Technical Guidance for the Development of Tribal Air Monitoring Programs

Tribal Air Monitoring Support Center

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Tribal Air Monitoring Support Center
Las Vegas, Nevada

Foreword

The intent of this document is to help tribes gain a better understanding of the ambient air monitoring process and provide information on resources and tools that help to build and sustain an air quality program. This document includes the following information to help tribes plan, implement and assess their air quality program activities:

- steps for identifying goals and objectives for conducting air monitoring;
- information for planning and selecting the appropriate type of monitoring network including discussions of staffing, network design, monitor selection, quality system development and training;
- costs for operating a monitoring network, funding sources and resources for writing a grant proposal and work plan;
- implementation of monitoring networks;
- data acquisition, management and reporting, and
- data analysis and interpretation including information on modeling techniques.

The intended audience for this document are the tribal environmental professionals. The document has been assembled by a team represented by Tribes involved in monitoring, personnel from the Institute of Tribal Environmental Professionals (ITEP) and EPA Regional Office and Headquarters. EPA Staff who are involved in resource allocations, tribal air grant award and management, program evaluation, strategic planning of monitoring networks, and providing technical support to monitoring programs were asked to work on this project. State monitoring officials benefit from reading this document by improving their understanding of tribal goals and how EPA strives to help them meet them.

The document might be considered the "yellow pages" of information on ambient air monitoring. It is not intended to provide the details of each specific aspect of a monitoring program but it will provide the key attributes and web addresses that will lead to those details.

This guidance should also be considered a "living" document. As new environmental problems arise, as regulations change or as improvements are made in monitoring technology, this document will be revised changes. It is anticipated that the document will undergo a formal review and revision every 5 years with minor edits at any time. Therefore, comments and suggestions are encouraged at any time and should be emailed to the current OAQPS Tribal Air Coordinator listed at the following website: https://www.epa.gov/tribal-air/tribal-air-coordinators. This document and subsequent updates resulted from the Tribal Air Monitoring Steering Committee goal of providing resources to help tribal air programs succeed.

Disclaimer

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TAMS Steering Committee Members (2019)

Vallen Cook	Grand Portage Band of Chippewa
Lori Howell	Shoshone-Bannock Tribes
Carma Huseby	Leech Lake Band of Ojibwe
Mike Natchees	Ute Indian Tribe
Taylor Smoke	St. Regis Mohawk Tribe
Camille Quickbear	Sisseton Wahpeton Oyate
Darold Wallick	Pala Band of Mission Indians

TAMS Steering Committee Members (2018)

Joe Cebe	Forest County Potawatomi Community
April Hathcoat	Cherokee Nation
Craig Kreman	Quapaw Tribe of Oklahoma
Camille Quickbear	Sisseton Wahpeton Oyate
Kris Ray	Confederated Tribes of the Colville Reservation
Frank Spurgeon	La Jolla Band of Luiseño Indians
Shaina White	Inter Tribal Council of Arizona, Inc

Tribal Monitoring Organizations and Associations

Annabel Allison	Institute for Tribal Environmental Professionals
Pamela Atcitty	Morongo Band of Mission Indians
Ryan Callison	Inter-Tribal Environmental Council
Jon Castillo	Morongo Band of Mission Indians
Ken Cronin	National Tribal Environmental Council
Ruben Cu:k Ba'ak	Tohono O'odham Nation
Farshid Farsi	Institute for Tribal Environmental Professionals
Glenn Gehring	Institute for Tribal Environmental Professionals
Bill Grantham	National Tribal Environmental Council
Kevin Greenleaf	Kootenai Tribe of Idaho
Stephen Hartsfield	National Tribal Air Association
Christopher Lee	Institute for Tribal Environmental Professionals
Jay Littlewolf	Northern Cheyenne Tribe
Eric Nicolar	Penobscot Indian Nation
Tyler Moreis	Wampanoag Tribe of Gay Head (Aquinnah)
Lisa Reiner	Quinault Tribe

Melinda Ronca-Battista	Institute for Tribal Environmental Professionals
Emma Ruppell	Bishop Paiute Tribe
Julie Simpson	Nez Perce Tribe of Idaho
Doug Sternback	Makah Tribe
Kelcey Stricker	Pechanga Band of Luiseño Indians
Joy Wiecks	Fond du Lac Tribe

Environmental Protection Agency

Norm Beloin	Region 1
Motria Caudill	Region 5
Robert Coats	Office of Air Quality Planning and Standards
Mike Copeland	Region 8
George Dilbeck	Office of Indoor Air and Radiation
Tyler Fox	Office of Air Quality Planning and Standards
James Hemby	Office of Air Quality Planning and Standards
Phil Lorang	Office of Air Quality Planning and Standards
Tami Laplante	Office of Air Quality Planning and Standards
Nick Mangus	Office of Air Quality Planning and Standards
Julie McClintock	Office of Air Quality Planning and Standards
Laura McKelvey	Office of Air Quality Planning and Standards
Bill Nally	Region 6
Mike Papp	Office of Air Quality Planning and Standards
James Payne	Office of Air Quality Planning and Standards
Keith Rose	Region 10
Rich Scheffe	Office of Air Quality Planning and Standards
Joe Tikvart	Office of Air Quality Planning and Standards

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List of Abbreviations and Acronyms

AMDAS	Ambient Monitoring Data Analysis System
AQI	Air Quality Index
AQMG	Air Quality Monitoring Group
AQS	Air Quality System
BAM	beta-attenuation monitor
CAA	Clean Air Act
CAFO	concentrated animal feeding operation
CASTNET	Clean Air Status and Trends Network
CENRAP	Central Regional Air Planning Association
CFR	Code of Federal Regulations
CMAQ	Community Multi-scale Air Quality Model
CMB	chemical mass balance
CO	carbon monoxide
CV	coefficient of variation
DAS	data acquisition system
DQA	data quality assessment
DQOs	data quality objectives
EDO	environmental data operation
EPA	Environmental Protection Agency
EPM	Emissions Production Model
ESAT	Environmental Services Assistance Team
FCCS	Fuel Characteristic Classification System
FEM	Federal Equivalent Method
FRM	Federal Reference Method
GAP	General Assistance Program
GIS	geographical information systems
HAPs	hazardous air pollutants
ICR	information collection request
IHS	Indian Health Service
IMPROVE	Interagency Monitoring of Protected Visual Environments
IT	information technology
ITEP	Institute for Tribal Environmental Professionals
LEADS	Leading Environmental Analysis Display System
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MDN	Mercury Deposition Network
mg/m^3	milligrams per cubic meter
MQOs	measurement quality objectives
NAAMS	National Ambient Air Monitoring Strategy
NAAQS	National Ambient Air Quality Standards
NADG	National Air Data Group
NADP	National Atmospheric Deposition Program
NATA	National Air Toxics Assessment
NATTS	National Air Toxics Trend Stations
NCore	National Core Network

List of Abbreviations and Acronyms (continued)

NERL	National Exposure Research Laboratory
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOx	reactive nitrogen compounds
NO_x	nitrogen oxides
NPS	National Park Service
O_3	ozone
OAQPS	Office of Air Quality Planning and Standards
OAR	Office of Air and Radiation
OECA	Office of Enforcement and Compliance Assurance
OEI	Office of Environmental Information
OMB	Office of Management and Budget
ORD	Office of Research and Development
PBT	persistent bioaccumulative toxics
PE	performance evaluation
PEP	Performance Evaluation Program
PFIRS	Prescribed Fire Incident Reporting System
PM	particulate matter
$PM_{2.5}$	particulate matter $\leq$ 2.5 microns
PMF	positive matrix factorization
PPM	parts per million
PSD	Prevention of Significant Deterioration
PTFE	polytetrafluoroethylene
PQAO	Primary Quality Assurance Organization
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
QMP	quality management plan
READY	Real-time Environmental Applications and Display System
RPOs	Regional Planning Organizations
RSM	response surface model
SCRAM	Support Center for Regulatory Atmospheric Modeling
SIP	State Implementation Plan
SLAMS	State and Local Monitoring Stations
STAG	State and Tribal Assistance Grants
SO_2	sulfur dioxide
SOP	standard operating procedure
TAR	Tribal Authority Rule
TAMS	Tribal Air Monitoring Support Center
TEOM	tapered element oscillating microbalance
TEISS	Tribal Emissions Inventory Software Solution
TIP	Tribal Implementation Plan
TREX	Tribal Environmental Exchange
TRI	Toxic Release Inventory
TSA	technical systems audit

List of Abbreviations and Acronyms (continued)

USDA	United States Department of Agriculture
$\mu g/m^3$	micrograms per cubic meter
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
WRAP	Western Regional Air Partnership

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Section 1

Introduction and Purpose

Why Do Tribes Want to Conduct Air Monitoring?

One of the most important reasons that tribes are conducting air quality monitoring is to gather information on the long-term effects on the health of the tribal community and lands. In many cases, tribes use their lands for subsistence hunting, fishing and harvesting native plants. These subsistence cultures are affected by increased exposure to pollutants. In addition, the environment is often integral to religious and traditional practices. Some tribes are concerned that long-term exposures to air pollutants, acid rain, and heavy metal deposition will adversely affect these resources as well as their physical and mental health. The following information provides specific objectives for tribes to conduct ambient air monitoring and includes examples of tribes performing monitoring for these objectives. This technical guidance document has been developed to help those tribes interested in ambient air monitoring make the best steps forward in the development of their air monitoring programs.

Air Monitoring for Compliance with Health-Based National Ambient Air Quality Standards (NAAQS)

From the Wampanoag Tribe Cranberry Day-a celebration of the fall harvest.

Tribes are currently monitoring to determine compliance with national standards, primarily for ozone and particulate matter, in areas of the country that are not in compliance with the NAAQS for these pollutants or have no existing monitoring. The data from these sites may be used to demonstrate the need to develop a tribal implementation plan, to show the inadequacies of state or federal implementation plans (or monitoring networks) or to warn tribal members of unhealthy air quality. Tribes may also be well located to perform air monitoring that broadens the coverage of state monitoring networks. Several tribes in the Northeast operate ozone and PM2.5 air monitoring sites in areas that the states are less able to monitor. An example of this is the Wampanoag Tribe of Gay Head (Aquinnah) who is currently operating an air monitoring program consisting of an ozone monitor, an IMPROVE sampler and a meteorological station. The station is located in the Massachusetts non-attainment area in a location where there is no state air monitoring. In 2012, the station recorded eight days above the 2008 8-hr. ozone NAAQS and provided the tribe with health-related air quality data to inform tribal members. Data from this station will also provide the tribe with the ability to ensure that ozone air quality standards will be met in the future.

PM_{10} monitoring has been on-going in non-attainment areas on tribal lands in Montana for many years. The Confederated Salish and Kootenai Tribes and the Northern Cheyenne Tribe were designated non-attainment for PM10 in 1989. PM2.5 monitoring was also initiated in these two areas as a screening tool to ensure compliance with the PM2.5 standard.

Impairment of Visibility for Vistas Within or Near Reservations

Visibility is another important measurement objective for tribal reservations designated as Federal Mandatory Class 1 areas or in areas where regional haze is of concern. The CAA amendments of 1990 set a target of improving visibility in mandatory Class 1 areas to natural visibility conditions by 2064. Data from these sites will provide tribes important information on the impacts of regional haze on visibility on tribal lands. Examples of visibility measurements include the operation of IMPROVE monitors by a number of tribes and the operation of haze-cameras on tribal lands. The Aroostook Band of Micmac Indians operate both an IMPROVE monitor and a haze camera at their air monitoring site in Presque Isle Maine. Data from this site is included in the National IMPROVE web page. The Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation in northern Montana also operate an IMPROVE monitor which they use to monitor the status of their voluntary Class 1 airshed. They, the Confederated Salish and Kootenai Tribes, and the Northern Cheyenne Tribe operate IMPROVE samplers that

Visibility monitoring at Badger Peak, Northern Cheyenne Reservation.

supplement the core IMPROVE network and provide valuable information on areas that would otherwise lack monitoring resolution.

Toxic Air Pollutants for Health and Ecological Effects

Tribes are also monitoring for hazardous air pollutants and/or air toxics. Air monitoring for these pollutants can either be for short-term exposures when there is a chemical release, or for long-term community and ecological impacts. Sources of these pollutants include nearby stationary sources, area sources, mobile sources, and long distance transport from urban areas. Data from these sites provide the tribes critical information on hazardous pollutant exposures and impacts of air toxics on communities and tribal lands through risk analyses conducted using this monitoring data. Examples of this type of monitoring include mercury deposition monitoring or the impact of a nearby power plant or pulp mill. The Nez Perce Tribe completed a new phase of air toxics sampling for formaldehyde under a Community-Scale Air Toxics Ambient Monitoring Grant. Additionally, the Nez Perce Tribe has installed an EPA CASTNET site on the Reservation in Woodland, ID which monitors for atmospheric deposition and ozone. Several tribes in Maine conducted monitoring for metals and mercury deposition for long-term trend data on their tribal lands. The Morongo Band of Mission Indians recently completed arsenic monitoring as part of the School Air Toxics program through EPA and the TAMS Center. Additionally, TAMS has loaned to several tribes their mercury monitors for one-year studies. Multiple New England tribes are collecting and analyzing fish tissue data both as a measure of fish contamination and as an indicator of mercury deposition.

Monitoring to Support AQI and AirNow

Tribes are operating continuous monitoring for ozone and $PM_{2.5}$ and converting these data to the appropriate Air Quality Index (AQI). The AQI relates concentration of pollutants to potential health effects and can be used to alert a community to unhealthy air quality conditions. Another critical role for tribal monitoring is being part of the national AirNow mapping program. These sites provide near real-time data quality information and valuable information to better understand the fate and transport of air pollution. The data is also valuable for use in mapping programs in rural areas where there is little or no state data.

