only at Type 2 sites.
- NO_y monitoring required at one site per PAMS area (either Type 1 or Type 3).
- Trace level CO monitoring required at Type 2 sites.

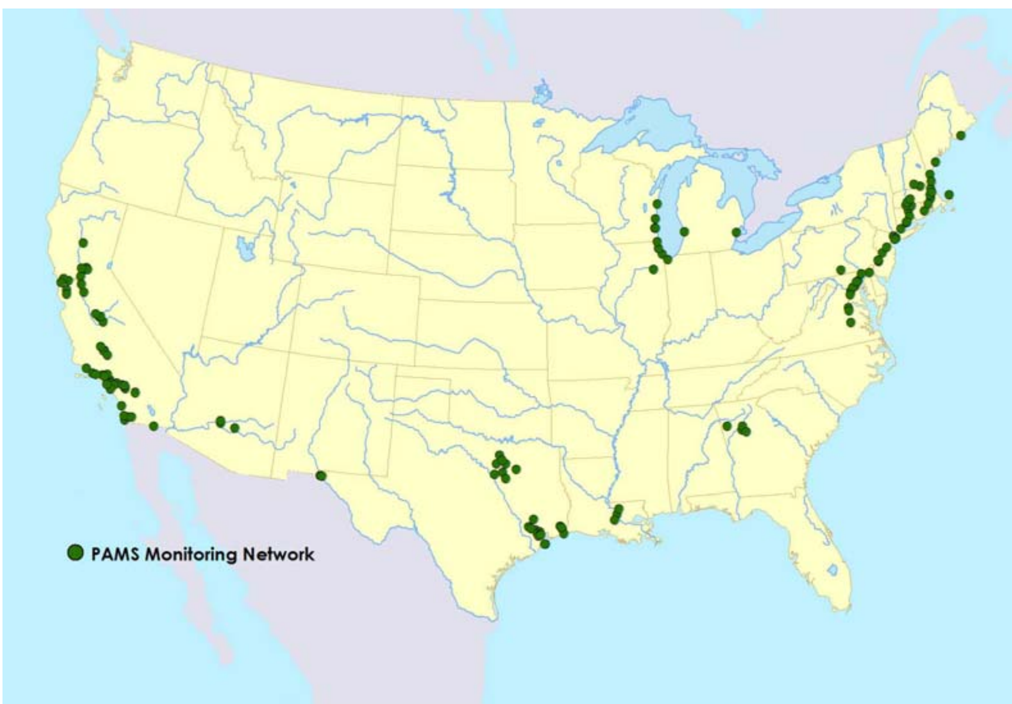

Figure 4-3. PAMS Sites as of Late 2007.

EPA recently completed a PAMS network assessment, the full results of which are anticipated to be shared by the end of 2008. However, one of the areas for improvement within PAMS that should be noted here is the collection of upper air meteorological data. The number of PAMS sites varies with each PAMS area, but each area is required to have one site that provides area or MSA-representative upper air meteorological measurements. This requirement can be met in a number of different methods including rawindsondes, radar wind profilers, or by relying on the twice-daily National Weather Service soundings. Upper air meteorological data has also been identified as a good resource for other programs besides PAMS, including supporting model applications, general data analysis, and air quality forecasting. EPA recognizes that there is a heterogeneous network of upper air data gathering methods in place, and that a shortfall exists in the lack of a universal or common formatting approach to acquiring and handling the data, and no current method to centralizing the data for further analysis. EPA also recognizes that there are relatively large resource burdens on PAMS operators from the capital equipment and maintenance costs of some upper air meteorological systems. A possible way around this acquisition and maintenance issue may lie in the identification, development, and piloting of alternative upper air methods, which are discussed in chapter 7 of this document. In the future, it is logical that some PAMS resources may be considered to address these upper air data issues, but that process will require the development of explicit goals by all stakeholders and support from both SLT and EPA leadership.

4.7 PM SPECIATION

EPA's strategy for the CSN includes completion of the conversion to uniform sampling hardware, completion of the changeover to IMPROVE-like carbon sampling, investigation of the incorporation of ammonia and nitric acid sampling and analysis, implementation of $PM_{10-2.5}$ (PM Coarse) speciation in 2011, and the continued observation of the evolution of continuous sampler technologies. The current CSN consists of approximately 53 STN sites and about 160 SLAMS supplemental sites, shown in Figure 4-4.

By 2007, MetOne brand samplers were being used by the vast majority of monitoring agencies for speciation monitoring in the CSN. In order to instill more consistency in sampler method and operations across the network, replace old hardware, and handle arising issues with hardware that is no longer supported by the original vendor, EPA managed the procurement of MetOne samplers for installation across the whole CSN. Insertion of MetOne SASS type samplers is occurring in phases, and should be complete sometime in late 2008.

Differences in carbon aerosol concentration measurements across the urban CSN and the rural IMPROVE monitoring network have been identified. In order to address these differences and provide consistent data for model evaluation and other data uses, the CSN is transitioning to a new method of sampling and analysis for organic and elemental carbon (OC and EC) that is consistent with the IMPROVE network methodology. The transition began in May 2007 with 56 CSN sites and is expected to be completed by 2009. The shift in the carbon method by introducing new hardware to the CSN will cause a slight increase in costs associated with previous carbon speciation measurements but will provide the capability for comparative carbon analysis across speciation networks.

The EPA issued revisions to the Ambient Air Monitoring Regulations (40 CFR Parts 53 and 58) on October 17, 2006 contained a requirement for $PM_{10\text{-}2.5}$ speciation at NCore multi-pollutant monitoring sites. The purpose of $PM_{10\text{-}2.5}$ speciation is to support continued research on particle distribution, sources, and health effects. It is anticipated that manually operated $PM_{10\text{-}2.5}$ speciation samplers will operate at a frequency of 1-in-3-day sampling and be collocated with $PM_{2.5}$ speciation at NCore stations. EPA is currently in the planning stages for implementation of this monitoring network. A draft discussion paper has been written and EPA is currently seeking comments on the paper, target analytes, issues associated with $PM_{10\text{-}2.5}$ speciation monitoring, and a possible pilot study of a small number of sites. Limited filter-based sampling and analysis technologies exist (speciation by difference or dichotomous sampling, discussed further in Chapter 7) for such monitoring, and options will need to be piloted soon in order to gain a better understanding of the limitations and prepare for implementation in 2011.

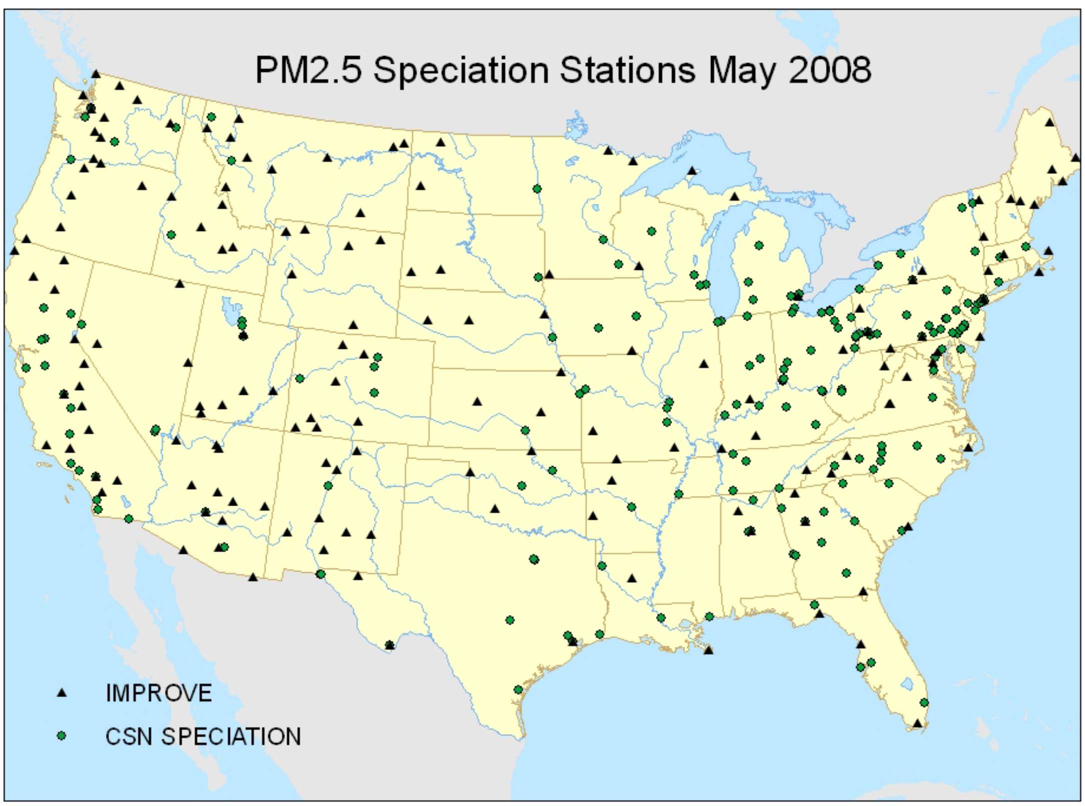

Figure 4-4. $PM_{2.5}$ Speciation Networks, Including CSN and IMPROVE Sites, as of Late 2007.

Ammonia (NH_3) is a major factor in the formation of $PM_{2.5}$ as the primary inorganic component in the sulfur-nitrogen $PM_{2.5}$-forming complex. It also has serious potential impacts on ecosystems through deposition. However, ambient ammonia concentration data are not regularly collected by any national monitoring network. EPA has initiated the development of a specially designed denuder which will fit into the infrastructure of the existing CSN and possibly be incorporated into other speciation programs. This initiative lays out the framework for denuder development, laboratory and field testing, and an eventual pilot by state and local agencies. EPA hopes to have prototype ammonia denuders by the end of fall 2008; field and lab testing underway by winter 2008; and a pilot deployment of the denuder into selected CSN or partner sites early in 2009. After the pilot study, EPA hopes to have sufficient information needed to plan, if practical, the appropriate steps for the potential deployment of ambient ammonia monitoring across its speciation-capable networks. Further, due to the newly designed denuder, this initiative may also lay groundwork for including nitric acid in EPA's speciation-capable networks. Details about prospective denuder design and CSN integration issues are discussed in Chapter 7.

Nitric acid is a primary component of NO_z (where NO_y - NO_x = NO_z) and, therefore, a key component in understanding gas/particle nitrate ratios as part of the total atmospheric nitrogen budget. Nitric acid is a very "sticky" gas and has proven to be very difficult to quantify using non-research grade monitoring equipment. EPA plans to pursue testing the same denuder proposed for measuring ammonia concentrations to determine if it would also be suitable to sample for nitric acid. The known difficulties with this approach are discussed in Chapter 7.

Finally, for PM speciation, this Strategy only commits EPA to take a cautious approach toward continuous speciation monitoring, based largely on findings from the Supersites and other programs indicating mixed performance across a variety of monitors. The recognized advantage of continuous or semi-continuous speciation monitors is the ability of monitoring networks to deliver data with a high temporal resolution so that the atmosphere can be characterized on a time scale relevant to how it changes and how people are exposed under dynamic processes. As a first step, EPA will consider the use of select methods in a pilot project to support the need for daily speciation which has been requested by the health research community. However, these new technologies are still viewed as supplemental to the filter-based methods.

4.8 AIR TOXICS

The NATTS are the primary, long-term component for characterizing air toxics concentrations over space and time. These trends measurements currently provide a basis for assessing program effectiveness, ground truthing air quality model output, performing exposure assessments, developing emission control strategies, and as input into source-receptor models which provide direct linkage between emission sources and receptor locations. As of June 2008, the NATTS Network is comprised of 27 sites, shown in Figure 4-5. Though no additional sites or new sampling and analysis protocols are anticipated, work will continue on issues such as improving detection limits, refining sampling, and/or analysis methods for pollutants such as acrolein and hexavalent chromium, and improving consistency across all aspects of the NATTS network from sampling to analysis to data reporting and applications thereof.

Beyond the NATTS, many state, local and tribal agencies have operated air toxics monitoring networks for some time in support of their own objectives. These program objectives can include monitoring to address "hot spots," environmental justice concerns, or citizen complaints. At any given time, up to 250 separate air toxics monitoring activities may exist at the SLT sites. EPA has supported these monitoring efforts since 1987 by offering access to laboratory analysis of air toxics samples collected by state and local agency monitors. Beginning in FY2003, EPA re-directed $6.5 million in Section 105 grant funding annually from criteria pollutant monitoring to air toxics monitoring. Access to analytical services via the national contract laboratory and air toxics designated Section 105 funds are expected to continue.

As noted in Section 1.3.3, initial ambient air toxics monitoring pilot studies showed that significant variations in pollutant concentrations occur across a city and cannot be characterized by a single monitoring site. Thus, EPA has incorporated support for competitively awarded community-scale projects into its air toxics program. Selected projects are well-developed in terms of basis, objectives, approach, and expected outcomes, and typically include several monitoring sites operated for one to two years. While not a network per se, these community projects serve local scale needs and may supplement other monitoring programs. The community scale projects, which began receiving funding in 2003/2004, are planned to continue.

In addition to these air toxic-specific monitoring activities, other monitoring programs primarily intended to address other air pollution concerns incorporate aspects of air toxics monitoring. The PAMS network collects data on some toxic VOCs and carbonyl compounds, while the IMPROVE and speciated $PM_{2.5}$ networks collect data on certain toxic metals.

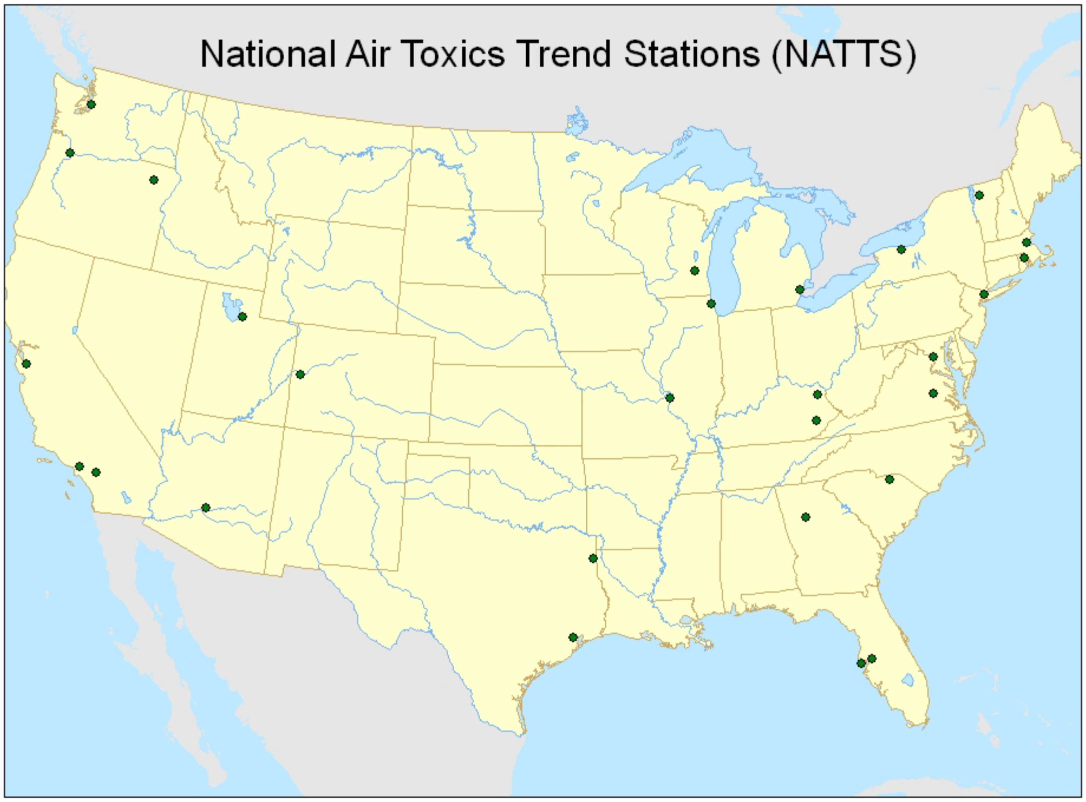

Figure 4-5. NATTS Network Locations as of June 2008. Note: the southern site shown in Kentucky is shutting down, and has transitioned to the northern Kentucky location.

4.9 NEAR-ROADWAY

Research monitoring efforts to characterize the impacts of mobile sources near roadways are emerging as a key area for multi-pollutant ambient air monitoring. Over 1,000 compounds have been identified in exhaust and evaporative emissions from motor vehicles. These compounds include criteria pollutants and air toxics. Motor vehicle emissions significantly impact air quality and contribute to national emission inventories for criteria and toxic air pollutants. Mobile sources account for over 75 percent of national CO emissions, over 50 percent of national NO_x emissions, and over 25 percent of national $PM_{2.5}$ emissions. Mobile sources significantly contribute to toxic air pollutant concentrations of gas- and particulate-phase compounds. For example, mobile sources emit over 50 percent of the nation's benzene, toluene, and acetaldehyde. PM air toxic emissions include metals, ions, and semi-volatile organic compounds (SVOCs).

Exposure to near-roadway emissions cannot properly be thought of as either a "hotspot" issue affecting relatively few areas in a city or a broader component of PM NAAQS attainment issues. Near-roadway exposure may, in fact, emerge as a dominant urban air quality issue. Air quality measurements collected near roads often identify elevated pollutant concentrations at these locations, as well as pollutant composition and characteristics that differ from those measured at a distance from roadways.

Elevated pollutant concentrations near roadways may lead to elevated exposures for populations working or residing near these roads. In addition, these populations may experience exposures to differing physical and chemical compositions of certain pollutants. The location of schools near major roads may also result in elevated exposures for children due to potentially increased concentrations indoors, increased exposures during outdoor activities, or increased exposures while commuting to school (e.g., walking along roads or riding in a school bus or passenger vehicle). Mobile sources influence temporal and spatial patterns of regulated gases, air toxics, and PM concentrations within urban areas. Since motor vehicle emissions generally occur near the breathing zone, near-roadway populations may be exposed to "fresh" combustion emissions as well as combustion pollutants "aged" in the atmosphere. Results from emissions and exposure studies suggest that simple methods of estimating the contribution of motor vehicle exhaust to exposure likely do not capture the substantial variability in the chemical and physical characteristics of motor vehicle exhaust that may be leading to adverse health effects. Comprehensive assessments of exposure will be a critical factor in identifying which compounds lead to adverse health effects in the near-roadway environment.

An estimated 35 million Americans live near four-lane roads, and EPA and others will need to investigate how to incorporate near-roadway conditions and exposures into NAAQS attainment monitoring. To date, ambient monitoring in these areas consists of targeted research efforts. For example, the Traffic-Related Exposure Study (T-REX) measured concentration gradients along roads, identified intrusion of roadway emissions into nearby buildings, and evaluated air quality and exposure models. As another example, the Detroit Exposure and Aerosol Research Study (DEARS) has measured personal exposure and assessed residential proximity to roads and other emission sources. These and other research efforts indicate the need to evaluate methods of integrating near-roadway monitoring into NAAQS compliance monitoring network design and siting.

With this background, EPA's Strategy currently recognizes (1) the importance of near-roadway exposures, and (2) the need for further exploration of the meaning of these exposures to both NAAQS-oriented monitoring networks and air toxics networks. Monitoring near roadways has, to date, been limited to research-level monitoring. As monitoring networks evolve, it is vital that monitoring near roadways be further investigated and eventually integrated into the monitoring networks. Currently, EPA and others continue to evaluate strategies for incorporating this monitoring into the other components of the monitoring Strategy primarily as a means of determining health risks and impacts on urban attainment. EPA intends to consult with SLTs and other stakeholders about the eventuality of developing the near-roadway component of ambient monitoring. The primary consideration would be to operate a small number of sites spaced in varying geographical areas of the country in an initial attempt to address near-roadway issues. Outcomes from EPA's Office of Research and Development's (ORD) near-roadway studies that began in 2006 and extend through 2009 or 2010 would heavily influence where, how, and when a near-roadway monitoring pilot would occur.

4.10 RADNET

Currently, RadNet is the nation's only comprehensive radiation monitoring network, often relying on voluntary cooperation by SLTs to carry out its field operations at more than 200 sampling stations located in largely urban areas throughout the United States. In February 2001, a key national monitoring system meeting was held in Montgomery, Alabama, to redefine the mission and objectives of the network and to develop an initial conceptual design to guide the reconfiguration of the network into the future. A significant outcome of the meeting was the determination and agreement that the primary purpose of the network's current and future radiation monitoring capability is to support EPA's emergency response responsibilities. The working mission of the system to be designed, it was agreed, would be to monitor radionuclides released into the environment during significant or major radiological emergencies. Three basic objectives to support the system's mission were defined:

- To the extent practicable, maintain readiness to respond to emergencies by collecting information on ambient levels capable of revealing trends.
- Ensure that data generated are timely and are compatible with other sources.
- During events, provide credible information to public officials (and the public) evaluating the immediate threat and the potential for long-term effects.

The RadNet planning team not only recognized the linkage between emergency response and the monitoring network, but considered the relationship of the monitoring network to other related emergency response assets. In August 2001, the planning team provided a vision of the new monitoring system that was developed on the basis of four design goals: (1) better response to radiological emergencies, (2) more flexible monitoring capability, (3) a more integrated and dynamic network, and (4) the ability to meet needs within realistic costs.

In January 2002, EPA's Office of Radiation and Indoor Air (ORIA) began a self-assessment of the existing monitoring program in light of homeland security concerns, and very early on decided that ORIA air programs could best support homeland security objectives. The assessment revealed two areas of weakness and identified solutions for those weaknesses.

The first weakness was that the 2002 infrastructure did not lend itself to quick data dissemination to decision makers. The proposed solution to this issue was to identify and invest in real-time monitoring methods coupled with real-time data dissemination techniques.

The second weakness was the inability to assess widespread impacts from an incident (or incidents) that may occur anywhere in the U.S., as the existing network infrastructure simply did not have enough spatial density. The proposed solution to this issue was two-fold: 1) significantly expand the number of fixed-monitor locations, and 2), provide the flexibility to augment fixed-monitor locations with deployable monitors that may be pre-deployed to areas of high risk (national significant security events e.g., Olympic games or political conventions) or quickly deployed as incident response, improving monitoring data density in areas of specific concern.

Since planning efforts prior to 9/11 had already endorsed the value and appropriateness of deployable monitors in a new RadNet air monitoring design, and because these monitors could be implemented more quickly, the first available homeland security funding (late 2001) was committed to acquiring them. The attention then turned to updating the fixed system. Based on the findings of the post-9/11 assessment and reinforced by similar findings in the earlier 2001 assessment, ORIA turned its attention to the system of fixed monitors to determine the most appropriate equipment; to find the most acceptable plan for siting the monitors across the nation; and to design an electronic capability for delivering verified data (from fixed as well as deployable monitors) quickly to decision makers and the public. By 2005, ORIA was able to complete the purchase of an initial order of upgraded fixed station radiation monitors.

The specific objectives and data uses that have guided the development of the RadNet air monitoring network are shown in Table 4-2. The objectives encompass the fixed monitoring network augmented by deployable (mobile) monitors operating in either routine or emergency mode. The objectives and data uses are presented in sequential phases reflecting the chronological progress of an event and the parallel status of the system from routine, to emergency, and back to routine.

Currently, the plan for upgrading the RadNet network answers the overarching question of "What changes should be made to the RadNet air monitoring component to best meet the current needs for national radiation monitoring?". Rather than simply targeting nuclear or radiological accidents, the mission envisioned in this plan for RadNet includes homeland security concerns and special problems posed by possible intentional releases of radiation into the nation's environment. The plan proposes new monitoring equipment, more monitoring stations, more flexible responses to radiological and nuclear emergencies, significantly reduced response time, and much improved processing and communication of data. The ultimate goal of RadNet air monitoring is to provide timely, scientifically sound data and information to decision makers and the public. The plan is currently being reviewed by EPA's Science Advisory Board, and remains subject to change. However, Table 4-3 provides a snapshot of the draft improvements to the RadNet air monitoring network currently being considered.

Table 4-2. Overview of Objectives and Data Uses for the RadNet Air Monitoring Network

	Ongoing Operations/ Pre-incident	**Early Phase (0-4 days)**	**Intermediate Phase (up to 1 year)**	**Late Phase (after 1 year)**
		Fixed Monitors		
Objectives	• Provide baseline data • Maintain system readiness	• Provide data to modelers • Develop national impact picture • Provide data to decision makers and the public	• Continue national impact assessment • Reestablish baseline • Provide data to decision makers and the public	• Determine long-term impact • Monitor baseline trends • Provide data to decision makers and the public
Data Uses	• Pre- and post-event comparisons • Provide public information	• Adjust model parameters and verify outputs • Assist decision makers in allocation of response assets • Identify non-impacted areas • Help determine follow-up monitoring needs • Verify or assist in modifying protective action recommendations	• Assist in determining if delayed contamination transport is occurring • Assure citizens and decision makers in unaffected areas • Assist in dose reconstruction • Determine short- or long-term baseline changes from event	• Assist in determining if delayed contamination transport is occurring • Assure public that conditions are back to normal • Ensure that recovery efforts are not causing contamination spread • Verify return to previous baselines
		Deployable Monitors		**(Options: May be Returned to Laboratories or Remain in Field)**
Objectives	• Provide baseline data (if deployed) • Ensure readiness by conducting regular exercises	• Provide data to modelers • Provide data to decision makers and the public	• Assess regional impact • Provide data to decision makers and the public	• Provide continuity of data in impacted or non-impacted areas • Provide data to decision makers and the public
Data Uses	• Pre- and post- event comparisons • Provide public information	• Adjust model parameters and verify outputs • Assist in identifying areas not impacted • Help determine follow-up monitoring needs • Verify or assist in modifying protection action recommendations	• Assist in determining if delayed contamination transport is occurring • Assure citizens and decision makers in unaffected areas • Help determine when to relax or reduce protective actions	• Assist in determining if delayed contamination transport is occurring • Ensure that recovery efforts are not causing contamination spread

Note: Objectives and data uses may overlap from one phase to another.

Table 4-3. Improvements Proposed for RadNet Air Monitoring Network

Improvement Area	New System	Old System
Number of Stations	180 (approximately) fixed; 40 deployable	59 fixed; 0 deployable
Time for Data Availability	Near-real-time (4-6 hrs)	36 hours minimum (if on alert)
Criteria for National Siting	Population and geography	Population and fixed nuclear facility proximity
Local Siting Criteria	Derived from Title 40 Code of Federal Regulations (CFR) Part 58	None
Data Dissemination	Central database with Internet access	Hard copy
Meteorological Data	Yes – deployable monitors Optional – fixed monitors	No
Telemetry	Phone (land line); cell phone; Internet; satellite link	None
Station mobility	40 deployable monitors (in addition to 180 fixed stations)	None
Data Security	High	None
Operator Dependency	Primarily for air filter changes; no operator action required for near-real-time data transmission to central database to support emergency response	Completely operator dependent
Gross alpha/beta data at station location	Gross alpha and beta	Gross beta only
U.S. Population Proximity	Approximately 60%	Approximately 24%
Frequency of Data Collection	Continuous (hourly data transmission during routine conditions) and two air filters per week for fixed lab analysis	Two air filters per week for fixed lab analysis

5. TRIBAL MONITORING

There is a growing movement in the United States of tribal governments taking an increased interest in ambient air quality issues in Indian country. Tribes wishing to examine ambient air quality issues on their reservations or tribal lands should have a good working strategy in place as they decide what their interests and concerns are in the development of their work plan and program strategy. Tribal covenants often decide that the best way to assess the current air quality situation is through the use of ambient air quality monitors. A strategic approach to monitoring should incorporate specific planning stages.

Initially, a tribe will need to work with its EPA regional contacts to begin development of a work plan that will be required for EPA operational grant funds and used to organize the direction of the program. The planning phase is especially important because many air monitoring development steps can be incorporated into work plan objectives and funded by EPA, which will be committed to providing guidance and technical assistance throughout the whole process. Note that, given the limited monitoring throughout Indian country, EPA believes that tribal network assessments similar to the national and regional efforts are inappropriate for the relatively new tribal programs, because those assessments addressed aged and relatively dense monitoring networks.

Within the context of this document, it is critical to note that in working with the tribes on air monitoring, EPA is not setting a strategy for tribal monitoring. Nevertheless, EPA intends to include tribes in ambient air monitoring programs as those programs evolve. It is also important to note at the outset that EPA believes that tribal monitoring is important within the broader NAAMS. While acknowledging these points, this strategy document does not attempt to define the entire subject of tribal monitoring.

Because the tribes are sovereign, they are not bound by EPA’s monitoring rules. However, monitors in Indian country must be properly sited, use adequate technology, and follow prescribed QA procedures if a tribe wants to use data from their monitor(s) to demonstrate NAAQS attainment or non-attainment. Tribal monitoring clearly can add value to national networks, particularly in filling data gaps in more rural areas of the country. In making determinations for siting rural monitors, EPA is committed to considering tribal territory, including for rural NCore sites. These comments should not be perceived as suggesting that the tribal monitoring priority is fostering a connection to national networks. Monitoring priorities must be based on tribal decisions, which in many cases involve developing a better characterization of local exposure to air pollutants. The linkage to national programs should be perceived as leveraging opportunities that simultaneously benefit tribes and the national network.