Significant Air Quality-Related Environmental and Cultural Resource Concerns

Tribes are conducting air quality monitoring to gather information on the long-term air quality effects on the tribal community and on tribal lands. In many cases, tribes use their ancestral lands for subsistence hunting and fishing, traditional rights and harvesting native plants. Tribes are concerned that long-term exposures to air pollutants, acid rain, and heavy metal deposition will adversely affect these resources. It should be noted that this type of air monitoring requires a long-term commitment of funding and resources (for operation of equipment and analyses/assessments of the data). Examples of this type of monitoring include operating trace level SO2, CO and NOx monitors, sulfate, nitrate, metals, and the operations of National Atmospheric Deposition Network (NADP), Mercury Deposition Network (MDN) and IMPROVE samplers. Data from this type of monitoring can also help to assess the short and long-term effects of long distance transport on tribal lands and the effects of atmospheric deposition on the ecology of their lands.

Regional Monitoring

Another critical role for tribal monitoring is being part of a Regional/State monitoring network. Tribes may be well located to perform air monitoring that broadens the coverage of State Implementation Plan (SIP) monitoring networks and supports the national AIRNOW mapping program. Several tribes in the Northeast operate ozone and $PM_{2.5}$ air monitoring sites in areas that the states are unable to monitor, such as the island of Martha's Vineyard, MA or far eastern ME. In the Pacific Northwest, EPA Region 10 contracts with the Washington State Department of Ecology to operate or co-operate air quality monitors within the exterior boundaries of Reservations. These monitors are part of the state's primary quality assurance organization with the data reported to AIRNOW and the Air Quality System (AQS). Six tribes, including the Alabama-Coushatta Tribe of Texas, Cherokee Nation, Kickapoo Tribe in Kansas, Nez Perce Tribe, Red Lake Band of Chippewa, and Santee Sioux Nation operate Clean Air Status and Trends Network (CASTNET) sites on tribal lands. This is part of a larger monitoring network consisting of 95 sites that is implemented by the EPA, Bureau of Land Management (BLM), National Park Service (NPS) as well as other federal, state, and local partners. CASTNET benefits the nation by understanding acidic pollution/deposition and providing insight to the mitigation programs that facilitate the reduction of acidic emissions and precursors.

Determining Air Quality Background Levels and Establishing Air Quality Baselines for Prevention of Significant Deterioration (PSD)

In some cases, tribes will need to conduct air quality monitoring to determine air quality background levels or to establish a baseline. This information is important for the protection of areas with pristine air quality and to provide quantitative data before new stationary sources are located in or near Indian country. This monitoring can also help in identifying the role of off-reservation sources and /or to build a case for developing partnerships to control emissions from those sources.

Sensor Technology

Tribes or individuals may find the use of low cost ($100-$2,500) sensors to be a benefit for understanding air quality or emission sources. Sensors of these types are still in an early phase of development and testing. In fact, the Quapaw Tribe of Oklahoma and the Cherokee Nation of Oklahoma tested and assessed the capabilities of ozone sensors (Aeroqual Series 500) to determine their linearity with Federal Reference Method (FRM) ozone monitors. Although currently non-regulatory, sensors can be used for understanding personal exposure, corroborating other monitor data, education and awareness events, and/or conducting research. The various types of sensors can measure pollutants that include the six criteria pollutants, Volatile Organic Compounds (VOCs), certain Hazardous Air Pollutants (HAPs) and Black Carbon (BC). More information on sensor technology, including purchasing considerations, collecting useful data, performance guidance, suggested performance goals and more can be found at https://www.epa.gov/air-sensor-toolbox.

The Air Sensor Toolbox for Citizen Scientists, Researchers and Developers

Is a website that provides information for citizen scientists and others on how to select and use low-cost, portable air sensor technology and understand results from monitoring activities. The information can help tribes and the public learn more about air quality in their communities.

Source Monitoring

Tribes may need to conduct emission monitoring on their major point sources for compliance purposes. This may be in the form of stack tests or by conducting continuous emission monitoring. Monitoring of this type is usually specified in the facilities Title V air operating permit. Normally, source monitoring is conducted for particulate, sulfur dioxide, nitrogen oxides, volatile organic compounds, carbon dioxide and/or carbon monoxide. The Morongo Band of Mission Indians in Southern California, as part of their Title V permit, conducts quarterly monitoring on their natural gas powered cogeneration facility. The cogeneration plant provides power, heating and cooling for the tribe's casino and resort and is tested to ensure that pollutants are at or below their permitted limits.

Indoor Air Quality

The increase in asthma and respiratory disease, and the attempt to discover their causes, has led to an enhanced awareness that indoor environments play a large, if not the largest, role in causing these health problems. Eighty-three tribes responded to the 2016 NTAA IAQ needs assessment which helped to identify a non-exhaustive list of IAQ concerns. In this list included exposure to molds, environmental tobacco smoke, carbon monoxide, radon, improper ventilation, biological infestations, lead, and cooking/heating fires. All of these play a role in increasing the effects of respiratory distress (with lead having an impact on neurological systems) on affected populations and, to a disproportionate extent, the tribal members. Funding for radon testing is available through certain EPA grants; funding is also available for testing and/or remediation through some state programs. EPA offers its "Tools for Schools" program as a kit and a phone app which is used to assist in identifying problems and determining solutions. This monitoring information can be used to act or to influence mechanisms that will help in the identification and/or the remediation of health problems related to indoor air quality.

Tribal Authority

EPA's tribal air policy emphasizes that as sovereign governments, tribes set their own air program goals. Section 301(d) of the 1990 Clean Air Act (CAA) Amendments provides federally recognized tribal governments the authority to implement CAA programs for lands for which they can demonstrate jurisdiction. The Tribal Authority Rule (TAR) promulgated on February 12, 1998, further delineates the authority of tribes to implement air quality programs under the Act.

EPA's goal for the tribal air program is to assist tribes in understanding air quality problems and to establish and meet air quality goals, rather than to set goals or timetables for the tribes. EPA's Strategic Plan for 2014-2018 states:

> *"By 2018, with EPA support including training, policy, and administrative and technical assistance, tribes will receive 15 additional approvals to implement the Clean Air Act in Indian country (as demonstrated by successful completion of an eligibility determination under the Tribal Authority Rule). The cumulative total will be 62 approved eligibility determinations, from the 2012 baseline of 47.*
>
> *Although some tribes may not seek primacy, authorization, approval, or delegation of federal programs, they nonetheless remain important partners in ensuring environmental protection. In other cases, a tribal government works with EPA to assist with the implementation of federal environmental programs in Indian country. The Agency will establish effective measures that capture the capacity development progress of tribes seeking to establish and implement*

programs in these two areas while also continuing to measure and report on tribes that EPA treats in a manner similar to a state."

In developing its annual budget plans, EPA considers whether sufficient resources are available to support tribal air monitoring that is necessary and appropriate to protect air quality in Indian country and to provide important data that helps meet state, local, or national monitoring data needs. Each year, EPA's budget request to Congress includes a certain amount of funding for use in awarding grants to tribes to support air quality management.

Currently, there are five hundred and seventy-three (573) federally recognized tribes in the United States. Of this number, approximately 110 tribes currently receive federal funding from the U.S. Environmental Protection Agency to address air quality issues that are pertinent to their lands and community members. As Figure 1.1 indicates, many tribes are using federal funds to monitor and report data to EPA national data bases.

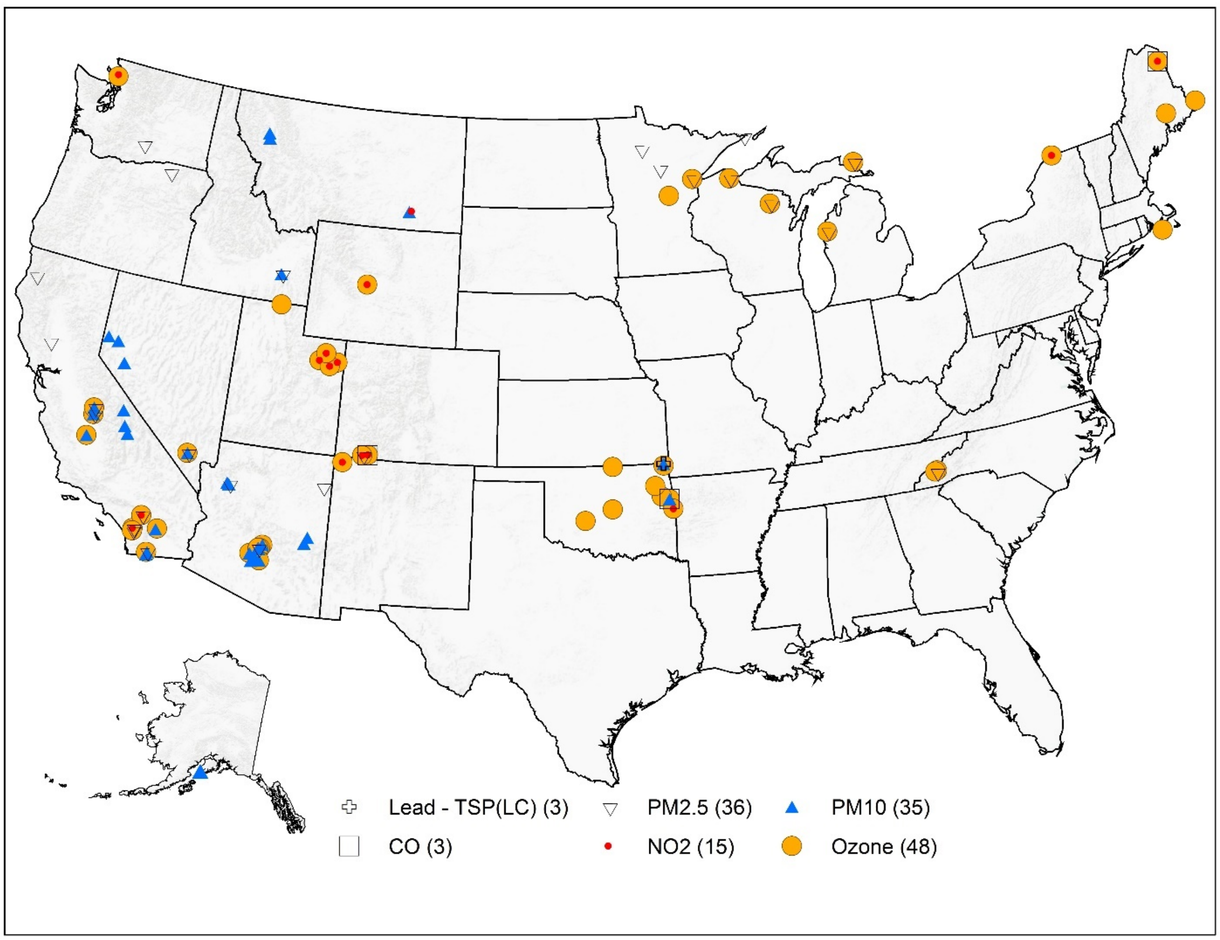

Figure 1.1 Tribal Air Monitors Active in EPA's Air Quality System.

What is EPA's National Ambient Air Monitoring Strategy (NAAMS), What is NCore, What is CASTNET, and Are There Opportunities for the Tribes?

Federal agencies, state, tribal and local air agencies operate and maintain a wide variety of ambient monitoring systems across the U.S. Many of these systems now serve multiple environmental objectives, even though they may have been sited originally for a more limited purpose. Over time, regardless of whether the original objective remains or diminishes in importance, air quality management developments may warrant rethinking how best to use the monitoring system for other environmental and air program objectives. Of importance is to recognize all of the different types of monitoring and the various environmental and other program purposes they serve, and then identify ways in which integration of these monitoring systems may aid in fulfilling those objectives, perhaps with increased efficiency. For example, national ambient air monitoring networks support the evaluation of trends in national air improvement; state, tribal and local air monitoring systems support local goals, and special purpose monitoring support individual studies.

Collectively, EPA refers to all of these various monitoring efforts as the National Ambient Air Monitoring Strategy (NAAMS). The Strategy is designed to outline EPA's current efforts and future plans to maintain and enhance the NAAMS to meet the nation's air quality goals and challenges. In addition, technology advances over time. This includes both the capabilities of the monitoring hardware and the ability to record, store, disseminate and analyze the monitoring data. A second key element of this Strategy is to ensure that the monitoring programs are flexible enough to provide incentives for improved monitoring and improved use of the monitoring data.

The 2005 NAAMS[1] looks at each of these areas discussed above and provides EPA's overall approach for achieving these objectives through an integrated strategy. Additionally, a subsequent 2008 Ambient Air Monitoring Strategy[2] is also available. The latter document differs from the previous in that it focuses more on criteria pollutant monitoring and the other more urban-oriented monitoring programs for state, local, and tribal air agencies. Both the NAAMS and AAMS identify and integrate tribal monitoring as part of their environmental/program objectives.

The NAAMS emphasizes multi-pollutant sites, continuous monitoring methods, and important pollutants normally not included in State and Local Air Monitoring

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[1] https://www3.epa.gov/ttn/amtic/files/ambient/monitorstrat/naamstrat2005.pdf

[2] https://www3.epa.gov/ttn/amtic/files/ambient/monitorstrat/AAMS%20for%20SLTs%20%20-%20FINAL%20Dec%202008.pdf

Stations (SLAMS), such as ammonia and reactive nitrogen compounds (NO_x). This network meets a number of important needs: improved data flow and timely reporting to the public; NAAQS compliance determinations; support for development of emissions strategies; improved accountability for control programs; and support for scientific and health-based studies.