Another EPA/tribal connection is through the Tribal Air Monitoring Support (TAMS) Center, which is a unique partnership between tribes, the Northern Arizona University Institute for Tribal Environmental Professionals (NAU ITEP), and EPA. Together, tribal environmental professionals, ITEP, and EPA provide the full range of air monitoring technical support, including monitoring network design, monitor siting, QA and QC, and data analysis and interpretation. The TAMS Center recognizes the sovereignty and diversity of tribal nations and is designed to build capacity and empower tribes to successfully manage their respective programs with equanimity on a national scale.

Since 2001, tribes also have been active participants in RPOs. The RPOs have provided leadership in establishing needed rural monitoring throughout the central core of the nation. As active participants in technical planning and monitoring operations of RPOs, Tribes have been further integrated into large-scale monitoring efforts. Through this interaction with RPOs, tribes are more likely to operate some number of NCore multi-pollutant sites.

6. QUALITY ASSURANCE

Quality assurance (QA) is a major component of an air monitoring program and is necessary to ensure the availability of data of sufficient quality to justify investments made in the program. Any reevaluation of air monitoring networks must include a reassessment of QA programs. To undertake such a reassessment, in 2000 EPA and individuals representing state, local, and tribal interests established a Quality Assurance Strategy Workgroup charged with developing the elements and activities of a quality system for an ambient air monitoring program. A quality system is a structured and documented system that describes an organization's policies, objectives, principles, authority, responsibilities, and implementation plan for ensuring quality in its processes, products, and services. A quality system is a framework for the organization's required QA and quality control (QC) efforts, which are essential to providing confidence in the data collected.

The Quality Assurance Strategy Workgroup participants developed several key recommendations which are discussed in the following subsections.

6.1 MOVE TOWARD A PERFORMANCE-BASED MEASUREMENT SYSTEM (PBMS) WITH SPECIFIED DATA QUALITY OBJECTIVES

PBMS is a set of processes that specify the data quality needs, mandates, or limitations of a program, and serve as the criteria for selecting appropriate, cost-effective methods to meet those needs. An important element of a PBMS is the development of Data Quality Objectives (DQOs), which, in turn, help in the development of FRM acceptance criteria (where needed). The DQO process is designed to ensure that the data collected and/or funded by EPA meets the needs of decision makers and data users. The DQO process establishes the link between the specific end-use(s) of the data and the data collection process, which is important for identifying the quality and quantity of data needed to meet a program's goals. The result of the DQO process is a series of data quality indicators (e.g., precision, bias, completeness, detectability) and acceptance requirements (called measurement quality objectives) for those indicators.

OAQPS will be responsible for developing DQOs for federally mandated data collection efforts such as the SLAMS or NCore multi-pollutant objectives. DQOs for other data collection activities (e.g., non-trends speciation sites, special studies) will be the responsibility of other federal agencies and the monitoring agencies using the graded approach to QA described later in this section. OAQPS will develop DQOs on the basis of resource availability and current priorities set by the National Ambient Air Monitoring Steering Committee.

6.2 USE A GRADED APPROACH TO QA

As with any EPA-funded activity, EPA QA Policy requires monitoring organizations to develop Quality Management Plans (QMPs) and Quality Assurance Project Plans (QAPPs). Under the Strategy, the use of air monitoring data will have multiple applications. Therefore, some monitoring objectives may not call for quality systems and QA documentation (i.e., QAPPs) to meet the stringent requirements for NAAQS comparison purposes and may have data quality needs that differ. The revised EPA QA Policy, found at http://www.epa.gov/quality1/, allows a graded approach to QA. This approach provides some flexibility in the development of QMPs, QAPPs, and DQOs. The Quality Assurance Strategy Workgroup developed and supports a graded approach for the Ambient Air Monitoring Program (http://www.epa.gov/ttn/amtic/geninfo.html).

6.3 MINIMIZE START-UP PROBLEMS WITH A PHASED IMPLEMENTATION APPROACH

For each new proposal of a monitoring network/program, adequate time needs to be provided to the monitoring community to become familiar with the equipment; gather QA data on detection limits, precision, bias, and completeness; and develop QA project plans and standard operating procedures. As an example, many monitoring organizations complained about the speed with which the $PM_{2.5}$ network was deployed and felt data quality and completeness suffered as a consequence. Monitoring program management needs to determine a process that allows for a reasonably phased implementation approach.

6.4 PROVIDE ADEQUATE RESOURCES FOR QA PROGRAMS

QA should be recognized as a cost of monitoring and should be explicitly built into monitoring costs. The elements and activities of the QA program that need to be considered in monitoring costs are listed in Table 6-1.

Whether these activities are implemented by EPA or the monitoring organization is not as important as the process to ensure that resources are available to implement these activities. Based on precedence set for other EPA monitoring networks, these costs should be included in Information Collection Request (ICR) estimates. As new monitoring programs are planned or current programs are revised, EPA will work with monitoring organizations to develop adequate quality systems that cover the elements described in Table 6-1 and provide estimates of the costs associated with the implementation of the quality system. The QA Handbook Volume II (found at http://www.epa.gov/ttn/amtic/qabook.html) addresses these elements so a detailed discussion of these elements is not provided in this section. QA Handbook Volume II is undergoing revision, to be completed in 2008, and will be revised in a manner that will allow section-by-section updates on the Internet in order to keep it current.

Table 6-1. QA Element and Activity List

Quality System Elements	Activities
Planning	Data Quality Objectives Performance Based Measurement Approach Regulation Development Graded Approach to QA - QMPs/ QAPPs and SOPs Guidance Documents
Implementation	Training Internal Quality Control Activities Data Verification/Validation Data Certification
Assessment/Reporting	Site Characterizations Performance Evaluations (NPAP, PEP, Region/SLT Performance Audits) Assessment of Quality Systems & Technical Systems Audits Data Quality Assessments QA Reports

6.5 ELIMINATE REDUNDANCIES TO IMPROVE COST EFFICIENCIES

As part of the Quality Assurance Strategy Workgroup's review of the quality system, each element and activity listed in Table 6-1 was examined to determine if the activity (1) was necessary, (2) was redundant, and (3) could be done better or more cost efficiently. EPA made changes to the quality system based on the output of the Workgroup in the October 17, 2006, promulgation of the monitoring rule.

In most cases, review of the quality system allowed EPA to reduce some of the frequencies of the QC requirements without affecting the ability to perform data quality assessments. As monitoring programs evolve, EPA will continue to review and assess data to ensure that quality systems are cost-effective.

6.6 DEVELOP CERTIFICATION AND/OR ACCREDITATION PROGRAMS

The Quality Assurance Strategy Workgroup members felt strongly about the need for training to accommodate turnover in monitoring network personnel. More emphasis can be placed on training by establishing a national accreditation process to certify QA personnel. At a minimum, OAQPS will pursue the development of an accreditation process for personnel filling the required quality management function defined in 40 CFR Part 58, Appendix A. Although not mandatory, this accreditation process would foster a level of consistency in the knowledge of quality systems across the nation. EPA will develop a Quality Assurance Lead accreditation curriculum using EPA Quality Staff courses, courses provided by the Air Pollution Training Institute (APTI), and courses developed in-house. The following training-related activities provide potential opportunities:

- Conduct a poll to determine training needs. Monitoring agencies should be polled, perhaps through National Association of Clean Air Agencies (NACAA) and National Tribal Air Association (NTAA), to determine what QA-related training is needed.
- Provide training at the annual QA conference. Since 2002, OAQPS has facilitated two days of presentations and training at the annual EPA National Conference on Managing Environmental Quality Systems. This conference provides training on a number of topics that will be required for QA lead certification. EPA provided an introductory QA course at the 2008 National Meeting. Monitoring agency QA leads should be provided opportunities to attend this meeting.
- Develop web-based training programs. Based on priority training needs, OAQPS will pursue the use of web-based training courses, in particular, the APTI courses and a training module related to the QA Handbook for Air Pollution Measurement Systems, Volume II, also found at http://www.epa.gov/ttn/amtic/qabook.html.

6.7 DEVELOP APPROPRIATE DATA QUALITY ASSESSMENT TOOLS

Because of the ever-increasing need for real-time data by the public, decision makers, and health researchers, SLTs will need to be able to ensure the quality of data more quickly. Through the use of AQS, the recently developed AMP255 report provides informative assessments of precision, bias, and completeness; however, the report can only use data uploaded into AQS. EPA's AIRNow database provides access to real-time data that have undergone cursory QC checks but not at the level at which SLTs consider the data valid. EPA and SLTs should work together to determine more effective and efficient data quality assessment tools:

- Automating QC procedures. Many newer digital data acquisition systems (DAS) reduce noise in recording pollutant monitoring data and can improve sensitivity. DAS can record and control instrument settings, internal diagnostics, and programmed activities of monitoring and calibration equipment. Such DAS also typically provide automated data quality assessments as part of the data acquisition process. Many monitoring agencies still perform manual zero/span and one-point QC checks that can be automated using DAS technology. Section 7 addresses the aspects of increasing awareness of DAS technology and the move to more automated systems. However, an initial expenditure of capital for both equipment and training will be required to ensure the achievement of this modernization.
- Data Assessment Statistical Calculator (DASC). The promulgation of the October 17th, 2006 monitoring rule (40 CFR Parts 53 and 58) included the use of a different set of statistics for calculating precision and bias. EPA developed a guidance document (Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58, Appendix A – Version 1.1, located at http://www.epa.gov/ttn/amtic/parslist.html) that explains the statistics, the AMP255 report on AQS, and an MS Excel DASC tool that can be used by SLT agencies for more real-time data assessments. In the future, as monitoring programs change, or new monitoring is implemented, various types of assessments and control-charting techniques should be developed for more real-time

assessments so that each monitoring agency does not have to develop the same types of assessment programs.

6.8 CONTINUE TO USE INDEPENDENT AND ADEQUATE PERFORMANCE EVALUATION PROGRAMS

Performance evaluations (PE) are a type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of an analyst or laboratory. PEs are an obligation of SLTs, but the evaluation is conducted by a separate entity that has an adequate level of independence. OAQPS will offer the following two types of audits. State and local agencies can either 1) allow for federal implementation of PEs (using State and Local Air Grant [STAG] funds) or 2) make arrangements for non-EPA independent audits. In the latter case, EPA must certify that the independent audit services will provide data comparable to EPA conducted audits.

6.8.1 National Performance Evaluation Program (NPEP)

The NPEP program will service NCore multi-pollutant and other monitoring agency NAAQS-oriented sites. The following PE programs will be included under the NPEP:

- $PM_{2.5}$ Performance Evaluation Program (PEP). This program has been operating since 1999 using Environmental Services Assistance Team (ESAT) contractors to collocate FRM $PM_{2.5}$ instruments at reporting organization's sites. In addition, during $PM_{2.5}$ audits, EPA will audit speciation monitors at both STN and supplemental sites.
- National Performance Audit Program (NPAP). NPAP has been operating since 1970 and is now retooled into a through-the-probe audit system implemented by EPA Regional personnel and/or ESAT personnel currently implementing the PEP. The PEP and NPAP programs are combined when possible to reduce the costs of the programs. In addition, OAQPS will evaluate the need for through-the-probe auditing in the NATTS and NCore sites and may opt to outfit the NPEP laboratories for this activity.
- NATTS Proficiency Test Samples. OAQPS will contract the development and distribution of quarterly audit samples to the laboratories analyzing NATTS samples. Details of these audits can be found in the NATTS strategy document (http://www.epa.gov/ttn/amtic/files/ambient/airtox/atstrat804.pdf).

6.8.2 Certification Programs

Certification programs provide independent testing of products and/or instrumentation and are used to provide a sense of quality and comparability. The following certification programs (with the exception of protocol gas) will be implemented for SLAMS/PAMS/NCore and other sites as needed.

- Standard Reference Photometer (SRP) Program. The SRP, which is used to certify monitoring agencies' ozone primary and transfer standards, will continue to be implemented through the OAQPS.
- PAMS and NATTS Gas Cylinder Certifications. ORIA currently performs gas cylinder certifications for the PAMS program and is proposing a similar service for certifying calibration standards for laboratories participating in the NATTS. Details of these audits can be found in the NATTS strategy document (http://www.epa.gov/ttn/amtic/files/ambient/airtox/atstrat804.pdf).
- Re-investing in the Protocol Gas Program. ORD for many years maintained a program that tested gas standards supplied by gas manufacturers to monitoring agencies in order to ensure a level of QC for gas manufacturers. The program was discontinued in 1997 as part of the ORD divestment. In response, OAQPS is developing plans to implement a protocol gas verification program in the near future.

6.8.3 Assessments of Quality Systems and Technical Systems Audits

The following types of qualitative assessments will be implemented in the national ambient air monitoring system:

- Assessments of Quality Systems. These assessments are systematic, independent, and documented examinations for which specified criteria are used to review a monitoring agency's quality system, mainly through the assessment of the monitoring agency's adherence to its QMP. Every three years, EPA Quality Staff will assess OAQPS' quality system, which will, in turn, assess the EPA Regions' quality systems. As part of the technical system audits described below, the EPA Regions will assess the quality systems of monitoring agencies. This process should provide feedback on the strengths and weaknesses at all levels of the Ambient Air Monitoring Program quality system.
- Technical Systems Audit (TSA). A TSA is a thorough, systematic, on-site, qualitative audit of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects. EPA will continue to require that the EPA Regions perform a TSA of the primary QA organization once every three years. The TSA audit checklist, currently in the QA Handbook Volume II, will be revised to reflect new monitoring methods and/or objectives, and to include questions relative to an organization's QMP. An area for tracking these audits will be developed within AQS.

6.8.4 Funding and Resource Issues

The expected schedule for full implementation of urban air monitoring will determine the year-to-year resources required to implement the QA activities at EPA Headquarters, EPA Regional Offices, and monitoring agencies. To ensure that expectations are met, it is imperative that the resources required to implement this quality system be enumerated and acknowledged as appropriate. If a monitoring agency believes the funds are not appropriate, the funds should be adjusted accordingly. In addition, QA activities must be intimately tied to the monitoring process so that costs for the quality system either increase or decrease commensurate with monitoring costs.