Structurally, the central component of this Strategy are the NCore multi-pollutant monitoring sites. Monitors at NCore multi-pollutant sites will measure particles ($PM_{2.5}$, speciated $PM_{2.5}$, $PM_{10-2.5}$), O_3, SO_2, CO, nitrogen oxides ($NO/NO_2/NO_x$), and basic meteorology. Monitors for all the gases except for O_3 would be more sensitive than standard Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitors, so they could accurately report concentrations that are well below the respective NAAQS but that can be important in the formation of O_3 and PM. The objective is to locate sites in broadly representative urban and rural locations throughout the country to help characterize regional and urban patterns of air pollution. By combining these monitoring programs at a single location, EPA and its partners can maximize the multi-pollutant information available. This greatly enhances the foundation for future health studies and NAAQS revisions. The NAAMS highlights the fact that the NCore strategy could benefit from including tribes because they can provide additional monitoring sites, fill data gaps, and measure background conditions.

In contrast to the NADP, which (except for the AIRMoN dry deposition sites) measures wet atmospheric deposition, CASTNET focuses on dry deposition and, more recently, an additional component to address fine particles and visibility. CASTNET measures ambient concentrations of gaseous phase pollutants and aerosols (O3, SO2, HNO3, particulate nitrate, and sulfate and ammonium species), along with meteorological parameters needed to estimate deposition velocities and dry deposition fluxes of these constituents. CASTNET is the only broad source of dry deposition data in the country. The data are used to determine relations among emissions, air quality, and deposition and to provide information necessary to understand the ecological effects of atmospheric deposition. As mentioned, 6 tribes are operating CASTNET sites on tribal lands.

What is the EPA Regions' Role in Managing Air Quality Monitoring Activities?

Because of the diversity in goals from tribe to tribe, EPA has taken the approach of delegating to the EPA Regional Office level the tasks of assisting tribes in identifying their goals and the task of managing the available resources to help meet those goals. Because EPA Regions understand individual tribal situations, effective decisions about funding and in-kind assistance are best made at the Regional Office level. Regional Offices have taken the initiative to help tribes design ambient monitoring programs that support their goals. Regions have prioritized requests from tribes when they collectively exceed the tribal air management grant funds available to the Regional Office. Regional Offices also negotiate, award and manage grants to individual tribes. They provide in-person, telephone, and written guidance and assistance to the tribal governments at all these stages. To date, Regional Offices and individual tribes have entered into grants that have dedicated a portion of the available tribal air management resources to plan, establish and operate a diverse range of ambient air monitoring activities in Indian country.

On the technical side, the Regional Office provides a wealth of experience in ambient air quality monitoring. They are in constant communication with the Headquarters Office and the Office of Research and Development (ORD) and keep current on advancements in monitoring technologies and information management. Technological development and research by ORD includes the advancement of sensor technology. Tribes also study the effectiveness and reliability of sensors. An example includes the Quapaw Tribe of Oklahoma and the Cherokee Nation of Oklahoma evaluating the capabilities of Aeroqual Series 500 portable gas monitors to compare against the ozone measurements obtained by FRMs within the jurisdictions of the Tribes. Regional offices have capabilities in helping to solve technical problems, provide audits of equipment and can assist in transferring data to national data bases.

In the course of this highly decentralized process, Headquarters and Regional Offices have prepared a limited body of technical guidance on tribal air monitoring to determine whether to monitor, what type of monitoring to do, and how EPA will prioritize requests for funding assistance. This guidance is rather general in nature, reflecting the need to accommodate the diversity of tribal situations.[3] In addition to this limited body of strategic guidance, tribes have access to the large body of EPA guidance on monitoring technologies, quality assurance, and data

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[3] The available strategic guidance (excluding technical guidance on monitor operations and maintenance) includes the following documents, and perhaps others at the individual Regional Office level:

1. *OAR National Program Manager Guidance Fiscal Years 2016-2017* Section 5.1 Program Guidance: Improving Outdoor Air Quality and Addressing Climate Change in Indian Country and Alaska Native Villages. EPA Pub. 450-B-15-001 https://www.epa.gov/planandbudget/national-program-manager-guidances#fy20162017
2. *U.S. Environmental Protection Agency Grant Guidance for Multipurpose Grants to States and Tribes,* April 27, 2016 https://www.epa.gov/sites/production/files/2016-04/documents/final_multipurpose_grant_guidance_0.pdf
3. **"**MENU ITEM**:** Air Quality Monitoring Activities**,"** in *The Tribal Air Grant Framework - A Menu of Options For Developing Tribal Air Grant Work Plans and Managing Grants for Environmental Results*, September 2004, revised 2015. https://www.epa.gov/sites/production/files/2015-10/documents/thetribalairgrantsframework_menuofoptions09_29_15_0.pdf
4. *Protecting Tribal Air Quality-Options and Opportunities* EPA Region 6, December 2015. https://www.epa.gov/sites/production/files/2016-11/documents/tribalairguidance-protectingtribalairqualitydec2015.pdf

management. While originally prepared for use by state and local government agencies, this technical guidance is equally applicable to monitors in tribal settings.

Resources Available for Monitoring

For the last several years, Congress has appropriated about $12 million (2016) for tribal air quality activities, which include air monitoring. This funding has not changed significantly over the past 22 years, yet the number of grant applications from individual tribes has increased. This has caused the funding to become competitive and many EPA Regional Offices report that they are not able to meet all requests to provide grant funds for tribal air monitoring. In addition, the tribes have opportunities to receive funds for monitoring from other sources. A good example of this is the Community-Scale Air Toxics Ambient Monitoring (CSATAM) Grant[4]. Tribes that have received the CSATAM grant include the Gila River Indian Community, Nez Perce, Cherokee Nation and St. Regis Mohawk. The projects helped to identify and characterize the sources of air toxics as well as to understand the severity of air toxics issues. The tribes are able to gain a more robust understanding of the regional hazardous air pollutants (HAPs) and their effect on local communities. The resultant benefit is an increased knowledge and awareness among the local population and industry, as well as actions to mitigate and/or reduce air toxic emissions and public exposure.

A rare snow event surrounds the PM monitor at the Pechanga Indian Reservation.

The EPA Office of Inspector General (OIG) performs audits, evaluations, and investigations of the EPA and its contractors to detect and prevent fraud, waste, and abuse. The EPA's Office of Inspector General is a part of EPA, although Congress provides their funding separate from the agency, to ensure their independence. OIG routinely provides reports and documents structured to

[4] https://www3.epa.gov/ttnamti1/local.html

assist in keeping EPA programs performing fairly and legitimately. In their *FY 2016 Management Challenges* report[5], they've identified that:

> *"The EPA Needs to Improve Oversight of States, Territories and Tribes Authorized to Accomplish Environmental Goals. We found the absence of robust oversight of entities authorized to implement environmental programs. Oversight requires establishing and maintaining consistent national baselines and monitoring programs to determine whether they meet federal standards. While the EPA has made changes in response to some of our recommendations, corrective actions to which the agency has agreed remain pending in various areas (e.g., permits, inspections).*
>
> *Oversight of state, territorial and tribal activities requires that the EPA establish and maintain consistent national baselines that state, territorial and tribal programs must meet; monitor state, territorial and tribal programs to determine whether they meet federal standards; and ensure that federal dollars expended help achieve oversight objectives."*

Purpose of the Technical Guidance Document

The intent of this document is to help tribes gain a better idea of the ambient air monitoring process and provide information on resources and tools that help to build and sustain an ambient air monitoring program. In order to help tribes plan, implement and assess their program activities this document includes:

- steps for identifying goals and objectives for conducting air monitoring,
- information for planning and selecting the appropriate type of monitoring network including discussions of staffing, network design, monitor selection, quality system development and training,
- discussion of using sensor technology to gain understanding of air pollution
- costs for operating a monitoring network, funding sources and tips and resources for writing a grant proposal and work plan,
- implementation of monitoring networks,
- data acquisition, management and reporting, and
- data analysis and interpretation including information on modeling techniques.

The intended audience for this document is the tribal environmental professional. The document has been assembled by a team represented by Tribes involved in monitoring, personnel from the Institute of Tribal Environmental Professionals (ITEP) and EPA Regional Office and Headquarters staff who are involved in resource allocations,

[5] https://www.epa.gov/sites/production/files/2016-06/documents/20160616-16-n-0206.pdf

tribal air grant award and management, program evaluation, strategic planning of monitoring networks, and technical support to monitoring programs. State monitoring officials may also benefit from reading this document, as it may improve their understanding of tribal goals and how EPA strives to help tribes meet their goals.

The technical guidance document attempts to provide a generic level of information on planning and implementing an air monitoring program and then describes the assessment of the monitoring data. Therefore, the sections have been developed in an order that one would plan and implement a monitoring program.

The document tries to provide information on all the major national monitoring programs although many examples are related to the criteria pollutant network. The first Appendix in the document provides factsheets on the major national monitoring programs like the Criteria Pollutant Network, NCORE, PAMS, National Air Toxics Trends Network, Chemical Speciation Network, IMPROVE, CASTNET, and the National Atmospheric Deposition Network which includes the National Trends Network, the Atmospheric Research Monitoring network and the Mercury Deposition Network. Each fact sheet contains internet links to subjects like:

Overall program objectives	Pollutants measured
References to the methods	Siting Criteria
Quality Assurance	Data Management

The document is not meant to replace any of this information so it does not try to provide all the details. It identifies and describes the important areas to think about during the development and implementation of air monitoring programs but then provides the important links to find the specific information a tribe might need.

The document is written in a manner that tells the reader what to consider. It's not intended to dictate what must be done, so throughout the document the reader will find discussions of options for consideration. For example, there is a discussion of the pros and cons of automated versus manual instruments and what might be best for certain situations. This document might be considered a "yellow pages" of information on ambient air monitoring. It is not intended to provide the details of each specific monitoring program but it can provide the key attributes and web addresses/links that would lead one to those important details.

Sunset over Camas Prairie on the Nez Perce Reservation.

Section 2

Developing the Monitoring Objectives

Before a tribe decides to monitor and go through the process of developing a network, or propose a monitoring project using federal funds, they should be able to describe why the monitoring is needed. In some cases, monitoring may be needed for the same objectives of some of the major EPA ambient air monitoring networks such as the State and Local Air Monitoring Stations (SLAMS) or Interagency Monitoring of Protected Visual Environments (IMPROVE). These networks have specific monitoring objectives and also have extensive technical documentation on how the networks are developed, implemented, quality assured and reported to specific data bases. Appendix A provides information on many of the important national monitoring programs and links to where additional monitoring implementation details can be found. The tribes may be asked to participate in these networks to fill data gaps or they may decide there is a need for a particular site. Previously, Section 1 described other reasons why a tribe might need or want to develop an air monitoring program.

Four important questions should be considered by the tribe before monitoring begins:

1) Why are we monitoring?
2) What are we monitoring?
3) Who in the tribal organization will watch the results as they come in and how?
4) What will be our response or plan if our monitoring data indicates unhealthy conditions?

Tribes will have a good idea whether there is a health or an environmental problem that needs to be solved, but it's not always explained in a way that helps all those involved in addressing the problem make the best decisions. It is important that resources spent on monitoring (funds and people) are used wisely and that the data collected help the tribes make the right decisions. Therefore, making sure everyone involved in the monitoring activity knows what the problem is, what decisions will be made, and with how much certainty the decision can be made, will be important first steps in the development of an appropriate monitoring network.

The following steps can help ensure the monitoring program will be developed in a way that allows for the proper communication of environmental problems and will assist in securing the resources necessary to develop the monitoring network. These steps do not have to be formal and they don't have to be followed in the order they are listed, but they do help in the development of a monitoring program geared to meet specific objectives.

Step1: Get the Right People Together

This first step is to get the key people together that need to develop the monitoring program. These key people can be identified as decision makers and technical personnel:

Decision makers- The term represents individuals who are the ultimate data users. The decision makers, in many cases, must provide answers and make the judgment to take further actions based on monitoring data.

Technical personnel – This term represents people with expertise in various fields like network development, monitoring methods, quality assurance, information technology and statistics. These people implement the monitoring program and provide the decision makers with valuable information, **during the planning stages**, on what is possible. This group needs to understand from the decision maker(s) exactly what needs to be collected and why it needs to be collected in order to tailor the monitoring network to answer the decision maker's question within the budget provided.

These two groups need to work together and should be communicating frequently to ensure that few misunderstandings arise.

Step 2: Determine Reasonable Budget Constraints

The ambient air monitoring a tribe will be able to perform will depend on the resources available both in manpower and funds. Although a tribe may be at the early stages in planning the project, management may have already provided the program with a budget that will help set the bounds for what is possible. If not, some reasonable estimate should be made so that the process proceeds through the following steps, a monitoring project is not developed that cannot be afforded. Over many years of monitoring, EPA has developed reasonable national estimates of the costs for ambient air monitoring for the SLAMS. Attachment B provides a listing of these costs for the 6 criteria pollutants.

The technical staff necessary to implement the program is an important budget consideration, especially if the personnel are not currently on staff. Staffing issues are discussed in Section 3.

Step 3: Determine What Is/Are the Problem(s) and the Pollutants of Interest

Data can be used to address more than one question (or objective), but many times it is important to prioritize these since the development of the monitoring network and the technology used might be better served for one particular monitoring objective than another. For example, monitoring for a hotspot (emission source affecting a community) versus monitoring to establish a good average background concentration level may require a different monitoring network and potentially different equipment (more sensitive monitors may be needed for background). In addition, there is a possibility that only one site might be necessary for hotspot monitoring, whereas a few sites might be required for the average background concentrations. By identifying the problem in as much detail as possible, the right monitoring solution can be developed. In the example above, the two problems could be written as:

1. *Tribal community X is suffering from increased pollutant concentration Y and we think it's because of the emissions of pollutant Z from industrial sources ABC.*

Or

2. *We think that the pollutant X coming from outside our community is significantly influencing our ambient air concentrations in community Y but we have no information on our background concentration levels to prove this.*

These problems are simplified, but very often decision makers and technical staff have different opinions on what the problem(s) is/are. Different problems could lead to different monitoring solutions and one solution is not necessarily the best solution for the most important problem. Only when the problem is defined in writing can people realize they have different definitions of the problem and by working together, come to clear agreement on the true (or agreed upon) and most important problem. This step helps put both the decision makers and the technical personnel on the same page.

Determine the Pollutant(s) of Interest

As a part of the step described above, the tribe will have identified a pollutant or pollutants of interest. A tribe can identify which pollutants are of the greatest concern through existing methods and tools such as:

- EPA Air Quality System (AQS): A national database that tracks air monitoring data from state, local, tribal, and other entities
- Air Quality Index (AQI) and AIRNow
- Toxic Release Inventory (TRI), National Emissions Inventory (NEI)

A REASON TO MONITOR

Road dust is a major issue in most Alaskan rural communities. Monitoring for particulates is done to collect baseline data for the communities. This monitoring is supported largely through the Alaska Native Tribal Health Consortium who understands "that our environment is a key factor in our people's health."

Outdoor Road Dust Monitoring Equipment Setup from the ANTHC.

- Other tribes and tribal consortiums who have their own monitoring programs
- Data from existing programs such as IMPROVE, Clean Air Status and Trends Network (CASTNET), National Atmospheric Deposition Program (NADP), etc.
- State and tribal emission inventories (many tribes do their own inventory prior to deciding on the need for monitoring)
- Private industry monitoring data
- Climatology data
- Observations from other environmental programs within the same tribal agency (i.e. water quality, forestry, wildlife management)
- Federal Land Managers
- Multi-Jurisdictional Organizations (MJOs) and Regional Planning Organizations (RPOs)
- Citizen science groups and individuals providing data

If monitoring is conducted to obtain information on specific sources, the monitoring should also focus on the category of source. The category of source will help determine what method of monitoring should be used and if it is worth pursuing. Source categories can be broken down as follows:

- Point sources (see Source Classification Codes [SCC] codes for full list https://ofmpub.epa.gov/sccsearch/)
  - Factories
  - Power Plants
  - Chemical Process Industries
  - Petroleum Refineries
- Non-point sources (please see AP-42 at: https://www.epa.gov/air-emissions-factors-and-

quantification/ap-42-compilation-air-emission-factors)

    - Dry Cleaners
    - Road Dust
    - Gas Stations, Auto Body Shops
    - Wood burning Stoves, Burn Barrels
    - Crop Burning/Prescribed Burning
- Mobile sources (please see AP-42, for full listing)
    - On-Road
        - Trucks (Semi tractors/trailers)
        - Buses
        - Cars
    - Off-Road
        - Farm vehicles
        - Construction Equipment
        - Trains
        - Recreational Vehicles (Boats, ATV's, Snowmobiles, etc.)

Tribes can assess the risks that different pollutants pose by studying unit risks and reference concentrations. This information is available on EPA's National Center for Environmental Assessment (NCEA), Integrated Risk Information System (IRIS) website: https://www.epa.gov/iris. The EPA, under the Office of the Science Advisor (OSA), has its own assessment group called the Risk Assessment Forum which was "*established to promote Agency-wide consensus on difficult and controversial risk assessment issues and to ensure that this consensus is incorporated into appropriate Agency risk assessment guidance*". The Risk Assessment Forum information can be found at the following website: https://www.epa.gov/osa/basic-information-about-risk-assessment-guidelines-development. Tribes should be aware that the scientific understanding of these pollutants may change over time as more data becomes available. Also, different organizations and experts can have different assessments of these substances.

Step 4: Turn the Problem into a Question

Once the problems are identified, they can be made into a question. If a tribe just focused on problem number 1 above (hotspot) the questions might be:

a. *What is the effect of pollutant Z from industrial source ABC on the ambient air concentration in tribal community X?*

Or

b. *What is the fence-line ambient air emissions from pollutant Z from industrial source ABC?*

So even with problem 1, the question might be asked in a number of ways (such as a or b). The way the final question is phrased would then lead to additional questions. Let's say that question (a) is what the tribe wants to answer. Some additional questions might be:

- Do we need to know what the background concentrations would be without industrial source ABC? We might need background estimates.
- What constitutes tribal community X? This would determine the geographical boundary of the study and describes the area the monitoring data is trying to represent.
- Are we going to try and correlate pollution concentrations to a particular health problem(s) (maybe an incremental increase in hospital admissions or some other measurement of a health condition)?
- How much data is needed in order to say with confidence that industrial source ABC is a problem? Should we make sure source ABC agrees that this would be proof so we don't get into arguments later on?
- Is there a threshold value (action limit like the NAAQS) where a decision will be made to take some kind of action? If some type of action limit is developed, then that is where we want to be sure our data is correct. For example, a statement could be made like:

"If we find that industrial source ABC contributes 50% of the pollutant Z concentration on community X and the ambient air concentration reaches 90% of the NAAQS (or the threshold value) we will require industrial source ABC to shut down until the air gets cleaner.

Beside the pollutant measurements, what other measurements are needed (meteorology, hospital admissions, questionnaires, locational information etc.)?

- What are the time periods of interest? Do we care about hourly concentrations, 24 hour concentrations or work week? This would determine the sample frequency. Is it better to have more sites sampling less frequently or fewer sites sampling more frequently?
- What quality of measurements are needed (precision, bias, completeness, detection limit[6])? Is it better to have fewer measurements that are sampled more accurately with a more expensive device or more measurements (at

[6] Definitions for these terms can be found in Section 3 of the QA Handbook Volume II Part 1 https://www3.epa.gov/ttnamti1/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf

maybe more sites) with equipment that is less expensive to operate but may not be as accurate?

- How much money do we have to do this?

These are some of the important questions that need to be asked. What is important to know is whether the initial question can be answered with an acceptable level of certainty with the funds that are available. There are tradeoffs with many of the questions, but the idea is to have the right people around who focus on the ultimate question that needs to be answered so that when the network is developed, it is optimized to provide the best information for the money available. It is also suggested that the answers to the above questions are documented because it will provide the rationale for the final decisions, can be used to develop program documentation (quality assurance project plans) and provides a historical record that can be used by those that may be responsible for future monitoring efforts. Going through this process is beneficial because the information can be used to improve the network if additional resources become available or the problem changes.

Step 5: Optimize the Sampling Design and Start Planning the Network

By using the objective setting process, the tribe will have clearly defined monitoring objectives. Within the available resources (funds and technical personnel), it will also know where it needs to monitor, how often it needs to monitor, and the quality of the data it needs to collect. It is very important to document the decisions that have been made through these steps, since this information will be important in the development of sampling plans and quality assurance project plans.

Do You Want More Information About Setting Objectives?

The approach discussed in the material above follows the process described in the EPA guidance document: *Systematic Planning Using the Data Quality Objectives Process*[7]. In addition, there is a case study titled *Systematic Planning: A Case Study of Particulate Matter Ambient Air Monitoring*[8] that has been developed for a PM_{10} monitoring project that provides a good example of the steps involved in this process. The case study demonstrates how the objective setting process can work to bring different concerns, people of various levels and kinds of expertise, and limited resources together to produce data that serves the most important decisions.

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[7] https://www.epa.gov/quality/guidance-systematic-planning-using-data-quality-objectives-process-epa-qag-4
[8] https://www.epa.gov/sites/production/files/2015-08/documents/casestudy2-final.pdf

The Kootenay River hugs the Kootenai Reservation.

Section 3

Program Planning

Once it is decided what type of monitoring is needed, based on the development of the monitoring objectives, the next step is planning the network. This step will involve compromises that can affect whether or not the monitoring objective(s) are met. It is important to keep this in mind as the tribe plans, funds and implements the network. The important aspects of planning the network include the following topics:

- Staffing
- Network Design
- Monitor/Sampler Selection
- Quality System Development
- Information Technology
- Training

These are listed in the order that a tribe might use in planning a monitoring network. As mentioned in Section 2, one does need to have some rough estimate of the funds that either are available or could be available (if seeking federal funds) for the monitoring program. However, as a tribe steps through the aspects of planning, it will find that it is an iterative process where compromises between staffing, network design, monitor selection and QA will be made and all will have an affect on the monitoring program costs. Once all the technical decisions are made, a tribe will have a better idea of what the actual monitoring programs costs will be and this detail will help justify the costs to management and in any grant application.

3.1 Technical Staffing

Depending on whether a monitoring program is new or an addition to activities it routinely performs, the staffing issue may or may not be important. However, there are a number of functions, depending on the type of monitoring, which will require expertise within the tribe or funds available to secure that expertise. Table 3-1 identifies these functions and provides some of the key activities within the functional category. The monitoring organization can use this list as a starting point and add functions and activities as needed. Once the list is completed, it can be used in the development of position descriptions for recruitment and training programs.

Not all functions are needed for the entire duration of the project. Tribes may feel that it can contract some of the functions that are needed. For example, a tribe may wish to contract the information technology (IT) function to have the monitoring instruments connected to a data logging system that would transfer data to a local data base and eventually to an external data base like AQS. This part of the process might be considered a "one-time" event needing a particular expertise whose function might not require a full time person. However, it is critical that someone within the program understands this IT function to ensure data collection is operating properly on a day-to-day basis.

Table 3.1 Monitoring Functions that Need Some Level of Staffing or Expertise.

Function	Activities
Procurement	- Purchasing capital equipment and consumables - Developing contracts and maintenance agreements - Applying for EPA grants
Technical	- Setting up a monitoring site, electricity, communications - Developing standard operating procedures - Selecting and installing monitoring equipment - Calibrating equipment, performing quality control - Shelter and equipment maintenance
Data Analysis (Statistical)	- Understanding population and measurement uncertainty - Developing sampling designs - Developing networks to achieve objectives - Assessing/interpreting data (data quality assessments)
Quality Assurance	- Developing quality systems, QMPs/QAPPs - Developing data quality objectives - Implementing technical systems audits, performance evaluations - Validating data - QA reporting
Information Technology	- Selecting information technology (data loggers and local data base) - Developing analyzer outputs to data loggers and data transfer to local data base - Transfering data from local data base to external data repositories (AQS, etc.)

3.2 Network Design

A monitoring site or a network of monitoring sites should be chosen based on the objectives described in Section 2. If monitoring will be implemented to support one or more of the nationally implemented networks, there will most likely be requirements or guidance available on the development of an appropriate network and the sites within the network. Appendix A provides information on the network/site requirements of the most common national air monitoring networks.

Some tribal boundaries are so large that monitors are needed in multiple locations or multiple monitors may be needed to study transport issues. Monitors for different pollutants may be placed at the same site, which can provide a more robust data set for understanding what is happening to air quality and why (one of the objectives of the NCore network[9]). In all cases, whether developing a network for a specific tribal issue or providing data vital to support national monitoring networks, the network should be designed with consideration for the following:

Representativeness – One of the most important attributes of any ambient air monitoring network is representativeness. This term refers to the degree in which data accurately and precisely represent the condition that is being measured in order to meet the objectives of the monitoring program. It does not matter how accurate or precise the data are if a site was placed with the intent to measure background conditions actually reported pollutant concentrations that were influenced by a source because conclusions drawn from the data has a high probability of being incorrect. So, the first goal should be finding the most representative site(s) for the monitoring objective.

[9]National Ambient Air Monitoring Strategy http://www.epa.gov/ttn/amtic/monstratdoc.html

Monitor/Sampler Requirements and Siting- Some monitoring technology requires that analyzers be kept within a certain operating temperature range. Maintaining this temperature range will most likely require some type of shed or enclosure and require heating and cooling. Selecting monitors/samplers may require tradeoffs between data quality (higher sensitivity instruments that may need more care and maintenance) and those that may be more "hardy" under the conditions (remote site that receives less frequent site visits) that prevail at the site. Section 3.3 provides more detail on the decisions that need to be made to select an appropriate monitor, but it is obvious that the type of monitor selected can affect the network design and the siting requirements. Determine if meteorological measurements will be necessary and whether the closest source of this information is adequate. Sensor technology will also have varying degrees of siting requirements, keeping in mind that air pollution sensors are still in an early stage of technology development, and many sensors have not yet been evaluated to determine the accuracy of their measurements.

Logistics- Because many reservations are located in rural areas, access to the site, as well as electrical, internet or phone service, may be limited. Tribes are encouraged to look at alternative solutions, such as radio or satellite communications systems and generator, wind, or solar-derived power. Also, there will be some frequency at which operators will need to visit sites for maintenance, filter and/or data collections and quality assurance activities. There needs to be some thought given to ensuring that the operator will be able to get to the site **safely** to perform the required monitoring activities and for carrying equipment and gases needed for quality assurance audits. The site should be accessible year-round and should allow for the location of a shed or trailer, if needed. Adequate security (locked fences) is usually required.

TRIBAL SITING

The Confederated Tribes of the Colville Reservation chose their 3 sites for their spatial distribution across the reservation, and because they were located within communities, close to electric and internet. All sites also met the EPA siting criteria.

Omak Washington Monitoring site operated in partnerhsip with the Washington Department of Ecology.

Depending on the type of monitor chosen and the local climate, a monitoring shed or trailer that is weather-tight, temperature-controlled, and has adequate space may be needed. If a trailer is not available, shed kits can be purchased locally. There should be a consideration for future monitoring needs when arranging for a shelter so that extra space and adequate power sources are available. Depending on the monitoring objectives, the organization may be able to house the monitors/samplers in existing buildings and run monitor probes and inlets out of these buildings. Once again, lower cost sensor technology can be used for many applications that may be constrained by logistical considerations.

NOTE: It may sometimes be necessary to make compromises in the network design which may affect the representativeness of the site(s). Any compromises should be brought to the attention of the decision maker/data user before final network design decisions are made. In addition, the reasons for these compromises should be documented so that if data are found to be non-representative or additional resources are acquired, the monitoring program can justify making the necessary improvements.