7. MONITORING TECHNOLOGY DEVELOPMENT AND TRANSFER

7.1 OVERVIEW

This section of the Strategy focuses on the technologies that EPA, monitoring agencies, and other partners will use to deliver timely data from ambient air monitoring sites. During the earlier planning stages of the NAAMS, a technology workgroup, with input from the Quality Assurance and Regulatory Review Workgroups, NMSC, CASAC, and NACAA, identified three overall needs for new technology investments. Notes and documents stemming from this workgroup can be found at http://www.epa.gov/ttn/amtic/mettech.html. In addition to the new investments, the existing infrastructure for programs, such as the ozone network, will continue to be employed. Other technologies, such as routine CO, SO_2, and NO_2 monitoring and filter-based PM monitors, could be adjusted, depending on network assessments that take into account the new investments and possible changes stemming from NAAQS reviews. While other technology investments will likely be made during ongoing implementation of the strategy, most of those technologies fall under one of three major technology needs:

1. Timely reporting of high-quality, highly time-resolved ambient monitoring data;
2. Promotion of high-quality, highly time-resolved, spatially rich $PM_{2.5}$ mass data; and
3. Collocated characterization of CO, SO_2, NO, and NO_y using high sensitivity analyzers.

The timely reporting of high-quality, highly time-resolved ambient monitoring data (both gaseous and PM) will require a continued coordinated effort to ensure that data management systems (DMS) continue meeting desired performance needs. These DMS can provide validated data, in near real-time, to multiple clients within minutes of the ending of a sample period. To increase utilization of the nation's ambient air monitoring networks, the DMS provide not only efficient processing and validation of data, but also proper communication of that data in a format appropriate and available to multiple users. The main impetus for continued improvement of DMS is providing near real-time, high quality, hourly data from all NCore continuous monitors, including ozone; high sensitivity CO, NO, NO_y, and SO_2; $PM_{2.5}$; and meteorological metrics. By emphasizing the availability of data in near real-time, the networks will better serve their clients by providing data as air quality episodes are occurring. This timeliness will allow technical and policy staff to better understand the exposure to and interactions of air pollutants in the present atmosphere.

The characterization of trace level gases and $PM_{2.5}$ in near real-time is emphasized in the networks. The use of monitoring technologies in the networks is generally limited to reference and equivalent methods for gaseous criteria pollutants. EPA has promoted the implementation and use of continuous PM methods since 1998. Earlier guidance encouraging the use of continuous PM methods can be found at http://www.epa.gov/ttn/amtic/mettech.html and http://www.epa.gov/ttnamti1/files/ambient/monstratcont/contimp.pdf. More recently, the October 17th, 2006 revisions to 40 CFR Part 53 provided the opportunity for continuous $PM_{2.5}$ methods to become FEMs or Approved Regional Methods (ARM). This was a huge boost in the effort to continue promoting adoption of PM continuous methods where possible.

To address the need to continue characterization of trace levels of CO, SO_2, NO, and NO_y, instrument manufacturers introduced high sensitivity analyzers which utilized the vendor's base reference or equivalent methods and made modifications to improve their detection limit (thus performance), at low concentrations relative to NAAQS levels while maintaining their FRM/FEM status. For PM criteria pollutants, EPA continues to move toward a base network of FRMs/FEMs coupled with a larger network of approved continuous PM monitors that meet appropriate DQOs, such as recently approved $PM_{2.5}$ FEMs, or potential ARM candidates.

The challenge for implementation will be to produce a framework that encourages widespread adoption of the technologies described in this section, which some agencies already use. Specific technologies will not be required in most instances; however, select parameters are required at NCore sites. The concern with requiring specific technologies is that, over time, new technologies will become commercially available, making existing technologies obsolete. One of the main tenets of the Strategy has been to adopt a Performance Based Measurement System (PBMS) approach. Doing so for each parameter of interest in the network allows new or improved technologies to enter the market place and gain acceptance over existing technologies if the data demonstrate they are a better solution for the network. For parameters of interest that do not have reference methods, the strategy will be to use PBMS through a DQO process, when possible, to identify both a relative standard approach to the method and acceptable error rates.

Despite the need to invest in many areas of ambient air monitoring, doing so indiscriminately may not lead to an improved system. The technology workgroup recommended focusing on the following issues in addressing this concern:

- Choosing the Right Technology. For any one type of technology, there may be several choices to consider. The most cost-effective current choice may be outdated in a year. Careful consideration is needed in selecting monitoring and analysis methods, and, even then, the choice may not be optimum.
- Transitioning from Current to New Technology. Important considerations in the transition to new technology include allowing downtime in the system and providing a contingency plan should the new system fail.
- Training Staff. New technologies may require a higher level of expertise than that required by the technologies they are replacing.
- Obtaining Technical Service. The need for a service plan may affect the true cost of the technology. Another important consideration is the responsiveness of technical service.
- Using Proprietary Software. The use of software that is not in the public domain may arise as an issue.
- Providing the Ability to Transfer to New Technologies in the Future. Agencies must carefully select technologies that do not preclude the selection of newer technologies in the future.
- Identifying Appropriate Technical Specifications. Appropriate technical specifications should be included on purchase requests so that air monitoring agencies purchase the

right equipment. This is especially important in cases where technologies have similar features, but the lower cost product is inferior.

7.2 MONITORING TECHNOLOGY

There is greater potential now than at any time in the past to improve monitoring methods, monitoring support capabilities, such as computer-controlled instrument calibrations and QA functions, and the transfer of information to the public. Yet, some monitoring network components continue to function with less automation, efficiency, and speed than is necessary. The explosion of computer and communications technologies over the past 15 years presents significant opportunities for air quality monitoring networks.

Of the three major technology needs described in Section 7.1, EPA has made successful strides to address the known technological gaps:

- EPA promulgated regulations that support a transition to new, real-time, high sensitivity methods.
- EPA provided funding for the procurement of instrumentation that would be needed to outfit an NCore site, particularly encouraging the acquisition of high sensitivity gas analyzers.
- EPA investigated multiple commercial products and subsequently promoted ‘digital data acquisition’ which provides any monitoring agency the capability to collect monitoring data (concentrations and instrument diagnostics) digitally.
- EPA engaged instrument vendors and procured prototype and first-run high sensitivity analyzers to quantify method reliability and sensitivities.
- EPA provided training in the form of “Precursor Gas Training” courses and the development of SOPs and training videos.

The information technologies used in ambient air monitoring cover all types of hardware and software used in the measurement, calibration methods, data logging, data transfer, data storage, data validation, and data reporting. Many areas identified are already using state-of-the-science technologies. For instance, many gaseous criteria pollutants are measured using continuous monitors with automated features for calibration and data output. Other areas, such as data transfer, are relying on technologies that may be outmoded or antiquated. Yet, because an instrument or DAS operates well and satisfies the needs of data users, they may not represent an opportune area for investment.

Table 7-1 lists the major technology areas of the ambient air monitoring program into individual technology elements, summarizes the state of technology used in a typical ambient air monitoring program, provides recommendations for each technology element, and states the expected benefit of moving to this element.

Table 7-1. Technology Implementation Investments.

Technology Element	State of Technologies used in Typical Program	Recommendations	Expected Benefit
Data Management Systems – recording of data from back of instrument to data logger	Analog connection.	Move to digital capture of data. Could be RS232, Ethernet, FireWire, or USB.	Allows tracking of instrument performance beyond concentration alone. Allows for diagnostic data access and improved remote troubleshooting.
Telemetry systems	Everything from low baud modems used on standard telephone lines to satellite, cable modem, DSL, and other high speed Internet systems.	Focus on performance needs of moving low interval data very quickly to support real-time reporting and other data uses. Choose most optimal telemetry system depending on availability in area of monitoring.	Improves timely reporting of data. In many cases, there may actually be a reduced cost for using broadband or satellite systems rather than dial-up modems due to long distance charges.
Data validation	Limited range checks are used on most systems.	Move toward comprehensive automated QC systems with graphical display of data and point-and-click validation.	Reduced manual validation. Automated QC features improves quality of real-time reported data.
Data reporting format	For AQS reporting, bar-delimited format is used. For AIRNow reporting, “Obs” file format is used.	Move to common “XML” schema that can serve both reporting needs.	By using one format, data analysis tools developed for one system will be compatible with both systems.
Gas pollutants – CO, SO_2, NO_2/NO_y	FRM/FEMs.	Trace gas analyzers that are also approved as FRM/FEMs.	Allows tracking of trends and signals that may be important. Allows for better model evaluation.
Gaseous criteria calibration systems	Mixed –from fully automated to manual.	Move all agencies towards fully automated systems.	Improved data quality.
$PM_{2.5}$ monitoring	Approximately 947 filter-based FRMs and 591 $PM_{2.5}$ continuous monitors.	Continue trend toward more continuous monitoring vs. filter-based monitoring to reduce dependency on a filter-based network and to optimize resources.	Better spatial characterization of $PM_{2.5}$ for episodes. Improved temporal characterization. Reduced operating costs.

7.3 MULTI-POLLUTANT SITE MEASUREMENT METHODS

This section considers the measurement methods to be implemented at NCore sites, elaborates on the investigation of new methods for pollutants currently being monitored, and also introduces concepts to investigate and possibly implement new pollutants that are not currently part of the routine monitoring networks.

When possible, continuous methods should be implemented over manual methods. Most importantly, continuous methods deliver data with a high temporal resolution so that the atmosphere can be characterized on a time scale relevant to how changes occur and how people are exposed. In addition, continuous instruments are usually much less resource-intensive to operate, have a higher sample frequency, provide greater precision due to reduced human intervention, are easier to automate with respect to data delivery, and provide data that are easier to validate.

However, EPA also recognizes that a mix of continuous and integrated (e.g., filter, canister, cartridge, denuder) systems in the networks will continue to be necessary for three important reasons:

1. Integrated samples allow more extensive chemical and physical property analysis in the laboratory.
2. Due to uneven performance characteristics exhibited by continuous methods, collocated integrated measurements enable appropriate transformations of continuous data, thereby improving their quantification attributes (the basis for regionally approved continuous $PM_{2.5}$ methods).
3. Retention of integrated methods allows a smooth transition to new continuous technologies with minimal compromise of the ability to construct air quality trends analyses.

7.3.1 High Sensitivity Gas Analyzers

One of the major areas of investment in the strategy is the use of high sensitivity gas analyzers to characterize CO, SO_2, NO_2, and NO_y, so-called ‘precursor’ gases, at NCore monitoring stations. These analyzers are approved FRM/FEMs; however, modifications have been made to improve the sensitivity of the measurements while maintaining their original reference or equivalency rating. EPA evaluated several different high sensitivity gas analyzers from several vendors (note: an evaluation of a particular instrument does not imply EPA endorsement). The evaluation resulted in the development guidance documents, including a Technical Assistance Document, SOPs, training materials, and tabulation of method sensitivity metrics. This information can be found at http://www.epa.gov/ttn/amtic/precur.html.

Using high sensitivity gas analyzers instead of conventional gas analyzers, monitoring agencies can not only determine compliance with the NAAQS, but can also can provide valid measurements at much lower detection limits. Providing data at lower detection limits will enable better characterization of confounding factors associated with air pollution episodes given the collocation of high sensitivity gas measurements at NCore sites. In addition, improved gas monitoring data will result in reduced uncertainties in data sets used to model air pollution episodes and will enhance an array of multiple factor-based source apportionment analyses. The true measurement objective remains the characterization of actual levels of gases. Thus, in most cases, conversion to high sensitivity gas methods and associated calibration regimes will be necessary given the low levels of these gases in many "representative" NCore or SLAMS sites. Therefore, EPA recommends high sensitivity gas monitoring for non-NCore sites as well, on a case by case basis.

Known issues with the high sensitivity gas analyzers are similar to those inherent in the older, standard analyzers. For CO, the high sensitivity analyzer uses the same non-dispersive infrared (NDIR) technique as the standard monitor, with known interference issues from water vapor and carbon dioxide corrected by using a gas filter correlation wheel. High sensitivity is achieved through drying the sample stream via Nafion dryer, baseline determination and correction using heated or catalytic converter, frequent auto-zeroing, and use of an 'ultra sensitive' or 'hot' IR detector. EPA field evaluations estimated that high sensitivity CO analyzers have a minimum detection limit around 20 parts per billion (ppb).

For SO_2, the high sensitivity analyzers are subject to issues such as hydrocarbon interference, ultraviolet (UV) lamp performance, and NO interference. The analyzer avoids these interferants by using an efficient band pass filter to increase NO rejection, using a longer optical bench, and employing high sensitivity detectors. EPA field evaluations estimated that high sensitivity SO_2 analyzers have a minimum detection limit around 400 parts per trillion (ppt).

For NO and NO_y, the method requires a change in hardware configuration versus traditional NO_x measurement methods. In order to detect all oxides of nitrogen, the analyzer uses a remote converter situated at 10 meters above ground as the sample inlet. The analyzer also uses a pre-reactor chamber, when quantifying non-NO species, to reduce detector interference created by NO reactions with ozone. The NO_y analyzer also has a flow rate higher than typical NO_x analyzers, while maintaining reduced reaction chamber temperature and pressure. EPA field evaluations of high sensitivity NO_y analyzers produced somewhat variable results, but generally showed detection limits ranging from around 50 ppt to 230 ppt.

EPA is also investigating the feasibility of photolytic converters embedded in NO_y or NO_x analyzers as a novel approach to determine "true" NO_2. While this is not a direct method, as is used to determine NO, this true NO_2 approach may prove to be an easy addition to either NO_x or NO_y monitoring systems. EPA is aware of two vendors of photolytic converters that may be utilized in conjunction with existing analyzers and will continue to investigate this topic.

7.3.2 Ozone

The ozone monitoring network is expected to remain one of the most spatially rich monitored pollutants throughout the United States, and ozone monitoring efforts may modestly grow due to the recently revised NAAQS and upcoming monitoring rule. However, no major needs exist to adjust or change from the typical UV absorption FEM measurement method used in SLT networks; therefore, FRMs or FEMs will be used to implement procedures laid out in 40 CFR Part 50, Appendix L. Nonetheless, EPA will always attempt to stay aware of emerging methods, especially those with increased accuracy, sensitivity, or ease of use that could be considered for use in the collective ambient air monitoring networks. Additionally, EPA recognizes possible value in increased understanding of the capabilities of low power and portable ozone analyzers for screening rural areas that may have access and power issues.

7.3.3 Continuous PM Mass

The strategy emphasizes PM continuous methods as a major component of the overarching monitoring network plan. In response to requests from state and local agencies (specifically through NACAA) and from the CASAC Subcommittee on PM monitoring, EPA developed an ambitious continuous monitoring implementation plan to create a PM monitoring network that can meet multiple objectives at a lower cost. The regulatory components of that plan were proposed in the December 2005 notice of proposed rulemaking and were finalized on October 17th, 2006. Major outcomes of the final rulemaking incorporating provisions for approved $PM_{2.5}$ continuous methods include:

- support for a hybrid network of filter-based and continuous methods, with increasing ratios of PM continuous monitors versus FRM samplers;
- use of performance-based criteria developed in a DQO process to determine the acceptability of PM continuous monitors in the individual networks where they are used; and
- a parallel DQO approach for approval and applicability of methods on a national basis.