3.3 Monitor Selection

Once the pollutant parameter has been identified, the sampling method/monitor can be selected. The final decision depends on many factors such as: cost, detection limit, precision and bias, level of tribal monitoring experience, seasonal conditions, expected program continuity, the need to monitor for one or multiple pollutants, monitor maintenance/service requirements, and conditions at the monitoring site (electricity and communications availability). In addition, some monitoring programs, such as the SLAMS network, require the use of monitors that have been designated and certified as FRM or FEM. Therefore, monitoring for SLAMS purposes restricts the type of monitors/samplers available for selection. Tribes that plan to participate in established national networks should consult with experts in the networks for advice and/or any restrictions on the monitors/samplers that can be used.

Ambient air monitors can be broken down into two general groups, manual and continuous:

- Manual Samplers
    - Produce time-averaged data
    - Use sampling media
        - filters, cartridges, canisters, precipitation samples
    - Samples are analyzed in a separate step in a qualified laboratory
    - Generally do not need a shed or trailer, may need shade

- Continuous Samplers

    - Analyze the air in the field providing a signal which is converted into a concentration
    - Can produce a continuous data stream that can be saved (data logger), aggregated over various time intervals (e.g.,1-minute, 5-minute, 1-hour) and transferred to other databases
    - Most need to be housed in a shed or trailer

- Sensor Technology
    - Can individually analyze various pollutants including air toxics
    - Most collect continuous data and provide instantaneous information, though some can use a filter for additional analysis
    - Varying degrees of durability requiring differing amounts of protection from the elements

The selection of a particular monitor is very important. For example, many tribes conduct $PM_{2.5}$ monitoring. They will have to make a choice of what type of technology to deploy. The table below presents some decisions that will have to be weighed in selecting the optimal instrumentation.

Table 3.2 Air quality collection comparison.

Manual $PM_{2.5}$ Sampler	Continuous $PM_{2.5}$ Monitor	Sensor Technology
	Pros	
Easy to use Do not need a shelter Does not need much information management technology	Produces daily or more frequent (event) results Better chance of complete data for better data certainty Some are FEM or FRM rated for comparison to the NAAQS	Least expensive Instantaneous data Certain devices are wearable for personal monitoring Easier to use (sometimes)
	Cons	
May not be able to afford every day sampling Must have filter analysis at a lab (added cost) Filters can get lost/damaged reducing data completeness	More sophisticated to operate and require data logger May not produce results similar to FRM Need a shelter, adding to expense Costs almost twice as much as a manual instrument	Varying degrees of durability Results are non-regulatory Accuracy still being determined

Tribes are encouraged to collect meteorological data at the monitoring site. Usually, a minimal meteorological station measures wind speed and direction, relative humidity, temperature, barometric pressure, and precipitation, and uses a data logger for gathering and storing data. This involves purchasing and operating additional pieces of equipment.

Each monitor has requirements for siting to ensure that it collects "real" ambient air. These criteria should be investigated for each monitor before a purchase or a site is decided upon. Most importantly, monitors need to be situated a certain distance away from trees or other tall obstructions, such as buildings, and the monitor probe needs to be situated a certain distance above the ground. See Appendix A for references and web addresses to the appropriate siting information for some of the national monitoring programs.

3.4 Quality System Development

During the objective setting process, the acceptable level of data quality for the monitoring program will be defined. Data is virtually useless unless its quality is known. As an example, can the following statement be accepted:

The average height of all men in Idaho is 5 ft. 8 in.:

if the measurements were done correctly but were based on measuring 3 men in Idaho?

Or

if they selected 2,000 men from Idaho at random but had someone estimate the height instead of using a reliable measuring device?

In both cases there is serious doubt about the quality (the amount or accuracy) of the data that was used to make the statement. If it is not known how the information was collected, it might be considered believable because the average height is somewhat close to the national average height for men. However, with more information, the validity of the statement would be questioned. In order to ensure that the statements that are made from the data collected from a monitoring program can be believed, a quality system needs to be developed and implemented.

A quality system is the "blueprint" or framework by which an organization applies sufficient quality control (QC) and quality assurance (QA) practices to ensure that the results of its environmental programs meet or exceed expectations[10]. It is based upon

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[10] *Quality Systems for Environmental Data and Technology Programs-Requirements with Guidance for Use* American National Standard 2004. https://asq.org/quality-press/display-item?item=T400E

the model of planning the work, doing what was planned, assessing the results against the performance criteria, validating data, and making improvements if necessary.

Although this guidance document has not been developed specifically for programs supported with EPA funds, it is believed that all data collection programs need some form of quality system. The system will provide the organization information about the quality of data collected and do it often enough so that measurements systems that are out of control can be corrected without significant data loss.

The EPA, as well as many federal, tribal, state, local and international organizations are developing and using consensus standards to implement vital aspects of environmental programs. These consensus standards help ensure consistency in products and information from various sources and entities. The foundation of the EPA quality assurance policy is derived from the *"American National Standard: Quality Systems for Environmental Data and Technology Programs-Requirements with Guidance for Use*[2]*(ANSI/ASQ E4)."* Tribes not utilizing EPA funds for the collection of environmental data may want to follow the suggested requirements in this document.

Quality System Requirements for EPA Funded Programs

The EPA QA Program Policy[11] CIO 2105.0, outlined in *EPA Quality Manual for Environmental Programs,* requires that all organizations funded by EPA for environmental data collection develop quality management plans (QMPs) and quality assurance project plans (QAPPs) before collecting data.

- **QMP** - describes the quality system in terms of the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, and assessing activities involving environmental data collection. The QMP is not specific to any particular project, but related to how the monitoring organization implements its quality system. It is possible to use General Assistance Program (GAP) grants to fund the development of QMPs (see section 4).

- **QAPP**- is a formal document describing, in comprehensive detail, the necessary QA/QC and other technical activities that must be implemented to ensure that the results of work performed will satisfy the stated performance criteria, which may be in the form of a data quality objective (DQO). The QAPP is specific to a particular monitoring project. Standard operating procedures (SOPs) are part of the QAPP development process and are vital to the quality of any monitoring program.

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[11] https://www.epa.gov/sites/production/files/2015-09/documents/cio_2105-p-01-0.pdf

Guidance for the development of both these documents can be found on the EPA Agency-wide Quality System Documents website[12]. In addition, EPA has provided flexibility to EPA organizations on how they implement this policy, allowing for use of a graded approach. Since EPA funds the collection and use of data for a number of monitoring objectives and for organizations with a broad range of capabilities, flexibility in the QMP and QAPP requirements is necessary. For example, data collection for the purpose of comparison to the National Ambient Air Quality Standards (NAAQS) will require more stringent requirements, while monitoring programs for special purposes may not require the same level of quality assurance. The level of detail of QMP and QAPPs, as explained by the EPA Quality Staff in the EPA Quality Manual, "should be based on a common sense, graded approach that establishes the QA and QC requirements commensurate with the importance of the work, available resources, and the unique needs of the organization."

Appendix C provides information on this approach. If a tribe is using EPA funds for their project, they should consult with their EPA Regional Office on how to use the graded approach.

Quality Assurance Manager

One major component of the quality system is the quality assurance manager (QAM). The following description is derived from the previously referenced EPA Quality Manual for Environmental Programs (CIO 2105.0):

> *"The quality assurance manager (QAM) is the individual designated as the principal manager within the organization having management oversight and responsibilities for planning, documenting, coordinating, and assessing the effectiveness of the quality system for the organization."*

Any organization accepting EPA funds for environmental data operations (which includes air monitoring) is required to have a position that covers the functions listed above. It is realized that many tribes, due to the size of its monitoring organization, will have difficulty meeting this requirement. However, the QMP and QAPPs must address how the tribes will ensure that some level of independent oversight of its quality system is performed. This requirement can be covered by:

- establishing a QA management function within the monitoring organization
- different divisions/branches (air and water) within the monitoring organization providing this function
- different tribes providing this function for each other
- tribes combining funds to hire an organization to provide an independent QA

[12] https://www.epa.gov/quality/agency-wide-quality-system-documents#guidance

function

- working with tribal consortia or organizations to provide this function

It is very important for tribes to work with the organization that will be approving the QMP and QAPP(s) to ensure that the QA management function is adequately addressed.

Quality Assurance Project Plans and Standard Operating Procedures

For most of the major national monitoring programs, QA requirements and/or guidance have been developed that must (if a regulatory requirement), or are strongly suggested, be followed. Many programs such as the $PM_{2.5}$ Chemical Speciation Network and the National Toxics Trends Network have developed program QAPPs that can be referenced and/or adopted by the monitoring organization by providing written confirmation to the EPA Regions.

QAPP/SOP development can be a lengthy process, depending on the complexity of the monitoring and the monitoring objective. Partnerships and resources definitely help in the development. Working intermittently with the Idaho Department of Environmental Quality (IDEQ) over the course of 6 months, the Kootenai Tribe of Idaho was able to adapt IDEQ's QAPP and have it approved by EPA. Once a tribe has finished writing the QAPP, it is submitted to the Regional Office for approval. QAPPs should be written and approved before any "official" data is collected. The QAPP provides the funding organization some assurance that the monitoring organization has performed adequate planning to control and assess the quality of its data before funds are spent on data of questionable quality. In many

TRIBAL QAPP

The La Jolla Band of Luiseño Indians in Southern California developed a BAM-1020 continuous PM2.5 monitoring QAPP, along with all supporting documentation, utilizing a template provided by the Institute of Tribal Environmental Professionals (ITEP). EPA approved this QAPP in 2016, and La Jolla is developing their ozone monitoring QAPP by the same method.

La Jolla's continuous PM2.5 monitor and ozone analyzer in the rack.

cases, EPA provides funding for the tribal monitoring organization to purchase the necessary equipment and consumables to start a monitoring project, as well as time, to become familiar with the instruments in order to develop an adequate QAPP. However, once this initial funding is provided, the QAPP should be written before any funding for routine monitoring is spent. There are a number of ways QAPPs can be developed:

- Start from scratch and use the EPA guidance documents and technical assistance documents for developing a project specific QAPP. This may be necessary for very specific projects.
- Utilize various model or generic QAPPs that have been developed for some of the ambient air monitoring programs. An example of these include:
  - PM2.5 Model QAPP[13]
  - National Toxics Trends Site (NATTS) Model QAPP[14]
- Utilize generic QAPPs that are approved for implementing networks such as the $PM_{2.5}$ Chemical Speciation Network and the IMPROVE Networks.
- Utilize QAPPs developed from other monitoring organizations but modify it to the appropriate specific language for the monitoring activity and the Regional requirements.
- Find example QAPPs, SOPs and other pertinent documents in ORCA, an ITEP document repository.
- Utilize Turbo-QAPP software for the development of criteria pollutant QAPPs. This program is provided by the Institute for Tribal Environmental Professionals (ITEP) free to Tribal programs

The EPA has worked with the Institute of Tribal Environmental Professionals (ITEP) to develop a generic ambient air monitoring QAPP software product called Turbo-QAPP. Turbo-QAPP mimics the functions of software like Turbo-Tax to lead tribal monitoring personnel through the development of their project specific ambient air monitoring QAPPs. Turbo-QAPP should help tribes by providing most of ambient air monitoring guidance for the criteria pollutants within a click of a mouse. For information on Turbo-QAPP, contact ITEP (http://www4.nau.edu/itep/).

Quality Control

Quality Control (QC) is the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards

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[13] PM2.5 Model QA Project Plan (QAPP) https://www3.epa.gov/ttnamti1/files/ambient/pm25/qa/totdoc.pdf

[14] Quality Assurance Guidance Document -- Model Quality Assurance Project Plan for the National Air Toxics Trends Stations http://www.epa.gov/ttn/amtic/airtoxqa.html

to verify that they meet the stated requirements established by the customer. The process establishes techniques to both prevent the generation of unacceptable data and take appropriate corrective action when data is determined to be unacceptable.

There is a wide variety of techniques that fall under the category of QC. Figure 3.1 lists a number of these activities. However, it is the responsibility of the tribal monitoring organization, through the development of their QAPP and quality system to develop and document the:

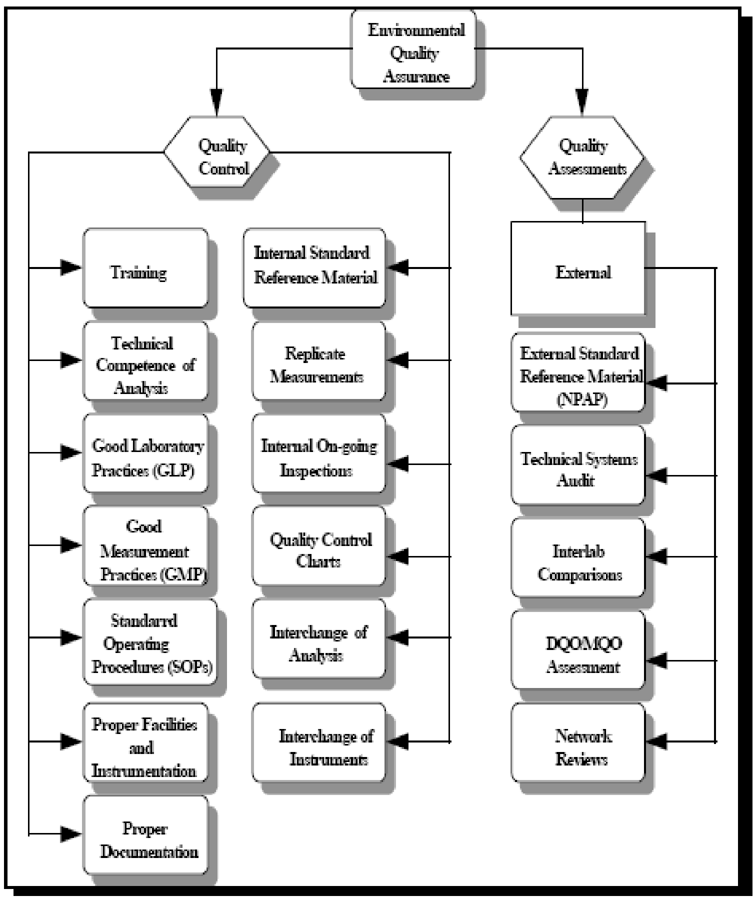

Figure 3.1 Types of quality control activities

- QC techniques
- frequency of the check and the point in the measurement process in which the check is introduced
- traceability of standards
- matrix of the check sample
- level of concentration of analyte of interest
- actions to be taken in the event that a QC check identifies a failed or changed measurement system
- formulae for estimating data quality indicators
- procedures for documenting QC results, including control charts
- description of how the data will be used to determine that measurement performance is acceptable

Many of the national monitoring programs implement many of the techniques discussed in Figure 3.1. Appendix A provides the references to the quality system material where these QC checks are discussed. Some programs, such as the ambient air monitoring program, develop measurement quality objectives tables for the criteria pollutants, which provide listings of the major quality control samples and the acceptance criteria. Tribes can work with each other or state partners to implement QC activities saving time and resources while building valuable networks. An example is the Southern California Tribal Air Monitoring Collaborative who assist each other with documentation as well as physical QC tasks such as conducting the required semi-annual flow rate audits.