An enlarged continuous PM monitoring network will improve public data reporting and mapping, support air pollution studies more fully by providing continuous (i.e., hourly) PM measurements, and decrease the resource requirements of operating a large network of filter-based FRM/FEM particulate samplers. The Continuous Monitoring Implementation Plan, which can be found at http://www.epa.gov/ttnamti1/files/ambient/monstratcont/contimp.pdf, provides recommended directional guidance to move forward in deploying a valued continuous PM monitoring program operated by SLT governments. The plan addresses a range of topics: relationships between continuous and reference measurements; performance analyses of collocated continuous and filter-based samplers; recommended performance criteria; regulatory modifications; and identification of outstanding technical issues and actions to be taken in the near future.

The continuous monitoring implementation plan encourages a hybrid network of filter-based and continuous mass samplers. The hybrid network reflects a reduced number of existing FRM samplers for direct comparison to the NAAQS, and continuous samplers that meet specified performance criteria related to their ability to produce sound comparisons to FRM data. The plan proposed, which is now feasible through the recent 40 CFR Part 53 revision, uses two approaches for integrating continuous mass monitors to maximize flexibility: (1) continuous FEMs and (2) expanded use of non-designated ARMs. For FEMs, new equivalency criteria are derived based upon a DQO exercise that matches the required performance criteria with the needs of the data. ARMs are analogous to the Regional Equivalent Monitors (REMs) described in the continuous monitoring implementation plan, and will be approved in individual SLT networks where data quality meets specified criteria. The major emphasis of the DQO process was to tie historical equivalency criteria based on slope, intercept, and correlation with network operation DQOs based on bias and precision. The major advantage, from a DQO perspective, of using $PM_{2.5}$ continuous monitors over filter-based FRMs is that they provide hourly data. Many FRM sites operate on sample frequencies of once every third day or once every sixth day. A method that provides a daily sample will reduce the uncertainty of a decision with the data, compared to a method based on a lower sample frequency.

Since the promulgation of the regulatory revisions in 2006, and at the time of release of this document, one continuous $PM_{2.5}$ method has been approved as an FEM, and EPA anticipates at least one more application to be submitted this year (2008). The latest documentation on approved reference and equivalent methods can be found at: http://www.epa.gov/ttn/amtic/files/ambient/criteria/reference-equivalent-methods-list.pdf. EPA is working on implementation issues associated with deploying $PM_{2.5}$ FEMs and expects to provide a technical note during 2008 that will supplant the existing Continuous Monitoring Implementation Plan.

7.3.4 Continuous $PM_{2.5}$ Speciation

With continuous or semi-continuous monitoring, networks can deliver data with a high temporal resolution that allows the atmosphere to be characterized on a time scale relevant to how it changes and to how people are exposed under dynamic processes. In that respect, continuous speciation is desired; however, only a few of the technologies may be ready for wider network deployment. The EPA is beginning to plan a new pilot for continuous speciation sampling technology in combination with limited filter-based analyses, with the hope that one day, continuous sampler operations at NCore multi-pollutant and comparable sites will fully evolve.

To date, EPA has not reduced funding for other types of monitoring to make a major investment in continuous speciation monitoring due to findings from the Supersites and other programs that indicate mixed performance across a variety of monitors. During EPA's investigation in this area, a pilot study of semi-continuous $PM_{2.5}$ speciation monitors was conducted at five STN sites: Deer Park, TX; Indianapolis, IN; Chicago, IL; Phoenix, AZ; and Seattle, WA. The pilot study began in 2002, with the final comparison report completed in 2005, which can be found at http://www.epa.gov/ttn/amtic/files/ambient/pm25/spec/semicont454.pdf. The goals of the pilot study were to assess the operational characteristics and performance of continuous carbon, nitrate, and sulfate monitors for routine application at STN sites, to work with the pilot participants and the vendors to improve the measurement technologies used, and to evaluate the use of an automated data collection and processing system for real-time display and reporting. Results from this pilot work indicate operational issues with the effectiveness of the flash volatilization process and/or thermal and catalytic conversion efficiencies. EPA discussed with instrument vendors modifications and adjustments to the monitors to resolve these issues.

As the monitoring technologies improve and new technologies are developed, EPA will continually assess its position on increasing its resources to proliferate this type of continuous technology.

7.3.5 $PM_{10\text{-}2.5}$ Speciation

In order to support the design and implementation of a $PM_{10\text{-}2.5}$ speciation method, as is required by 40 CFR Part 58 for NCore sites, significant questions are to be answered during the proposed pilot study to be carried out prior to the NCore implementation deadline in 2011. At the time of release of this document, more questions than answers exist. Some of the major questions and design concepts include:

- What are the $PM_{10\text{-}2.5}$ speciation sampling artifacts that may be expected?
- What are the key $PM_{10\text{-}2.5}$ species that need to be measured? Are all ions, elements, metals, etc. needed?
- Is the elemental analysis output package from XRF sufficient? Are the major soil components (Si, Al, Ti, Ca, Fe) enough?
- Do we need to distinguish urban from rural coarse particles?
- What issues may arise from the actual monitoring methods that may be used that may hamper an "apples to apples" comparison between $PM_{2.5}$ and $PM_{10\text{-}2.5}$ data?
- To what extent can we address the collection of biological materials (e.g., pollen)?
- Will differing flow rates from different methodologies be problematic with respect to cut-points and particle intrusion between the coarse and fine fractions?

EPA anticipates more answers to these questions to be derived from published materials stemming from an EPA - ORD multi-city field evaluation. EPA – OAQPS is in the process of designing the pilot study, which is planned to provide results with sufficient time to allow the agency to make decisions on the methods and implementation prior to NCore start up in 2011.

7.3.6 Lead Monitors

The lead (Pb) NAAQS review, had proposed rule changes listed in the Federal Register (73 FR 29184). The final rule, signed October 15, 2008, can be found with supporting documents at http://www.epa.gov/air/lead. The new lead rule calls for monitoring of lead in TSP (known as Pb-TSP), which is the traditional, high-volume flow rate hardware and associated analysis methods (FRM/FEM methods) implemented since the 1970's. However, there was much interest from the ambient air monitoring community in the option for monitoring lead through low-volume flow rate TSP methods or through PM_{10} (Pb-PM_{10}) methods.

In the NAAQS review process, EPA, the Clean Air Scientific Advisory Committee (CASAC) Ambient Air Monitoring and Methods (AAMM) subcommittee, and commentors on the proposed lead ruling discussed the interest in moving towards using low-volume TSP monitors for lead monitoring. Ultimately, the CASAC – AAMM subcommittee advised EPA to take a course of action that would ensure the characterization of any low-volume TSP monitor across a wide range of particle sizes if any efforts were ever made to have a low-volume TSP sampler approved as an FRM for lead. EPA may further investigate this method in the coming years, with EPA's ORD providing the means to characterize any new low-vol method.

In the same forum as the discussion on low-volume TSP methods, the options for monitoring lead in PM_{10} were also examined. EPA had proposed, and subsequently adopted via the new lead rule, to promulgate a new FRM for Pb- PM_{10} based on the already promulgated PM_{10C} FRM, where the PM_{10C} FRM is the PM10 monitor in a pair of PM FRMs (the other PM monitor is a $PM_{2.5}$ FRM) used to determine the mass of particles with aerodynamic diameters between 10 micrometers and 2.5 micrometers, also known as PM coarse, $PM_{10\text{-}2.5}$ or PM_C. The PM mass collected on the PM_{10C} FRM would be analyzed for lead by X-ray fluorescence (XRF). The PM_{10C} FRM, a low-volumetric flow rate device, was proposed in lieu of a standard PM_{10} FRM because the PM_{10C} FRM meets more demanding performance criteria, and includes features such as sequential sampling capabilities, active flow control at local conditions, and would provide for network efficiencies and operational consistencies with most of the samplers in the PM networks. The associated XRF analysis was chosen because it does not require sample preparation or extraction prior to analysis, a non-destructive method, and it is a cost-effective approach that could be used to simultaneously analyze for additional metals useful in source apportionment work. Further, XRF is currently used in the CSN and IMPROVE networks, and under consideration for use in $PM_{10\text{-}2.5}$ coarse speciation.

The new lead rule introduced changes to FEM requirements. EPA proposed and adopted to revise the lead concentration requirements for candidate FEM test levels to a range of 30% of the revised level to 250% of the revised level. The new requirements are now percentages instead of actual concentration values to allow FEM to remain appropriate if subsequent changes to the NAAQS levels occur again. Also, the old FEM language did not have a requirement for a maximum MDL. The new rule ensures that candidate analytical methods have adequate sensitivity or MDLs by adding a requirement for candidate FEMs demonstrate an MDL of less than 1% of the lead NAAQS level. Further, adjustments were made to the requirements for audit samples allowing FRM to FEM comparisons, changing the comparison levels from actual concentrations to percentages. Finally, the FEM requirements were adjusted to accommodate the new low-volume methods, and the rule now has language addressing both high-volume glass-fiber and low-volume Teflon sample media.

7.3.7 Ammonia and Nitric Acid

Both ammonia and nitric acid are important precursor gases to the major aerosol ion components. These two gases represent some of the larger gaps in ambient measurements that are needed to better understand the total atmospheric nitrogen budget, specifically to support air quality model and emission inventory evaluations and to aid in tracking the long-term progress of emission reduction strategies targeting nitrogen species, such as the (now-vacated) Clean Air Interstate Rule (CAIR). These gaseous species also play a role in watershed acidification and eutrophication through atmospheric deposition. The strategy to address the lack of data associated with these compounds is to investigate the use of the existing CSN. By the end of calendar year 2008, EPA expects to have a denuder of novel design created for eventual insertion into the existing CSN infrastructure. EPA plans to pilot the use of this new denuder in 2009 and evaluate the potential of standardizing its use in NCore sites or over the whole CSN. EPA feels that although continuous methods are more desirable, they are still too immature for network operations. Therefore, this integrated sampling approach will still allow the air quality community to significantly further our understanding of these species.

Ammonia

Chemiluminescence monitors are widely used and are perhaps the most popular means of measuring ambient ammonia concentrations. These monitors do not actually measure ammonia directly; rather, they determine the ammonia concentration by the difference method. To do this, a thermal converter must oxidize the ammonia to NO, which is then further oxidized using ozone to produce NO_2, whose luminescence is measured. Two thermal converters operating at different temperatures either oxidize all reactive nitrogen species or all of the oxides of nitrogen, which excludes reduced nitrogen (ammonia), to produce a difference signal to represent the ammonia concentration. One drawback of this method is the interference of organic nitrogen compounds and nitric acid, forcing the use of ammonia-specific scrubbers that have been adapted to the monitors. Another drawback to chemiluminescence methods is that detection limits are not nearly low enough for use in ambient applications away from sources, such as is the case with NCore sites and most CSN sites. It is anticipated that a continuous ammonia analyzer suitable for use in NCore or the CSN would need a minimum detection limit around or below 0.1 ppb.

Several other continuous systems have been developed that use optical systems which have been adapted for use in real-time ammonia monitoring. These systems include differential optical absorption spectroscopy (DOAS), Fourier transform infrared spectroscopy (FTIR), tunable diode laser absorption spectroscopy (TDLAS), photoacoustic spectroscopy, and ion mobility spectroscopy. Several recent field research studies using photoacoustic spectrometers have monitored ammonia concentrations as low as 0.1 ppb, with good accuracy over a range from 1 ppb to 3 ppb. However, these instruments are currently labor intensive with respect to maintenance and reliability in the field, making them still immature for implementation into large-scale, routine ambient networks. EPA plans to continue to watch the development of these optical methods so that continuous ammonia methods may be evaluated for network implementation as soon as the methods are ready for routine monitoring applications.

Monitoring for ambient ammonia has traditionally been conducted through a variety of time-integrated sampling methods. The most prevalent time-integrated methods use denuders typically coated with phosphorous, citric, or oxalic acids to collect ammonia, which is then analyzed through ion chromatography or colorimetric analysis. Other time-integrated methods include the use of gas sorbent detector tubes or passive diffusion devices. Although these methods are inexpensive and relatively simple to implement, their limitation is that temporal resolution is dictated by the sample collection time; therefore, the concentrations are not known until after laboratory analysis. Despite this issue, denuder-based sampling for ammonia appears to be the most appropriate method to employ in NCore or the CSN due to the relatively low cost, ease of insertion into existing hardware, logistics, and laboratory infrastructure.

Nitric Acid

Nitric acid has traditionally been sampled in time-integrated systems. These systems use either filter packs or a combination of coated diffusion tubes followed by filter packs for sampling at the monitoring site. The samples are then transported to a laboratory for analysis. These systems typically collect samples over several hours and are, therefore, limited in providing fine temporal concentration resolution. A major problem associated with nitric acid sampling and detection is sample loss through the sampler inlet. Nitric acid is so "sticky" that it will essentially stick to some degree to any surface it comes into contact with. Indications are that if an inlet manifold must be in place upstream from a continuous monitor, denuder, or other sample medium, PFE and PTFE may serve as a somewhat suitable inlet material, but manifold length still must be minimized to reduce losses. Due to this difficulty with sample losses, EPA will not actively pursue semi-continuous measurements specific for nitric acid until the technology reaches a higher level of maturity and proven reliability. Some other technological developments in sensing nitric acid exist:

- Thermal denuders with selective coating, such as tungstic acid, have been used for semi-continuous monitoring with data resolution of 30 minutes or less. The denuders are thermally desorbed and measured by a chemiluminescence detector. Several versions of parallel-operated denuder systems that are coupled to chemiluminescent detectors for semi-continuous measurement of nitric acid and ammonium nitrate by difference calculations have been developed. Commercial chemiluminescence monitors for NO have been modified to design real-time nitric acid detectors using two inlets, one with only a particle filter and another with a particle filter and a nylon filter. The difference signal is attributed to nitric acid.
- Wet denuders have been developed in which nitric acid is captured in an aqueous system using diffusion scrubbers or parallel-plate-wetted denuders and then analyzed by ion chromatographic or colorimetric means. Prototype instruments providing up to 10-minute resolution at a detection limit of 10 ppb have been field-tested.
- Real-time measurement of nitric acid has been possible using chemical ionization mass spectrometry with detection limits of less than 15 ppt for a one-second sample interval. Systems employing tunable diode laser absorption spectroscopy and open-path, multi-pass Fourier transform infrared spectroscopy have been successfully operated for monitoring nitric acid by interpretation of IR spectra. For nitric acid, the published detection limits are 4 ppb for the diode laser and 10 ppb for the Fourier transform instrument.