3.5 Information Management

Information management covers many aspects of a monitoring program. It should not refer simply to the data that is produced by a monitor that gets uploaded to a data logger. It also needs to encompass the entire measurement system which includes:

- Personnel – training/certification records, who visited the site, performed checks, removed and shipped filters etc
- Logbooks- shelter logs, instrument logs, filter logs
- Control charts
- QMP/QAPPs/SOPs and date of approvals or changes
- Field data sheets and chain of custody forms
- Calibration and standards certifications, repair and maintenance records
- Important memos that reflect decisions made to the monitoring program
- Data certification letters
- Data collection

Part of information management involves site and instrument logbooks where information and results are recorded manually. A paginated site logbook should be kept to detail maintenance activities, problems at the site and how these problems were corrected. For example, power outages and equipment failures need to be noted. In addition to a site logbook, a separate logbook should be kept for each individual monitor to record the results of calibrations and other procedures. Logbooks serve as the "institutional memory" of a site or monitor and can help staff members remember when a specific problem occurred and how it was addressed. Newer technologies that provide for the capture of data electronically are acceptable, as long as the information is easily accessible for review and it provides the same capabilities as the logbook. In addition, if this information is stored electronically, a second copy of these records should be stored in a safe and separate place.

Tribes need to appropriately handle the information they produce because any of the information discussed above can affect the ultimate validity of the data. As a tribe starts planning the monitoring network, it should create a list of the vital information that will pertain to the program and develop a filing system to ensure this information is identified and stored appropriately. ITEP has an online data management course that covers, in detail, how to set up a data management system that can be taken at a student's own pace.

Data Collection Technology

Continuous monitors collect large volumes of data that need to be recorded as it is generated. Data from all types of monitors needs to be stored until it can be reviewed and quality assured. Once the data is quality assured, it needs to be corrected, flagged as necessary, and placed in a repository where other interested parties can view it. Section 6 is devoted to data acquisition and management.

3.6 Training

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. Training is aimed at increasing the effectiveness of employees and their organization. When thinking about what training an organization might need, Table 3-1 can be used as a guide and can be used to determine whether the person performing the function is trained in the activities assigned to that function. If not, then a training program can be worked out with an employee to get the necessary skills to be successful in that function. In order to keep track of the capabilities of the technical staff, some information that can be recorded in personnel files include:

- personnel qualifications- general and position specific
- training requirements - by position
- frequency of training

Cross-training should also be considered so that more than one individual can adequately perform some of the more important functions. Due to high rates of turnover in many monitoring programs, the development of detailed standard operating procedures (SOPs) is critical for ensuring a smooth transition from one person to the next. The importance of good SOPs can not be overemphasized.

Training Courses

Over the years, a number of courses have been developed for personnel involved with ambient air monitoring and quality assurance aspects. Such training may consist of classroom lectures, workshops, teleconferences, and on-the-job training. Formal and informal training is offered through the following organizations:

Institute for Tribal Environmental Professionals (ITEP) http://www4.nau.edu/itep/ - assists Indian Tribes in the management of their environmental resources through effective training and education programs. More information about the ITEP courses is discussed below.

EPA Air Pollution Training Institute (APTI) https://www.apti-learn.net - provides technical air pollution training to state, tribal, and local air pollution professionals, although others may benefit from this training. The curriculum is available in classroom, telecourse, self-instruction, and web-based formats.

Air & Waste Management Association (AWMA) http://www.awma.org/ - A&WMA- offers a variety of products and services to help meet the professional development and educational needs of environmental professionals, university students, grades K-12 students and teachers, and the general public.

American Society for Quality Control (ASQC) https://asq.org/training - serves as an advocate for quality. It is a knowledge-based global community of quality control experts, with nearly 100,000 members dedicated to the promotion and advancement of quality tools, principles, and practices in their workplaces and in their communities.

EPA Quality Staff https://www.epa.gov/quality/ - develops generic training on quality-related issues and also organizes a national conference that includes training. Attendance to conferences and training is free.

EPA Regional Offices https://www.epa.gov/tribal-air/regional-tribal-air-quality-resources - provides a wealth of technical experience and often holds meetings, conferences and training activities. Most Tribes are in contact with one or more Regional Offices.

Regional Planning Organizations (RPOs) https://www.epa.gov/visibility/visibility-regional-planning-organizations **-** evaluate technical information to better understand how their States and Tribes impact visibility across the country, pursue the development of regional strategies to reduce emissions and regional haze, and help states meet the consultation requirements of the Regional Haze Rule. RPOs have been diminishing in recent years due to lack of funding.

National Monitoring Programs - Many of the websites representing the national monitoring programs (see Appendix A) advertise training and should be reviewed at some regular frequency to take advantage of these opportunities.

Instrument Manufacturers – Some manufacturers offer regular training courses at their facilities or offer services to set up the monitor and train staff for a daily fee plus travel costs. As part of the purchase/review process, tribes should ask the manufacturers whether training is offered.

In addition, the EPA provides a tribal website that describes upcoming training and provides links to other training opportunities that might be of interest to tribes. https://www.epa.gov/tribal-air

ITEP Courses

ITEP and the Tribal Air Monitoring Support (TAMS) center offer in-person and online courses[15] including: air toxics monitoring, meteorological monitoring, writing a QAPP, dataloggers, air quality computations, data management, ambient air quality monitoring, permitting, Tribal Emission Inventory Software Solution (TEISS), Geographic Information Systems (GIS), wildland smoke, and more. ITEP offers data analysis courses where tribes can learn basic statistical techniques used for demonstrating compliance with the NAAQS. Tribes should consider which of these courses they want to attend and plan for travel costs.

ITEP courses are available for some types of monitors, but not all. Neighboring tribes, tribal consortiums, or state or local agencies, where appropriate, may also offer assistance. Federal agencies such as the U.S. Forest Service and National Park Service sometimes operate monitors and may offer assistance. Additionally, ITEP can offer individualized training for their Tribe as part of their Professional Assistance program.

Participants at an ITEP class working with data, models, and hands-on activities.

[15] https://www7.nau.edu/itep/main/Training/training_air

Section 4

Funding

FUNDING TRIBES AND CONSORTIA

Individual tribes and tribal consortium are eligible to receive grant funding. The Alaskan Native Tribal Health Consortium Tribal Air Quality Program receives CAA 103 funds which are used to provide technical assistance, education, equipment loans and subawards for tribal air quality projects throughout the state of Alaska.

Air Equipment Training in Nanwalek, Alaska.

Tribes should seek monitoring funds once the pollutants of concern have been identified, the size of the monitoring network has been determined, the site(s) selected, and the specific monitor(s) chosen. It is likely that the source of these funds may be a federal grant. The following sections provide information on the major sources of ambient air monitoring grant funding available to the tribes, explain the process of seeking those funds through the development of a grant proposal and workplan, and provide some specific information on the costs of some of the ambient air monitoring activities.

4.1 Clean Air Act (CAA) Grants

The EPA offers ambient air funding under Sections 103 and 105 of the Clean Air Act. Section 103 grants are for air program planning and short-term projects, although it is worth noting that some tribes have received 103 funding for over 10 years, which has helped to meet the objectives of both the Tribe and EPA. Section 103 grants have the advantage of not requiring the tribe to match any of the federal funds.

Section 105 grants are for operating ongoing air programs and for long-term projects. A match of up to 40% is required for a CAA §105 grant unless the Tribe has established eligibility to be treated in the same manner as a state (TAS) to qualify for a reduced match of 5% to 10%. Tribes with CAA §105 grants in a Performance Partnership Grant qualify for a reduced match of 5% to 10%.

Further information on tribal match requirements can be found in 40CFR § 35.575 or 40CFR § 49.4{q} http://www.ecfr.gov. A tribe may want to begin with a 103 grant and apply for 105 funding after the air program has been established. Keep in mind that regional differences exist with funding availability; a tribe should discuss their options with their regional grant project officer.

4.2 General Assistance Program (GAP) Grants

Tribal requests for EPA assistance may involve more than one media program. In those instances, the statutes require the tribes to separately account for each programs' funds. This is a barrier for most tribes because it inhibits integrated environmental approaches, and tribes sometimes lack the basic infrastructure to comply with the accountability requirements of these diverse statutes and regulations.

In response to the Agency's request for more flexibility in assisting the tribes to build their overall environmental management capacity, Congress first authorized EPA to create the Multi-Media Assistance Program and subsequently enacted the "Indian Environmental General Assistance Program Act of 1992". This program provides general assistance grants to tribal governments and intertribal consortia to build capacity to administer environmental regulatory programs on Indian lands. GAP provides technical assistance from EPA to tribal governments and intertribal consortia in the development of multimedia programs to address environmental issues on Indian lands. Information on GAP can be found at the following website https://www.epa.gov/tribal/indian-environmental-general-assistance-program-gap. As mentioned in

FUNDING PROGRESSION

Many tribes transition from 103 to 105 grants, changing from project funded tasks to implementing a program. The Kootenai Tribe of Idaho has done this several years ago. Additional National Environmental Information Exchange Network (NEIEN) grants have helped KTOI to achieve its air program objectives.

Air monitoring at Kootenai.

Section 3, some of the required quality system documentation like QMPs and QAPPs may be funded through the GAP grants, since these documents can cover more than one media.

4.3 Other EPA Grants

The EPA OAR maintains a tribal website at https://www.epa.gov/tribal-air. This site is designed to strengthen EPA and tribal air quality programs in Indian country by providing timely and user-friendly access to key information, promoting the exchange of ideas, and making available relevant documents to all environmental professionals who live and work in Indian country. This website provides a link https://www.epa.gov/tribal-air/current-announcements-and-opportunities to the following grants and funding that may be of interest to the tribes:

- Science to Achieve Results (STAR) Research Grants[16] - EPA's National Center for Environmental Research, STAR Requests for Applications invite research proposals from U.S. academic and non-profit institutions and state and local governments.
- Federal Grants[17] - Allow organizations to electronically find and apply for competitive grant opportunities from all federal grant-making agencies.
- OAR Grants[18] - This website includes the local community air toxics grant solicitations and includes Community Air Toxics Monitoring grants and grant information for the Community Action for a Renewed Environment (CARE) Program.
- EPA Environmental Justice Grants[19] – Provides grants focused on environmental justice.
- Tribal Grants[20] – Describes funding opportunities available from EPA's American Indian Environmental Office (AIEO).
- Exchange Network Grants[21] - Tribes can apply for funding from the EPA Office of Environmental Information (OEI) to support the development of the National Environmental Information Exchange Network (NEIEN). The primary outcome expected from Exchange Network (EN) assistance agreements is improved access to, and exchange of, high-quality environmental data from public and private sector sources.

[16] https://www.epa.gov/research-grants
[17] https://www.grants.gov/
[18] https://www.epa.gov/grants/air-grants-and-funding
[19] https://www.epa.gov/environmentaljustice
[20] https://www.epa.gov/tribal/grant-programs-tribes
[21] https://www.epa.gov/exchangenetwork/exchange-network-grant-program

4.4 Other Funding Options

As more tribes apply for EPA air grants, competition has become tighter. This means that tribes may have to find alternate funding sources. Creative opportunities can be found for tribes to link their interests to those of other organizations. For instance, the National Oceanic and Atmospheric Administration (NOAA) may award grants to tribes to obtain meteorological data that is of interest both to NOAA and the tribe. A United States Department of Agriculture (USDA) – Concentrated Animal Feeding Operations (CAFO) grant might be obtained to fund ammonia monitoring (of interest in regional haze considerations). Additionally, through the USDA Natural Resources Conservation Service (NRCS), there may be funding available to address air quality issues. Indian Health Services (IHS) may fund monitoring, if it is believed that air emissions are directly causing health problems on a reservation. The La Jolla Band of Luiseño Indians plans to utilize a Supplemental Environmental Project (SEP) policy through the California Air Resources Board (CARB) to purchase ozone monitoring equipment that will prolong the La Jolla's air quality program. SEPs provide funding through penalties that are received during settlement of environmental enforcement actions.

The desire to keep data confidential may also lead tribes to pursue other alternatives. Some tribes pay for their monitoring using tribal funds. Other tribes have obtained monitoring funds through Regional Planning Organizations (RPOs) to collect monitoring data beneficial to both the tribe and the RPO. Some tribes work with state agencies to share monitoring costs and responsibilities and then share the data with the state agency. Some air-related activities can coincide with other federal grants. For example, a meteorological station could gather air quality data that includes data for alternative wind energy feasibility studies under a Federal Energy Regulatory Commission grant.

4.5 The Grant Workplan- For the Tribe Seeking Federal Funds

Developing a comprehensive workplan is one of the first efforts in seeking grant funds. Grants are competitive, so the EPA Regions select those monitoring programs that appear to be the best candidates to achieve success. They will judge this, in part, by the grant application and workplan. To assist tribes in writing effective grants, OAR developed a document entitled: *Tribal Air Grants Framework: A Menu of Options.* This document can be found on https://www.epa.gov/tribal-air/tribal-air-grants-framework-menu-options. Additionally, EPA Region 6 published *Protecting Tribal Air Quality-Options and Opportunites*[22].