Given the lack of mature continuous methods and the difficulty in sampling nitric acid continuously, EPA will consider evaluating the same denuder under development for ammonia sampling in NCore and the CSN for use with nitric acid. EPA is aware that inlet losses will persist even with integrated denuder sampling. However, EPA will consider testing the prototype denuder using a variety of manifold configurations, including Teflon-coated cyclones, or without an inlet manifold. Any testing of this type will follow the evaluation of the denuder for use in sampling ammonia.

7.3.8 Aethalometers™

Aerosolized black carbon is a primary emission from combustion sources. Black carbon is ubiquitous and absorbs light. It can be found in diesel and gasoline exhaust and is also emitted from all incomplete combustion sources together with other species such as toxic and carcinogenic organic compounds. The Aethalometer is a semi-continuous instrument that measures black carbon using a continuous filtration and optical transmission technique. The light attenuation through a sample spot and a blank reference on a filter tape are used to determine light absorption. The absorption is converted to black carbon using an absorption coefficient. Originally, the Standing Air Monitoring Working Group monitoring subcommittee recommended the use of Aethalometers at every urban site in the NATTS. These instruments were added to the network to measure black carbon, with the intent of developing an indicator for diesel emissions. However, EPA recognizes that all mobile sources emit black carbon; and other potential urban sources, such as wood combustion, emit it as well. EPA continues to study the relationship between ambient levels of black carbon and diesel emissions to assess the effectiveness of this type of indicator monitoring. Although the Aethalometer will not specifically measure diesel-related black carbon, it potentially can be used with other supportive information (e.g., meteorology, measurement of other toxic pollutants like PAHs, and traffic patterns) to assess the impact of diesel emissions.

The more widely used Aethalometer is the 880-nm single-beam Aethalometer, which has an estimated detection limit of 0.05 $\mu g/m^3$ black carbon for a 5-minute average. Because no black carbon or elemental carbon particulate standards are available for use in calibrating this monitor, only flow rate calibration using a NIST-traceable device is possible. Technical guidance can be found in the NATTS document found at http://www.epa.gov/ttn/amtic/airtxfil.html.

7.3.9 Surface and Upper Air Meteorology

Until 2006, meteorological monitoring has never been required of SLTs other than the requirements existing for PAMS sites. This fact changed with the revisions to the ambient air monitoring regulations promulgated on October 17th, 2006 (40 CFR Parts 53 and 58). According to Part 58, NCore sites are required to measure "basic meteorology," which is further defined in Part 58, Appendix D, Section 3b as temperature, Relative Humidity (RH), wind speed, and wind direction. These measurements will be obtained through a variety of methods options described in the guidance provided in "Quality Assurance Handbook for Air Pollution Measurement Systems," EPA-454/D-06-001, October 2006. This document, also known as QA Handbook Volume IV, can be found at http://www.epa.gov/ttn/amtic/met.html. This QA Handbook Volume IV is provided purely as guidance, but is considered up to date (as of 2008) and covers the issues that SLTs will likely encounter as they create or enhance their meteorological monitoring capabilities. These methods include sonic anemometers, traditional anemometers, temperature sensors, hygrometers, pressure sensors, precipitation gauges, solar irradiance sensors, and upper-air monitoring systems. The document also covers siting issues and provides QA suggestions for NCore sites and other non-NCore sites.

Upper air meteorology is only required through the PAMS program, although upper air meteorological data has been found to be very useful to model applications, data analysis, and air quality forecasting as well. Besides the lack of a common data acquisition and storage paradigm among stakeholders, one of the main issues lie with the sheer cost of acquiring and maintaining upper air systems. The primary upper air methods in use by SLTs are Radar Wind Profilers (RWPs) and rawindsondes, with a few other methods in use including Sonic Detection and Ranging (SODAR) and Radio Acoustic Sounding Systems (RASS). In some cases, SLTs may utilize upper air data from other programs, such as the data produced by the National Weather Service or other National Oceanic and Atmospheric Administration groups. EPA recognizes that there are some SLT groups and other atmospheric science programs investigating alternative upper air measurement systems that may eventually develop into effective and possibly more economical methods for gathering upper air meteorological data that would be useful to SLT and EPA air quality management programs. These developments include the use of Doppler Light Detection and Ranging (LIDAR), microwave radiometetry, and the use of laser based ceilometers to variably aid in determining boundary layer heights, and in the case of the LIDAR, estimates of wind speed and direction at height. EPA plans to continue to work with partner SLT and federal agencies to keep up to speed on the development of these alternative methods and watch to take advantage of opportunities to improve existing upper air measurement systems or even upgrade to newer systems if resources allow it.

7.4 IMPLEMENTATION PRODUCTS AND DELIVERABLES

Technical method guidance documents have been prepared to guide monitoring agencies in the proper installation and operation of high sensitivity CO, SO_2, and NO/NO_y, analyzers. This method guidance provides information on the setup, installation, configuration, operation, and calibration of these instruments. In addition, the SOPs that have been prepared for EPA's on-site operation of these types of equipment are available at http://www.epa.gov/ttn/amtic/precur.html.

The implementation of new measurement methods will require additional training. Training has and will be provided by EPA, equipment manufacturers, and experienced SLT monitoring agencies. EPA uses a variety of mechanisms for both formal and informal training, including workshops, video training, technical assistance, and guidance documents, to provide training and assistance to monitoring agencies. EPA utilizes its Ambient Monitoring Technology Information Center (AMTIC) website at http://www.epa.gov/ttn/amtic to disseminate information and guidance documentation to the public. Further, as of September 2008, EPA/OAQPS has provided ten "Precursor Gas Training Workshops," with one or two more workshops to be provided through 2009.

7.5 COLLABORATING EFFORTS REGARDING NEW TECHNOLOGY IMPLEMENTATION

EPA recognizes that cross coordination within the agency and with external stakeholders such as SLTs and RPOs is critical in any effort to successfully introduce and implement new monitoring technologies. The outstanding example of this concept is the ongoing collaboration in the development of the novel denuder for ammonia and possibly nitric acid in the CSN between various offices within EPA and the outreach that is to occur with SLTs to pilot this novel method. Other opportunities for methods development collaboration exist for true NO_2, continuous ammonia, continuous PM speciation, and possibly for new Pb methods. EPA plans to continue and increase its collaborative efforts both internally and externally to identify, evaluate, advance, and potentially implement new monitoring technologies.

8. MONITORING NETWORK MANAGEMENT AND COMMON ELEMENTS

8.1 REGULATORY FRAMEWORK

EPA promulgated three sets of regulations to provide the framework for monitoring agencies to conduct ambient air quality monitoring: 40 CFR Parts 50, 53, and 58. Part 50 applies to the NAAQS and the FRMs for each pollutant; Part 53 provides air quality monitoring equipment vendors with the application and testing requirements for FRM/FEMs; and Part 58 applies to ambient air quality surveillance. Parts 53 and 58 have been the primary focus of regulatory change needed to implement this Strategy.

The regulations set forth in CFR are only minimum requirements. SLTs can, and are encouraged to, exceed such minimums, and this Strategy is intended to be a tool to encourage that endeavor. Tribes, as separate sovereign entities, generally are not required to meet CFR, unless they want to use monitoring data to document NAAQS compliance or violation.

Monitoring regulation revisions are needed from time to time to remove potential obstacles in implementing the Strategy and to foster technically creative instrument approaches and measurement systems. The monitoring regulations remain the most authoritative guide for air agencies and will ultimately serve as the principal communications tool to convey many of the details of the Strategy to EPA's partners at the state and local levels. Regulatory topics that have been changed in the October 2006 CFR revisions include:

- A reconfiguring of the traditional SLAMS monitoring components with reduced number of single-pollutant monitoring sites and adoption of the NCore multi-pollutant site framework (40 CFR Part 58).
- New minimum requirements in criteria pollutant monitoring to enable action on results from network assessments and the continuous PM monitoring implementation plan (40 CFR Part 58).
- New provisions for $PM_{2.5}$ monitoring, including new performance-based criteria for FEMs (40 CFR Parts 53) and ARMs (40 CFR Part 58).
- Revised PAMS monitoring requirements to emphasize accountability as a primary objective and to reduce non-Type 2 sites (40 CFR Part 58).
- Restructured QA requirements (40 CFR Part 58).
- Revised national equivalency specifications for $PM_{2.5}$ and expected $PM_{10\text{-}2.5}$ that will be based on updated DQOs and structured to accommodate continuous technologies (40 CFR Part 53).

Even in light of the recent CFR revisions, the review and revision of these regulations is an ongoing process. EPA has recently renewed its commitment and responsibility to review all of the criteria pollutant NAAQS on a five year cycle. As a result EPA has established a general schedule by which its review processes will occur, with many of these processes being court-ordered. The current NAAQS revision schedule is shown in Table 8-1.

Table 8-1. Ongoing NAAQS Review Schedules as of November 2008.

MILESTONE	POLLUTANT						
	Ozone	Lead	NO_2 Primary	SO_2 Primary	NO_2/SO_2 Secondary	PM	CO
Notice of Proposed Rulemaking	Jun 20, 2007	May 1, 2008	May 28, 2009	Jul 30, 2009	Feb 12, 2010	Jan 2011	Oct 2010
Notice of Final Rulemaking	Mar 12, 2008	Oct 15, 2008	Dec 18, 2009	Mar 2, 2010	Oct 19, 2010	Oct 2011	May 13, 2011

Note: Underlined dates indicate court-ordered or settlement agreement deadlines.

8.2 PLANNING AND ASSESSMENT

State and local agencies have always reviewed and made changes to their networks from time to time. As a result, the networks are ever-changing to meet more current needs. However, for many years no concerted efforts were made to look critically at monitoring sites to determine if there were redundancies and inefficiencies in network designs. Furthermore, networks were traditionally laid out in increments as new needs arose, such as an ozone network, a CO network, a PM_{10} and $PM_{2.5}$ network, an atmospheric deposition network, a visibility network, and so forth. Each new pollutant-specific network often for logistical reasons made use of sites established earlier for other pollutants, but not necessarily with much explicit thought to cross-pollutant considerations.

In 2000, EPA commissioned a national assessment of the SLAMS networks, with considerations for population, pollutant concentrations, pollutant deviations from the NAAQS, pollutant estimation uncertainty, and the area represented by each site. This national assessment indicated substantial reductions in monitors could be made for pollutants that are no longer violating NAAQS on a widespread basis. Next, each of the ten EPA Regional Offices was charged with conducting regional assessments of the SLAMS networks. This process began in early 2001. The monitoring network changes that have happened since 2001, and the changes proposed in this Strategy, reflect many of the findings of both the regional assessments and the 2000 national assessment.

EPA subsequently developed standardized guidelines for these assessments (available at http://www.epa.gov/ttn/amtic/cpreldoc.html).

In the revised regulation in 40 CFR Part 53 and 58 EPA affirmed the importance of network assessments and proposed that these assessments be performed on a five year cycle. The first round of these assessments has a deadline of July 1, 2010. The primary objectives of the network assessments are to ensure that the right parameters are being measured in the right locations, and that network costs are kept at a minimum. Related secondary objectives include:

- Identify new data needs and associated technologies.
- Increase multi-pollutant sites versus single-pollutant sites.
- Increase network coverage.
- Reduce network redundancy.
- Preserve important trends sites.
- Reduce manual methods in favor of continuous methods.

EPA intends that the network assessment process be a collaborative effort between EPA and monitoring agencies. EPA plans to provide analyses and tools to the State and Local agencies to aid them in the assessments. EPA has already developed standardized guidelines and examples for the data analysis needed to complete some aspects of the assessments (available at http://www.epa.gov/ttn/amtic/cpreldoc.html). EPA also plans to develop software tools that will conveniently create graphics and tables for monitor location statistics, pollutant trends, and various other metadata which could be included in individual states' network assessment documents. Additionally, EPA plans to analyze some of individual pollutant monitoring networks across the entire U.S. to quantify the information value of individual sites; this analysis would be available to the States and Local agencies as a starting point for their own assessment and network redesign work.

8.3 DATA ACCESS

Over the past several years, one of the most important emerging uses of ambient air monitoring data has been public reporting of the Air Quality Index (AQI). This effort expanded on EPA's AIRNow website (http://www.airnow.gov) from regional-based, near real-time ozone mapping products that are color-coded to the AQI, to a national, multi-pollutant mapping, forecasting, and data handling system of real-time data. Since ozone and $PM_{2.5}$ are the principal contributors to the highest reporting of the AQI in most areas, these two pollutants are the primary parameters with comprehensive reports from AIRNow. While other pollutants such as CO, SO_2, NO_2, and PM_{10} may not contribute significantly to the AQI, they are still important for forecasters and other data users to understand for model evaluation and tracking of air pollution episodes, and can also be submitted to AIRNow-Tech (http://www.airnowtech.org), AIRNow's behind-the-scenes companion web tool. Therefore, this Strategy seeks to encourage sharing all continuous monitoring data, nationwide, in near real-time when possible.

An objective of this Strategy is to enhance access to ambient air monitoring data. Within resource constraints, EPA's ongoing approach will be to make available more timely and effective data than are currently available. EPA is already addressing these issues with a variety of approaches emerging from a long-range OAQPS planning effort such as the "data warehouse," as well as inter-office collaboration with the EPA's Office of Environmental Information (OEI).

Another effort is underway to make all measured (versus reduced) data in AQS available on demand, allowing a customer to extract a data file based on his or her selection of geographic area, time frame, and pollutants of interest. A subsequent addition of the timelier AIRNow data (including QA caveats) would provide enhanced data delivery.

Another goal is to make detailed air quality data summaries available to anyone at any time by offering a variety of self-service tools to access the data. Currently, web pages exist that allow querying of annual summary information; and air quality professionals can access any data in the system. The relevant databases and tools are being upgraded to enable public availability of daily summary information through Internet access. EPA is also beginning to make data available for existing commercial visual tool applications, such as .kml files for displaying data in applications such as Google Earth. The timeliness of this information also will improve as EPA reduces the time necessary to process data before making them available to the public and its external partners. Some of the current web-based access portals to data are:

AirExplorer: http://www.epa.gov/airexplorer/

AirData: http://www.epa.gov/oar/data/

VIEWS: http://vista.cira.colostate.edu/views/

Where You Live: http://www.epa.gov/air/emissions/where.htm

Finally, the collaboration with OEI offers the longer range potential to merge multimedia data sets that could be used, for instance, to support ecosystem assessments. EPA will continue to examine those responsibilities and to broaden its outreach efforts beyond traditional SLT partners to key consumer communities, such as academia, public health organizations, and the private sector, to ensure delivery of effective products and services as recommended by the CASAC Subcommittee.

8.4 DATA ANALYSIS

An effective monitoring program must include an appropriate analysis and interpretation component. Without that component, the value of collecting the monitoring data is diminished. EPA acknowledges the need to improve archival processes, as well as access to and analysis of air quality data. By allotting resources annually to data analysis and interpretation, sufficient funding would be available to make adequate use of the data, enhance information transfer, and provide a higher order of QC and network assessment that emerges from data reviews and analysis. A specified resource allotment would require an integrated perspective across pollutant categories and could serve as a catalyst for numerous local and other specific, topic-based analyses.

8.4.1 Regular Analysis for Status and Trends of Criteria and Toxic Air Pollutants

The large amount of data being collected in the monitoring networks, along with important supplementary data (e.g., meteorology, remote sensing, and QA data), will allow air program managers to adjust ongoing activities/decisions and explore new aspects of air pollution as they occur. For these data to be useful for managers, they must be analyzed on a regular basis for a complete set of measures, including detailed characterizations and specific progress or trend measures. In parallel, and perhaps more importantly, a "tool set" to facilitate analysis should be developed to deliver data on annual, seasonal, near-term, and real-time bases for various air pollutants across various spatial domains. The products would be based on a variety of techniques, from the computation of simple temporal trends at an individual monitoring site to maps depicting concentrations surfaces using complex spatial interpolation, and would be useful at the national, regional, state, local, and Tribal levels. This "tool set" approach would develop, for the entire air program, a set of analytical products analogous to those developed for the visibility program (e.g., VIEWS website http://vista.cira.colostate.edu/views/ developed by the RPOs). A "dashboard" website would be needed to view regular updates and provide access to useable products; thus, automation of the basic tool set would be needed. In addition to the basic tool set, an automated approach would allow expansion of the tool set as special studies produce operational techniques, and would be useful in identifying unusual air quality events to study or address in the context of public health tracking.

8.4.2 Special Studies on Technical and Policy Relevant Topics

Monitoring and air quality data (technical and analytical) uncertainties and limitations may affect policy decisions. These topics should be investigated through special studies that rely on ambient monitoring data and would include a number of topics. An assessment of major programs (and their effectiveness), such as the NO_x SIP call, the 2005 CAIR (now vacated), and other approaches to reduce ozone concentrations, would be undertaken to provide insights into these programs, with the potential to adjust those programs periodically. An investigation of multiple pollutants affected by independent control program elements (e.g., PM, ozone, air toxics) would advance the ability to "co-control" pollutants and avoid shifting air quality problems across programs (e.g., increasing air toxic emissions in response to VOC controls). A thorough study of "exceptional" and "natural" events is needed to provide a factual basis for the proper exclusion of data from program decisions. Along these lines, source attribution studies would be undertaken to inform regional and specific issue decisions. In addition, studies to evaluate the quality and uncertainties associated with collected data and special characterization of monitoring sites would be undertaken, and the collective information would provide dynamic feedback into network design.

8.4.3 Building Air Quality Data Analysis Tools and Capacity

Broadening the capacity for analyzing air quality data facilitates greater engagement, and adds analytical and QA power to the entire network measurement and design process. With expanding detail in monitoring data and the need to understand air quality issues better, analytical tools have become complicated to use. Backward trajectory and source apportionment techniques and assimilation of satellite and monitoring data have great potential to advance the ability to understand the progress of the national efforts to address air quality problems. Guidance is needed for a range of applications including network assessments and design, emission inventory and model evaluation, conceptual model building (i.e., genesis and attributes of air quality problems), and observational models (e.g., source attribution and emissions strategy tools), as well as a spectrum of more direct regulatory problems. As special studies are completed by EPA, SLT, and regional analysts, there will be a need to develop new operational tools for the analytical techniques developed within the study. Accordingly, "how-to" instructions to aid in the use of existing and new tools would be developed and distributed. Specific tools would be developed, evaluated, and otherwise made available, as the need arises, to provide the analytical capacity to implement air programs. Efforts to bring knowledge developed within the research communities to practicing analysts would be undertaken. For example, an annual conference and a virtual homepage for air quality data analysts could be developed to facilitate communication among analysts for expanded understanding of tools and exchange of ideas on monitoring and data analysis topics.

8.5 FUNDING ISSUES

This section provides information on resources for the strategy, including background and an overview of funding and how resource allocations are made in support of the ambient air monitoring program.

8.5.1 General Funding Issues

One of the main themes in this strategy is to plan out investments and divestments with an assumption that resources available to support the ambient air monitoring program will be stable. However, at both the Federal level and within State and local agencies, resources may actually be declining or possibly eroding due to inflation. For instance, even with level funding, pre-negotiated competitive contracts used as part of Associated Program Support (APS) (e.g., the filter contract) rise in cost each year, thus fewer funds are available for direct grant award to State, local and Tribal agencies. Despite this kind of limitation, and others like it, EPA and its partner monitoring agencies must ensure that ambient air monitoring programs continue to deliver high quality data valued by customers for use in a variety of assessments. By providing high value and high quality data the ambient air monitoring community creates support among its customers and ensures the long-term stability of the ambient air monitoring program. The steps necessary to ensure investment in high value monitoring and divestment of low value monitoring are complicated by a number of factors; however, many agencies have been able to successfully optimize their network over the last several years through a number of mechanisms. The sections below provide a summary of how resources are prioritized and allocated for use in support of the ambient air monitoring networks. Program information for several of the national networks is described in the section under Specific Funding Issues.

Generally, this strategy implies moving resources from programs of decreasing value to those of higher value, consistent with the principles presented in Section 1 (respecting the strong partnership across EPA and monitoring agencies, retaining stability for the monitoring programs, and accommodating SLT flexibility). Although not guaranteed, the strategy assumes that resources will remain level, with no significant decrease in funding to support ambient monitoring initiatives. This "zero-sum" constraint implies a reconfiguration of monitoring networks. This approach contrasts with the process of expanding networks significantly with the deployment of the PAMS and $PM_{2.5}$ networks throughout the 1990s and early 2000s, respectively.

The early strategy discussions evoked a concern that any change in the networks, especially a thinning in monitoring sites, would result in a reduction in resources and serious degradation of monitoring agencies. Despite these concerns and overall government budget uncertainties, EPA seeks to allay lingering concerns by stressing the importance of retaining stable funding as a basic operating principle, and by emphasizing a reallocation of skill mix (from labor to technical) and measurement approaches. Retaining a stable funding base for monitoring agencies and tribes is of paramount importance among numerous resource concerns. Although many environmental assessment initiatives are based on short duration efforts (1-3 years), effective ambient monitoring practice requires a longer, stable operation that can capture gradual signal changes in atmospheric concentrations over decades. Those operations must maintain and enhance a substantial infrastructure. Both the cost-effectiveness and technical credibility of monitoring operations are compromised if operated in a cyclical "ramp up, ramp down" mode. As implementation of concepts highlighted in this strategy continues, funding and priority decisions must continuously balance the desire for network responsiveness and flexibility with maintaining the necessary stable operations needed for long-term ambient assessments.

Consistent with these goals and operating principles, implementation plans may need to include a variety of funding shifts within the current program structure. These shifts would require consensus building if there is no explicit pool of new resources. The basic shift of moving resources from filter-based methods to continuous and single pollutants stations to highly leveraged collocated or multi-pollutant stations is relatively straightforward, although it requires a substantial communications and training effort (i.e., operation of high-sensitivity gas measurements).

8.5.2 Background – Funding Authority

Over the last several decades, federal legislation involving ambient air has evolved from general recognition of air quality issues to specific roles and responsibilities for how federal and state and local governments cooperate in managing air quality. Recognizing the need to accelerate improvement in air quality, EPA and its predecessor agency, were tasked through legislation (CAA 1963) with providing grants for establishing and expanding state and local air quality programs. These grants have evolved over time to the existing legislation re-authorized in the clean air act amendments of 1990. In this legislation, EPA is authorized under §103 and §105 to provide grants to state and local agencies to support a number of activities including monitoring. For monitoring, grants provided under §103 are generally used to implement new monitoring programs that provide information for uses beyond the NAAQS, including research, development, and testing of methods, monitoring, analysis, and modeling of air pollutants[6]. §103 grants are provided with no funding match requirements, while those under §105 are used to support on-going programs with a requirement that at least 40 percent of the cost of the overall program be supported by the recipient agency. Grants to State and local agencies utilizing funds from §105 are authorized for implementing programs for the prevention and control of air pollution or implementation of NAAQS. These §105 grants are often provided as part of a performance partnership agreement (PPA) or performance partnership grant (PPG) covering a variety of program elements beyond monitoring (examples of other major program elements include emission inventory development, modeling, SIP development, inspection and maintenance programs, and source permitting). Since these §105 grants cover a variety of program elements and grant funding is not specifically tied to ambient air monitoring, EPA and state and local agencies must work cooperatively to prioritize resources from within these grants as well as matched funding by the receiving agency to new and emerging ambient air monitoring needs.

Non-federal funding for state and local agencies is typically provided as part of a larger budget allocation for state or local government environmental commissions with many competing needs. In some cases agencies have dedicated funding streams that provide sufficient resources for §105 grant matching requirements. In other cases agencies are barely able to sustain the match each year due to limited or declining funding. Regardless of the funding status, state and local agencies must work closely within their own programs to identify and communicate how products from ambient air monitoring systems are of value to the level of government supporting the program.

8.5.3 Funding Planning and Cycles

At any given time, EPA and partner state and local agencies are managing or planning approximately 3 years worth of budgets. EPA operates on the federal budget cycle with the fiscal year starting on October 1 and running through September 30. State and local agencies often operate on cycles associated with their own state or local government budget, which usually lag the federal budget cycle by 3 to 9 months. This sub-section explains each of the three budget cycles as part of the federal budget planning and how they relate to monitoring:

- Out-year planning of EPA's budget including funds for use in §103 and §105 is typically performed 2 to 3 years in advance of the current federal fiscal year. This planning involves senior resource officials within EPA and the Office of Management and Budget (OMB). EPA and OMB work together to meet budget targets and priorities consistent with the EPA's strategic plan (see:

[6] Note: $PM_{2.5}$ funding is a special case in that EPA has either asked for or been directed by Congress to utilize §103 funds for this network since its inception.

http://www.epa.gov/ocfo/plan/plan.htm). The strategic plan includes five major goals. These goals are Clean Air and Global Climate Change, Clean and Safe Water, Land Preservation and Restoration, Healthy Communities and Ecosystems, and Compliance and Environmental Stewardship. Thus, ambient air monitoring falls within the goal of Clean Air and Global Climate Change. Targets for grant funds under §103 and §105 are included in the budget planning. It should be noted that State and Tribal Assistance Grants (STAG) planning numbers for state and local programs is detailed separately from tribal air programs in budget planning.

- Detailed planning for the next fiscal year normally takes place in the winter of the current fiscal year with the development of the National Program Manager (NPM) guidance document. The NPM guidance document provides EPA's Regional offices, the states and tribes with guidance on specific priorities and implementation strategies planned for the coming year. Each year, EPA works to incorporate the priorities and themes such as those presented in this strategy document on ambient air monitoring for inclusion in next years NPM guidance. The guidance typically includes a detailed breakdown of expected regional office distributions and associated program support (e.g., purchase of filters) for programs with specific funding allocations (e.g., $PM_{2.5}$ and Air Toxics monitoring). The NPM guidance is often complicated by the timing of its development in that the overall funding targets are usually not yet announced as they are part of the Presidents budget request to congress[7]. The NPM guidance is typically issued as a draft in mid-February with a call for public comment. Multi-state organizations, the National Association of Clean Air Agencies (NACAA) and individual SLT air agencies usually offer their input on how to best prioritize available resources within each specific monitoring program that receives dedicated funding. In late April, EPA provides final NPM guidance in consideration of the input received in the public comments and the available resources targeted in the Presidents budget request.

- In the current fiscal year, EPA normally expects to have a distribution of funds according to a budget approved by Congress and signed into law by the President. Funds are distributed to the regional offices consistent with the NPM guidance, unless there are differences between the funded amount and the funds identified in the NPM guidance. In this later case EPA consults with states and provides a distribution as directed in the appropriation and in consideration of the earlier NPM guidance and the states' input. Funds distributed to the EPA regional offices are used for negotiations of direct awards to recipient agencies as part of

[7] The draft guidance and allocation issued in February are based on preliminary budget information that are prepared in Nov-Dec. The budget released by the President in February of each year will likely be somewhat different, and EPA is not aware of those differences until the budget is released in February. So, although the draft guidance/allocation and President's Budget are released within a few weeks of each other, the guidance and allocation does not reflect the information in the President's Budget.

§103 and §105 grants. Although federal grant funds would ideally be available for distribution before or at the beginning of a federal fiscal year (October 1) it can often run several months in the year before these funds are fully available. In the later case recipient agencies are typically provided incremental funding as available from a continuing resolution.

8.5.4 Internal EPA Funding

EPA-led monitoring programs and initiatives use a variety of EPA funding resources, including Science and Technology (S&T) budget funds and Environmental Program Management (EPM) funds. The availability of these funds is shrinking at a rate substantially faster than overall budget decreases due to fixed costs associated with the uses of these funds in other parts of the air and research programs. The types of monitoring activities funded through internal EPA resources can be broken down into three distinct areas associated with the three EPA offices most strongly connected to ambient air monitoring:

- Tools and supporting information provided by the Air Quality Assessment Division's Ambient Air Monitoring Group (AQAD-AAMG) in OAQPS support the ambient air monitoring program with a focus on criteria pollutants, their precursors and composition (e.g., PAMS and the CSN), and Air Toxics. The main focus of the AAMG work is to support planning and implementation of SLAMS and Tribal Air Monitoring Stations (TAMS) and the ongoing coordination with the National Park Service for operation and support of the IMPROVE network; which is closely connected to the work in $PM_{2.5}$ monitoring. The AAMG competes for internal EPA-OAQPS funds to support development of a number of tools and products that help to maintain and enhance the ambient air monitoring program. Recent examples of tools and products developed with these funds include: Data Quality Objectives (DQO's) for measurement systems used in the ambient air monitoring program; Standard Operating Procedures (SOP's) for operation of high-sensitivity gas monitor used in the NCore network; and a Technical Assistance Document (TAD) for the high-sensitivity gas monitors used in the NCore network. EPA's ambient air monitoring program will continue to work to develop tools and supporting documents to enhance the ambient air monitoring program with both internal (the technical staff) and contract resources.

- Management of the Clean Air Status and Trends Network (CASTNET) and technical support and coordination of other deposition networks such as the National Acid Deposition Network (NADP) and the emerging mercury deposition network (MDN) are provided by EPA's Office of Atmospheric Programs' Clean Air Markets Division (OAP – CAMD) in Washington D.C. Many SLT agencies are partner agencies in the operation and use of data from these networks. For most networks, OAP-CAMD provides the overall coordination and tool development of methods and data management. In many cases additional monitoring stations are operated on a voluntary basis by SLT agencies where the operating agency provides in-kind assistance in the operation of station and "buys" into the analysis protocol provided through a national contract. National support activities are supported through internal EPA resources.