[22] https://www.epa.gov/sites/production/files/2016-11/documents/tribal_air_guidance_protecting_tribal_air_quality_-_options_opportunities_-_december_2015_revisions.pdf

Approvable work plans need to have:

1. one or more **objectives** (that's why the objective setting can be so important),
2. **activities** that support the achievement of the **objectives**, and
3. **outcomes** or **deliverables** that will produce **environmental results** within the **objectives**. The tribe should also develop performance measures and milestones that help measure progress on achieving the environmental results.

For example, in Section 2, one possible objective was written:

What is the effect of pollutant Z from industrial source ABC on the ambient air concentration in tribal community X ?

So from this example the words in bold would be solved as follows:

- The **objective** would be find out what the effect was;
- the **activities** would be the monitoring necessary to collect the data that proves or disproves an effect;
- the **outcomes/deliverables** would be a set of reports and various statistical analysis quantifying the effect that the pollution had, and;
- the **environmental results** would be the mitigation that would take place to reduce the harm from the pollutant on the community and performance measures may be the type of tracking or follow up that is done periodically to show measured progress in the mitigation (like an annual X% decrease in concentration over the next 5 years).

Helpful information on the grants process is available through https://www.epa.gov/grants. Additional tips on writing a grant proposal are included in Appendix D. These tips will help in the development of the workplan, as well as how to build a good budget proposal for the monitoring effort. Appendix D also includes a summary of EPA Grants, and a listing of websites for more information on the Indian GAP Program.

4.6 Costs of Monitoring

Before any kind of funding request can be made, cost information must be collected for implementing the monitoring program. Costs vary widely with the types of monitoring conducted and where it will occur. These costs may cover:

- personnel and travel,
- construction of a monitoring shed or purchase of an appropriate monitoring trailer/shelter, maintenance such as mowing/snow removal as needed,

PURCHASING TIP

When making any purchase, talk with other tribes or other monitoring agencies to see what they have and what they like and don't like about their equipment. Consider customer service, warranties, longevity, maintenance and consumables cost. Ask the manufacturers if there are newer models planned relatively soon so you don't purchase something that will soon not be supported.

Ask for a tribal discount. Many suppliers will provide them or give tribes GSA pricing. The General Services Administration establishes long-term contracts with many vendors to provide access to millions of commercial products and services at volume discount pricing.

- installation of electricity, phone, and internet service (these costs may be considerable in rural areas),
- purchase of a data management/acquisition system,
- audits and/or performance evaluations, and annual certifications,
- purchase of calibration devices and standards,
- spare parts and consumables for the monitor,
- tools for working on the monitor,
- shipping costs, and
- lab services [23].

If a tribe is becoming part of a program, such as IMPROVE, many of these costs will be combined into an annual program fee. Some monitors and/or calibration equipment are very complex and must be shipped back to the vendor for servicing or calibration. Certain types of monitors being used for comparison to the NAAQS also need to be shipped or delivered to outside parties or agencies for certification, so these costs should be considered. Vendors often offer services to visit the site and install more complex monitors and provide training sessions to tribal staff. Though this may be costly, tribes may want to consider this option.

Every three years, EPA is required to perform an Information Collection Request (ICR) for its major programs. The ICR provides national estimates on the costs to implement the ambient air monitoring program. EPA surveys a number of representative monitoring organizations, aggregates this information and provides an average cost for operating a monitoring site for an individual pollutant. Appendix B includes summary estimates of the costs for operating the criteria pollutants ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, lead,

[23] For example, the cost of lab and shipping services for an IMPROVE protocol site is ~ $35,000 per year.

PM_{10} and $PM_{2.5}$. There is an additional table that provides general costs not covered in the pollutant specific costs. The values should be used as "ballpark" estimates and a starting point. Tribes should consult with vendors, other air monitoring programs and the appropriate EPA Regions for more specific values.

A tribal program has the option to borrow monitoring equipment from the Tribal Air Monitoring Support Center (http://www7.nau.edu/itep/main/tams). The TAMS Center maintains a collection of well maintained and calibrated, EPA-owned monitors available on loan to tribal air programs. Typically, equipment is available for special studies of up to one year. In addition to monitors, a variety of ancillary equipment is available. Specific models, quantities, and time spans for loans can be arranged through direct contact with TAMS Center staff, who can also help Tribes to choose the best option(s) for their specific needs. The equipment loan list and contact information for TAMS Center staff can be found at http://www7.nau.edu/itep/main/tams/Services/EqpLoans.

Cherokee Nation/Inter-Tribal Environmental Council's mobile monitor in Wyandotte, OK

Section 5

Monitoring Implementation

TRIBAL PARTICIPATION

Tribes play a vital role in understanding our nation's air quality. Participating in monitoring networks is just one way that's accomplished.

Cherokee Nation of Oklahoma is part of CASTNet, MDN, AMoN, AMNet, IMPROVE, and NCore starting with CASTNet in 2002.

Quapaw Tribe of Oklahoma is part of the AMoN under the NADP.

Quapaw's Criteria Pollutant Shelter Site with ammonia monitoring.

Section 3 provided the reader with general information necessary to plan a monitoring activity in enough detail to determine the costs and resources necessary for monitoring and to develop a workplan to seek federal funds. This section provides additional details of monitoring implementation. The information is not specific to any one monitoring program and should be used as general guidance.

5.1 Participation in National Monitoring Programs

Tribes may be interested in participating in nationally established air monitoring programs. All of these programs provide **requirements** that must be met in order for the data to be used in a specific monitoring program, as well as **guidance** that provides additional detail of a requirement or suggestions for implementation that can be followed or modified as the tribe feels appropriate for its circumstance. An example of a requirement is the use of federal reference or equivalent methods (FRM/FEM) for monitoring for comparison to the NAAQS, whereas guidance is the suggested cleaning of the $PM_{2.5}$ very sharp cut cyclone every month.

National air monitoring programs of interest to the tribes include:

- State or Local Air Monitoring Stations[24] (SLAMS)
- National Core[25] (NCore)
- Photochemical Assessment Monitoring Stations[26] (PAMS)
- $PM_{2.5}$ Chemical Speciation Network[27] (CSN)
- National Air Toxics Trends Stations[28] (NATTS)
- Interagency Monitoring of Protected Visual Environments[29] (IMPROVE)
- Clean Air Status and Trends Network[30] (CASTNET)
- National Atmospheric Deposition Program[31] (NADP)
- National Air Toxics Assessment[32] (NATA)

Each program mentioned has detailed information and guidance on the objectives of the network, the types of monitors/samplers used, siting the equipment and the data to be collected. Appendix A contains a fact sheet for each of the programs mentioned above that can be used as a navigational tool to find the information on particular monitoring implementation subjects.

5.2 How Long Might it Take to Start Monitoring

Tribes should consider the timing involved in installing a monitor. For example, a grant received in late summer may result in monitors being placed the following spring. Time is needed to receive the grant money, hire personnel, order the monitor, prepare the site, write the QAPP, contract laboratory analysis, and learn how to operate the monitor. These steps can take months and can be slowed by weather conditions. Depending on the conditions of the grant and timeline described in the workplan, one year may be a reasonable time period to anticipate when the first day of "real" data collection might start. In any case, both the tribe and the organization funding the monitoring should come to agreement on a realistic implementation date.

5.3 Monitor Placement

Proper siting of the sampling equipment and sampling probes is necessary to ensure that the monitors and samplers are obtaining representative samples of the

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[24] https://www3.epa.gov/ttnamti1/slams.html
[25] https://www3.epa.gov/ttnamti1/ncore.html
[26] https://www3.epa.gov/ttnamti1/pamsmain.html
[27] https://www3.epa.gov/ttnamti1/speciepg.html
[28] https://www3.epa.gov/ttnamti1/natts.html
[29] http://vista.cira.colostate.edu/improve/
[30] https://www.epa.gov/castnet
[31] http://nadp.sws.uiuc.edu/
[32] https://www.epa.gov/national-air-toxics-assessment

LOCATION SELECTION

Tohono O'odham Nation in Arizona selected their location in part over concerns of dust and invading pollution from the surrounding cities including Casa Grande.

Many tribes, including Kootenai Tribe of Idaho and the Morongo Band of Mission Indians, choose to site their monitors in their populated residential areas.

Tohono O'odham setting up its first air monitor, on loan from TAMS.

ambient air. The EPA *Quality Assurance Handbook for Air Pollution Measurement Systems Volume II*[33] can provide detailed siting requirements; below are some guidelines based on that document.

Final placement of the monitor at a selected site depends on physical obstructions and activities in the immediate area, accessibility/availability of utilities and other support facilities in correlation with the defined purpose of the specific monitor and its design. Because obstructions such as trees and fences can significantly alter the air flow, monitors should be placed away from obstructions. It is important for air flow around the monitor to be representative of the general air flow in the area to prevent sampling bias. Detailed information on urban physiography (e.g., buildings, street dimensions) can be determined through visual observations, aerial photography and surveys. Such information can be important in determining the exact locations of pollutant sources in and around the prospective monitoring site areas.

Network designers should avoid sampling locations that are unduly influenced by down wash or ground dust (e.g., a rooftop air inlet near a stack or a ground- level inlet near an unpaved road); in these cases, the sample intake should either be elevated above the level of the maximum ground turbulence effect or placed at a reasonable distance from the source of ground dust.

Depending on the defined monitoring objective, the monitors are placed according to exposure to pollution. Due to the various physical and meteorological constraints discussed above, tradeoffs may occur to locate

[33] https://www3.epa.gov/ttn/amtic/files/ambient/pm25/qa/Final%20Handbook%20Document%201_17.pdf

a site in order to optimize sample collection. Any decisions that lead to a non-optimal (but most feasible at the time) location should be documented.

The goal in siting stations is to correctly match the spatial scale represented by the sample of monitored air with the spatial scale most appropriate for the monitoring objective of the station. The representative measurement scales of greatest interest are shown below:

Micro — Concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters

Middle — Concentrations typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer

Neighborhood — Concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range

Urban — Overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale would usually require more than one site for definition

Regional — Usually a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers

National/Global — Concentrations characterizing the nation and the globe as a whole.

Table 5.1 illustrates the relationships among the basic monitoring objectives and the scales of representativeness that are generally most appropriate for that objective.

Table 5.1. Relationship Among Monitoring Objectives and Scales of Representativeness.

Monitoring Objective	Appropriate Siting Scale
Highest Concentration	Micro, middle, neighborhood, sometimes urban
Population	Neighborhood, urban
Source impact	Micro, middle, neighborhood
General/background	Neighborhood, regional
Regional Transport	Urban/regional
Welfare-related	Urban/regional

5.4 Monitoring Station Design

Tribes should design their monitoring stations with the station operator in mind. Careful thought to safety, ease of access to instruments and optimal work space should be given every consideration. If the station operator has these issues addressed, he/she will be able to perform their duties more efficiently and diligently. Instruments placed in areas that are difficult to access can frustrate operators and prolong downtime. The goal is to optimize data collection and quality. This must start with designing the shelter and laboratory around staff needs and requirements.

EPA is aware that monitoring stations may be located in urban areas where space and land are at a premium, especially in large cities that are monitoring for NO_x and CO. In many cases, the monitoring station is located in a building or school that is gracious enough to allow an agency to locate its equipment there. Sometimes, a storage or janitorial closet is all that is available. This can pose serious problems. If the equipment is located in a closet, it can be difficult for the agency to control the temperature, humidity, light, vibration and chemicals that the instruments are subjected to. In addition, security can also be an issue if people other than agency staff have access to the equipment. Tribes should seriously consider locating its air monitoring equipment in stand-alone shelters with limited access, or modify existing rooms to the recommended station design, if funds and staff time are available.

In general, air monitoring stations should be designed for functionality and ease of access for operation and repair. In addition, the shelter should be able to withstand any weather that the local area may generate. In the past, small utility trailers were the norm in monitoring shelters. However, in some areas, this will not suffice. Recently, steel and aluminum storage containers are gaining wide acceptance as monitoring shelters. It is recommended that monitoring stations be housed in shelters that are fairly secure from intrusion or vandalism. All sites should be located in fenced or secure areas with access only through locked gates or secure pathways. The shelter's design dictates that it be insulated (R-19 minimum) to prevent temperature extremes within the shelter. All foundations should be earthquake secured. All monitoring shelters should be designed to control excessive vibrations and external light falling on the instruments, and provide 110/220 VAC voltage throughout the year. When designing a monitoring shelter, make sure that enough electrical circuits are secured for the current load of equipment, plus other instruments that may be added later or needed such as audit equipment. Figure 5.1 represents one shelter design that has proven adequate. This design is not a requirement, but should be thought of as an optimum condition, if funding for this type of shelter set-up is available.

In the shelter there are two rooms separated by a door. Having the entry into the computer/data review room allows access to the site without having to initially enter the room that houses the equipment. It also isolates the equipment from cold/hot air that can come into the shelter when someone enters. Also, the data acquisition system (DAS)/data review area is isolated from the noise and vibration of the equipment. This area can be a place where the operator can print data and prepare samples for the laboratory. This also gives the operator an area where cursory data review can take place. If something is observed during this initial review, then possible problems can be corrected or investigated at that time. The DAS can be linked through cables that travel through conduit into the equipment area. The conduit is attached to the ceiling or walls and then dropped down to the instrument rack.