- Planning and execution of short term research studies are provided by a number of laboratories in EPA's Office of Research and Development (EPA-ORD). Examples of recent work in this area include the near-road research study and the Detroit Exposure and Aerosol Research Study (DEARS). Resource prioritization for research studies is conducted through ORD as part of the offices research planning work across multiple media and labs. ORD also provides operation of the Reference and Equivalency (R&E) program. The R&E program provides designation of FRM or FEM methods used by SLT monitoring agencies at SLAMS stations used in comparison to the NAAQS.

EPA operates a number of activities and programs that can be utilized by the collective federal and SLT ambient monitoring entities to leverage resources. Over the last several years, EPA and SLT agencies have worked to develop or enhance methods and data management though these programs and dedicated grant activities. The following list provides a summary of the opportunities each of the activities, programs or grants can provide with a web address for those interested in more information.

- EPA's Small Business Innovation Research (SBIR) Program offers an opportunity for the EPA program and regional offices to describe the kinds of technology that is need to be developed to support air programs. This program has been successful in the past in leading to new developments in methods such as the Filter Dynamic Measurement System (FDMS). For more information see: http://es.epa.gov/ncer/sbir/

- EPA's Environmental Technology Verification (ETV) Program includes the Advanced Monitoring Systems Center which is operated in cooperation with Battelle. This center verifies the performance of commercial-ready technologies that monitor contaminants and natural species in air, water, and soil. The center tests both field-portable and stationary monitors, as well as innovative technologies that can be used to describe the environment (e.g. site characterization). This center is also part of the Environmental Technology Assessment, Verification and Outcomes staff, which is under EPA's National Risk Management Research Laboratory. See: http://www.epa.gov/nrmrl/std/etv/center-ams.html

- EPA's Office of Environmental Information (OEI) manages the Exchange Network Grant Program which provides funding to states, territories and federally recognized Indian tribes to support the development of the Environmental Information Exchange Network. Now in the sixth year, EPA has received approximately $105 million in federal appropriations for the grant program. All states, the District of Columbia, four territories, and more than 40 tribes have received grants and have been involved in the development of the Exchange Network. See: http://www.epa.gov/exchangenetwork/

8.5.5 Specific Funding Issues

Section 103 Versus 105 Funding

Monitoring operations performed by air programs are supported by §103 and §105 STAG funds as well as additional support, when available, through the SLT's own programs. Generally speaking, the use of §103 ensures that specific activities written into the grant are performed, while the use of §105 provides for more flexibility on the part of the recipient to move resources to the highest priorities within their program. The sub-units within state and local agencies responsible for conducting monitoring tend to favor the §103 funds, as they clearly are earmarked to support monitoring activities. Given the overall change implied by the strategy, it is imperative that a solid base of §103 resources serve as a basis for supporting both the stability of monitoring agencies as well as the needed change in monitoring approaches.

$PM_{2.5}$

§103 STAG funds have supported the ongoing operations and maintenance of the $PM_{2.5}$ network. The majority of resources have supported $PM_{2.5}$ FRM measurements, collection and analysis of chemical speciation data, and measurement of the $PM_{2.5}$ continuous mass.

The focus of the networks should continue to evolve toward characterizing the air quality impacts of national air quality-related programs and State Implementation Plans (SIPs) (i.e., for measuring accountability), providing an infrastructure for public health advisories (AQI through AIRNow.gov), and supporting health effects and exposure studies that feed into periodic evaluation of health standards. Accordingly, resources need to be shifted to assess the progress of implementation plans to ensure that the billions of dollars in resources required to reduce $PM_{2.5}$ levels are reaping observable benefits. And, in the event progress is not being achieved as planned, the networks must be able to support restructuring or "mid-course" corrections over the next 10 to 20 years.

Consequently, the funding base needs to be reconfigured to be consistent with that design, which will lead to divesting in areas of the current $PM_{2.5}$ monitoring system that have served their current primary objective. EPA's implementation approach will be to shift FRM and speciation program resources to continuous and multi-pollutant measurement systems. This proposed resource shift should address most resource requirements to reconfigure the SLAMS, and possibly other federally run networks. The current resources would be redirected to

- Add more approved FEM continuous $PM_{2.5}$ monitors;
- Enhancing continuous speciation on a limited basis;

- Support the NCore multi-pollutant sites including high-sensitivity gases and basic and where appropriate advanced meteorology;
- Identify common areas and goals between SLAMS and other federal networks, in order to mutually leverage resources;
- Enhance the IT infrastructure in the networks and the capital expenditures for hardware and site improvements to accommodate additional samplers and NCore sites; and
- Support training and QA needs arising from modification of network operations.

$PM_{10\text{-}2.5}$ Monitoring

Although no $PM_{10\text{-}2.5}$ standards (a.k.a. PM coarse) evolved out of the proposed revisions to the monitoring regulations that were promulgated in October 2006, $PM_{10\text{-}2.5}$ is required at NCore sites. EPA expects that new continuous technologies could be used to measure $PM_{10\text{-}2.5}$ with attendant capital, operational, and training expenses. Divestment in operator time for related programs such as PM_{10} should provide an available workforce for the required $PM_{10\text{-}2.5}$ monitoring.

PAMS

PAMS requirements have been scaled down to allow more specific special studies of interest by local areas/regions. A wealth of data has been collected from the PAMS program, but analysis and interpretation of the data in some cases has been less frequent and systematic than EPA believes is appropriate. To address this gap and yield value from the PAMS databases, EPA has already proposed to set aside some of the PAMS-related funds to conduct data analysis. Ideally, this funding should be combined with additional data analysis resources set aside for air toxics and $PM_{2.5}$.

Quality Assurance

Over the course of deploying the $PM_{2.5}$ network, EPA and state and local agencies reached agreement on utilizing Section 103 STAG funds to support the $PM_{2.5}$ Performance Evaluation program; which is the national level QA program enabling EPA to develop estimates of FRM performance. The rationale for using STAG funds was predicated on the premise that such QA was a required element of the program, and it was more efficient to manage the program nationally through EPA. However, agreement was reached that STAG funds are taken off the top for SLTs opting into the EPA managed Performance Evaluation Program (PEP) for $PM_{2.5}$ and the National Performance Audit Program (NPAP), while prorated funds are returned to SLTs who opt to use their own independent audit programs.

Data Analysis

This strategy also recommends more explicit designation of STAG funds to support data analysis. This approach follows the model established early in the air toxics monitoring program. The same issues discussed under QA apply here in an attempt to address an important gap in the monitoring programs. The actual data analysis may be performed at the state level by state and local agencies or at a regional/national level. In the latter case, EPA, multi-state organizations, and states would establish the mechanisms and resource commitments for allocating STAG funds to the analyses. Assuming consensus is generated to dedicate STAG funds to data analysis, a series of administrative questions remains regarding how such a program is carried out. Possible scenarios include establishing a management team of SLT/EPA members, or charging EPA or a multi-state organization with this task, with the possibility of rotational turns for lead responsibility.

8.6 GUIDANCE, TRAINING, AND PILOT EFFORTS

Implementation of this Strategy requires guidance and training for SLT staff. The primary areas for these outreach efforts are in assisting with new measurement methods, new QA and data analysis approaches, new information technologies, and pilot projects to support network deployment activities. The majority of the resources allocated to training and guidance will be directed toward the technical topics. These topics lend themselves to variety of training mechanisms:

- Satellite Broadcasts and Videos. These media can provide broad to semi-detailed information about a topic and be used to provide initial exposure to the area, concepts, and rationale for the direction or procedure, time line for implementation, and sources of more detailed information and training. These formal presentations of the topic areas are under development and are available in the topic specific areas for download on the AMTIC website (http://www.epa.gov/ttn/amtic).
- Hands-on Sessions. Formal detailed instruction in a particular topic area.
- Guidance Documents. Written guidance providing the necessary detail for an area when possible and generic guidance and suggestions when more than one alternative exits.
- Vendor. Training provided by particular vendors of instrumentation or information technology systems.
- Web-based training. Training developed through software that can be posted on the internet.
- Workshops. National, regional, or local workshops where various training activities could be presented.

EPA has already distributed a technical assistance document on the precursor gas monitors that will be part of NCore multi-pollutant sites (See TAD for Precursor Gas Measurements in the NCore Multi-pollutant Monitoring Network, Version 4,U.S. Environmental Protection Agency, EPA-454/R-05-003, September 2005, available at: http://www.epa.gov/ttn/amtic/pretecdoc.html) and has created SOPs (available at http://www.epa.gov/ttn/amtic/precur.html). While Tribes are not subject to the requirements of the proposed monitoring amendments, these technical resources are meant to assist all air monitoring agencies. Further, Tribes have additional training support from EPA and via grantees, notably through ITEP and the TAMS Center.

APPENDIX A

ACRONYMS AND ABBREVIATIONS

AAMP –Ambient Air Monitoring Program
AIRS – Aerometric Information Retrieval System
AIRMoN –Atmospheric Integrated Research Monitoring Network
ALAPCO – Association of Local Air Pollution Control Officials
AMTIC – Air Monitoring Technology Information Center
ANPR – Advanced Notice of Proposed Rulemaking (
APTI – Air Pollution Training Institute
AQI – Air Quality Index
AQS – Air Quality (data) System
AQRS – Air Quality Research Subcommittee
ARM – Approved Regional Method
BAM – Beta Attenuation Monitor
CAA – (Federal) Clean Air Act
CAC – Correlating Acceptable Continuous (monitor)
CAIR – Clean Air Interstate Rule
CASAC – Clean Air Science Advisory Committee
CASTNET – Clean Air Status and Trends Network
CBSA – Core Based Statistical Area
CENR – Committee for Environment and Natural Resources
CEU – Continuing Education Unit
CFR – Code of Federal Regulations
CMAQ – Community Model Air Quality (system)
CO – Carbon Monoxide
CRPAQS – Central Valley (California) Regional Particulate Air Quality Study
CSN – Chemical Speciation Network
CV – Coefficient of Variance
CY – Calendar Year
DAS – data acquisition systems
DC – Direct Current
DEARS – Detroit Exposure and Aerosol Research Study
DHS – Department of Homeland Security
DMC – Data Management Center
DMS – data management system
DOE – Department of Energy
DOI – Department of Interior
DQA – Data Quality Assessment
DQI – Data Quality Indicator
DQO – Data Quality Objectives
EC – Elemental Carbon
EML – Environmental Measurements Laboratory
EPA – Environmental Protection Agency
ESAT – Environmental Services Assistance Team
FEM – Federal Equivalent Method
FLM – Federal Land Manager
FRM – Federal Reference Method
FY – Fiscal Year
GAO – General Accounting Office
GC – Gas Chromatograph
GIS – Geographical Information System
HAP – Hazardous Air Pollutants
HEI – Health Effects Institute
IACET – International Association for Continuing Education and Training
IADN – Interagency Deposition Network
IC – Ion Chromatography
ICR – Information Collection Request
IMPROVE – Interagency Monitoring of Protected Visual Environments
ITEP – Institute of Tribal Environmental Professionals
ITT – Information Transfer Technology
K – thousand
M – million
MANE-VU – Mid-Atlantic/Northeast Visibility Union
MDN – Mercury Deposition Network
NAAMS – National Ambient Air Monitoring System
NAAQS – National Ambient Air Quality Standards
NAATS – National Ambient Air Toxics Sites (
NACAA – National Association of Clean Air Agencies
NADP – National Atmospheric Deposition Program
NAMS – National Air Monitoring Stations
NAPAP – National Acid Precipitation Assessment Program
NARSTO – North American Research Strategy for Tropospheric Ozone
NAS – National Academy of Science
NASA – National Aeronautics and Space Agency
NATTS – National Air Toxics Trends Stations
NAU – Northern Arizona University
NCore – The National Core Monitoring Network
NDIR – non-dispersive infrared
NIST –
NMHC – Non-Methane Hydrocarbons

NMSC – National Monitoring Strategy (or Steering) Committee
NO – Nitric Oxide
NO_2 – Nitrogen Dioxide
NOAA – National Oceanic and Atmospheric Administration
NO_x – Oxides of Nitrogen
NO_y – Reactive Nitrogen Compounds
NPEP – National Performance Evaluation Program
NPS – National Parks Service
NTN – National Trends Network
O_3 – Ozone
OAP – Office of Atmospheric Programs
OAQPS – Office of Air Quality Planning and Standards
OAR – Office of Air and Radiation
OC – Organic Carbon
OEI – Office of Environmental Information
ORD – Office of Research and Development
ORIA – Office of Radiation and Indoor Air
PAHs – polycyclic aromatic hydrocarbons
PAMS – Photochemical Assessment Measurement Stations
Pb – Lead
PBT – Persistent Bioaccumulative Toxics
PBMS – Performance-Based Measurement System
PE – Performance Evaluation
PEP – Performance Evaluation Program
PM – Particulate Matter
PM_{10} – Particulate matter with aerodynamic diameter less than 10 micrometers
$PM_{2.5}$ – Particulate matter with aerodynamic diameter less than 2.5 micrometers
$PM_{10-2.5}$ – PM_{10} minus $PM_{2.5}$
POP – Persistent Organic pollutants
ppb – parts per billion
PSD – Prevention of Significant Deterioration
QA – Quality Assurance
QAPP – Quality Assurance Program Plan
QC – Quality Control
QMP – Quality Management Plan
RADM – Regional Acid Deposition Model
REM – Regional Equivalent Monitor
RO – EPA Regional Office
ROM – Regional Oxidant Model
RPO – Regional Planning Organization
RTP – Research Triangle Park (North Carolina)
S & T – Science and Technology
SAB – Science Advisory Board
SAMWG – Standing Air Monitoring Working Group
SASP – Surface Air Sampling Program
SIP – State Implementation Plan
SLAMS – State and Local Air Monitoring Stations
SLTs – State, Local, and Tribal air monitoring agencies
SO_2 – Sulfur Dioxide
SOP – Standard Operating Procedure
SPM – Special Purpose Monitor
SRP – Standard Reference Photometer
SS – Supersite
STAG – State and Tribal Assistance Grant
STAPPA – State and Territorial Air Pollution Program Administrators
STN – Speciation Trend Network
Strategy – The National Air Monitoring Strategy
SVOC – Semi-Volatile Organic Compound
TAMS – Tribal Air Monitoring Support (Center)
TAR – Tribal Authority Rule
TBD – To Be Determined
TEOM – Tapered Element Oscillation Monitor
TIP – Tribal Implementation Plan
TNMOC – Total Non-Methane Organic Compound
TSA – Technical Systems Audits
TSP – Total Suspended Particulates
T-REX – Traffic-Related Exposure Study
UAM – Urban Airshed Model
USB – Universal Serial Bus
VOC – Volatile Organic Compound
XML – Extensible Markup Language