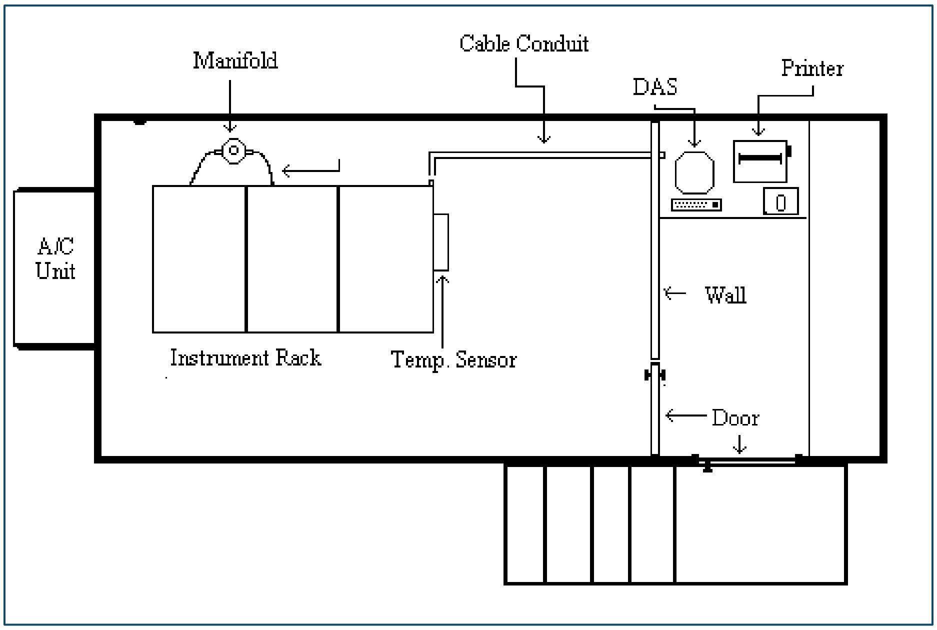


Figure 5.1 Example design for a monitor shelter

The air conditioning/heating unit should be mounted to heat and cool the equipment room. When specifying the unit, make sure it will cool the room on the warmest and heat on the coldest days of the year. Also, make sure the electrical circuits are able to carry the load. If necessary, keep the door closed between the computer and equipment room to lessen the load on the heating or cooling equipment.

All air quality instrumentation should be located in an instrument rack or equivalent. The instruments and their support equipment are placed on sliding trays or rails. By placing the racks away from the wall, the rear of the instruments are accessible. The trays or rails allow the site operators access to the instruments without removing them from the racks. Most instrument vendors offer sliding rails as an optional purchase.

Sampling Environment -

A proper sampling environment demands control of all physical parameters external to the samples that might affect sample stability, chemical reactions within the sampler, or the function of sampler components. The important parameters to be controlled are summarized in Table 5.2.

> **NOTE:** The following sampling environment information is specific to the requirements for the SLAMS monitoring network. Therefore, it may be acceptable to use different sampling environment conditions if the analyzers are used for other monitoring objectives and will not be used for comparison to the NAAQS.

With respect to environmental temperature for analyzers, most have been tested and qualified over a temperature range of 20°C to 30°C (68°F to 86°F); few are qualified over a wider range. This temperature range specifies both the range of acceptable operating temperatures and the range of temperature change which the analyzer can accommodate without excessive drift. The range of temperature change that may occur between zero and span adjustments, is the most important. When one is outfitting a shelter with monitoring equipment, it is important to recognize and accommodate the instrument with the most sensitive temperature requirement.

Table 5.2 Environment Control Parameters.

Parameter	Source of specification	Method of Control
Instrument vibration	Manufacturer's specifications	Design of instrument housings, benches, etc., per manufacturer's specifications.
Light	Method description or manufacturer's specifications	Shield chemicals or instruments that can be affected by natural or artificial light.
Electrical voltage	Method description or manufacturer's specifications	Constant voltage transformers or regulators; separate power lines; isolated high current drain equipment such as hi-vols, heating baths, pumps from regulated circuits.
Temperature	Method description or manufacturer's specifications	Regulated heating/air conditioning system with 24-hour temperature recorder; use electric heating and cooling only.
Humidity	Method description or manufacturer's spcifications	Regulated heating/air conditioning system with 24-hour temperature recorder.

To accommodate energy conservation regulations or guidelines specifying lower thermostat settings, designated analyzers located in facilities subject to these restrictions may be operated at temperatures down to 18°C (64°F) provided the analyzer temperature does not fluctuate by more than 10°C (18°F) between zero and span adjustments. Operators should be alert to situations where environmental temperatures might fall below 18°C (64°F), such as during night hours or weekends. Temperatures below 18°C (64°F) may necessitate additional temperature control equipment or rejection of the area as a sampling site.

Shelter temperatures above 30°C (86°F) also occur, due to temperature control equipment that is malfunctioning, lack of adequate power capacity, or shelters of inadequate design for the environmental conditions. Occasional fluctuations above 30°C (86°F) may require additional assurances that data quality is maintained. Sites that continually have problems maintaining adequate temperatures may necessitate additional temperature control equipment or rejection of the area as a sampling site. If this is not an option, a waiver to operate beyond the required temperature range should be sought with the EPA Regional Office, if it can be shown that the site can meet established data quality requirements.

In order to detect and correct temperature fluctuations, a 24-hour temperature recorder at the analyzer site is strongly suggested. These recorders can be connected to data loggers and should be considered official documentation that should be filed. Many vendors offer these type of devices. Usually they are thermocouple/thermistor devices of simple design and are generally very sturdy. Reasons for using electronic shelter temperature devices are two-fold: (1) through remote interrogation of the DAS, the agency can tell if values collected by air quality instruments are valid, and (2) that the shelter temperature is within a safe operating range if the air conditioning/heating system fails. Additionally, many DAS's can send automated alerts if

GIVE ME SHELTER

Shelters can range in size and material (and cost), but as long as they provide the needed protection and provide fundamental monitoring operation, they will suit the job.

The Fond du Lac Band of Lake Superior Chippewa are among the many monitoring organizations that utilize space within an administration building by collecting the samples through the roof to the monitors below.

Fond du Lac's Beta Attenuation monitor.

temperature ranges or other parameters go above or below set thresholds.

5.5 Design of Probes and Manifolds for Automated Methods

Ambient air quality monitoring probes, inlets, and optical paths are based on the monitoring objectives and spatial scale of representation; specific information can be found in 40 CFR Appendix E to Part 58. As such, there are a number of designs for sampling probes and manifolds. OAQPS has provided sample schematics for probes and manifolds design, available in Appendix F in the *QA Handbook for Air Pollution Measurement Systems VII*[34]. Since this information is appropriate to a number of monitoring networks, it is included in its entirety in Appendix E. Some important variables affecting the sampling manifold design are the diameter, length, flow rate, pressure drop, residence time and materials of construction. A few of these subjects will be described below.

Probe Material-

Depending on the pollutants monitored, the allowable material for sample probes, inlets and manifolds may be very specific. For example, borosilicate glass and FEP Teflon or their equivalent are the only materials allowed for monitoring the reactive gases, SO2, NO2, and O3. Additionally, borosilicate glass, stainless steel, or its equivalent are the acceptable probe materials for VOC and carbonyl sampling. This information can be found in 40 CFR Part 58 Appendix E. Monitoring organizations should check whether various monitoring programs have specific guidance on probe/inlet/manifold material.

Residence Time-

The residence time of pollutants within the sampling manifold is critical. Residence time is defined as the amount of time that it takes for a sample of air to travel from the opening of the cane (inlet probe) to the inlet of the instrument and is required to be less than 20 seconds for reactive gas monitors. It is recommended that the residence time within the manifold and sample lines to the instruments be less than 10 seconds. If the volume of the manifold does not allow this to occur, then a blower motor or other device (vacuum pump) can be used to decrease the residence time. The residence time for a manifold system is determined in the following way. First the volume of the cane, manifold and sample lines must be determined using the following equation:

Total Volume = Cv +Mv + Lv

where:

[34] https://www3.epa.gov/ttnamti1/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf

Cv = Volume of the sample cane and extensions
Mv = Volume of the sample manifold and trap
Lv = Volume of the instrument lines.

Each of the components of the sampling system must be measured individually. To measure the volume of the components, use the following calculation:

$V = pi * (d/2)^2 * L$

where:

V = volume of the component, cm^3
pi = 3.14
L = Length of the component, cm
d = inside diameter, cm.

Once the total volume is determined, divide the volume by the flow rate of all instruments to calculate the residence time.

Probe Placement-

Probes and manifolds must be placed to avoid introducing bias to the sample. Important considerations are probe height above the ground, probe length (for horizontal probes), and physical influences near the probe. Some general guidelines for probe and manifold placement are:

- probes should not be placed next to air outlets such as exhaust fan openings
- horizontal probes must extend beyond building overhangs
- probes should not be near physical obstructions (e.g., chimneys and trees etc.) that can affect the air flow in the vicinity of the probe
- height of the probe above the ground depends on the pollutant being measured

Probe and Manifold Maintenance-

This information can also be found in QA Handbook Volume II, Section 7.0 After an adequately designed sampling probe and/or manifold has been selected and installed, the following steps will help maintain constant sampling conditions:

1. **Conduct a leak test.** For the conventional manifold, seal all ports and pump down to approximately 1.25 cm water gauge vacuum, as indicated by a vacuum gauge or manometer connected to one port. Isolate the system. The vacuum measurement should show no change at the end of a 15-min period.

2. **Establish cleaning techniques and schedule.** A large diameter manifold may be cleaned by pulling a cloth on a string through it. Otherwise the manifold must be disassembled periodically and cleaned with distilled water. Soap, alcohol, or other products that may contain hydrocarbons should be avoided when cleaning the sampling train. These products may leave a residue that may affect volatile organic measurements. Visible dirt should not be allowed to accumulate. Care should be taken when disassembling and cleaning, sometimes necessitating two people to safely perform the procedure.

3. **Plug the ports on the manifold when sampling lines are detached.**

4. **Maintain a flow rate in the manifold.** Flow rate should be either 3 to 5 times the total sampling requirements or at a rate equal the total sampling requirement plus 140 L/min. Either rate will help to reduce the sample residence time in the manifold and ensure adequate gas flow to the monitoring instruments.

5. **Maintain the vacuum in the manifold.** This should be less than 0.64 cm water gauge. Keeping the vacuum low will help to prevent the development of leaks.

Most of the support services necessary for the successful operation of ambient air monitoring networks can be provided by the laboratory. The major support services are the generation of reagent water and the preparation of standard atmospheres for calibration of equipment. Table 5.3 summarizes guidelines for quality control of these two support services.

Table 5.3 Techniques for Quality Control of Support Services

Support Service	Parameters affecting quality	Control techniques
Laboratory and calibration gases	Purity specifications vary among manufacturers	Develop purchasing guides
	Variation among lots	Overlap use of old and new cylinders
	Atmospheric interferences	Adopt filtering and drying procedures
	Composition	Ensure traceability to primary standard

Reagents and water	Commercial source variation Purity requirements Atmospheric interferences Generation and storage equipment	Develop purchasing guides. Batch test for conductivity Redistillation, heating, deionization with ion exchange columns Filtration of exchange air Maintenance schedules from manufacturers

In addition to the information presented above, the following should be considered when designing a sampling manifold:

- suspending strips of paper in front of the blower's exhaust to permit a visual check of blower operation;
- positioning air conditioning vents away from the manifold to reduce condensation of water vapor in the manifold;
- positioning sample ports of the manifold toward the ceiling to reduce the potential for accumulation of moisture in analyzer sampling lines, and using borosilicate glass, stainless steel, or their equivalent for VOC sampling manifolds at PAMS sites as to avoid adsorption and desorption reactions of VOC's on FEP Teflon.

More detailed information on probe/manifold design can be found in Appendix A of the document titled: Technical Assistance Document for Precursor Gas Measurements in the NCore Multi-pollutant Monitoring Network https://www3.epa.gov/ttnamti1/ncoreguidance.html.

5.6 Preventive Maintenance

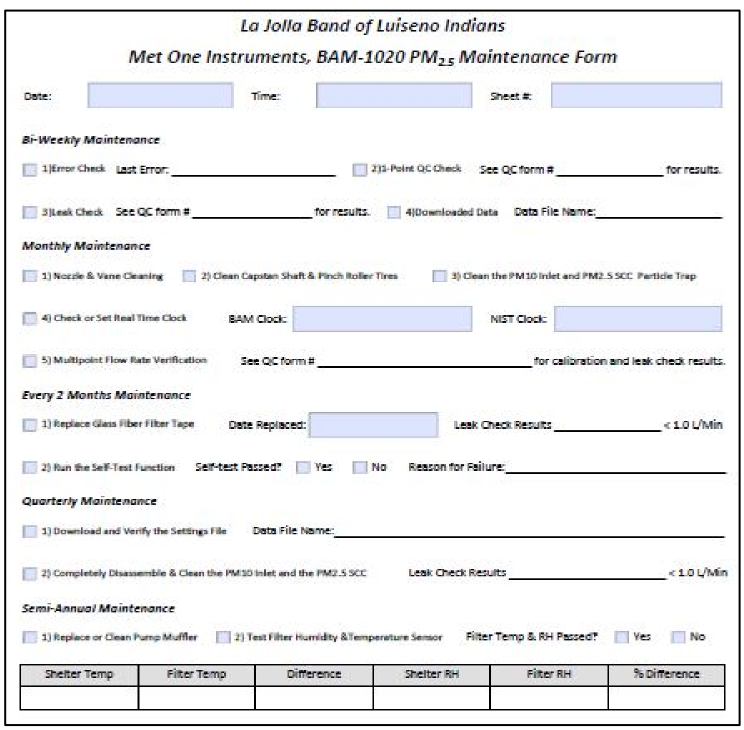
Every tribal monitoring organization should develop a preventive maintenance program. Maintaining the network equipment helps prevent downtime and costly repairs. Preventive maintenance is an ongoing portion of quality control. Since this is an ongoing process, it normally is enveloped into the routines performed at some designated frequency such as weekly, monthly, quarterly, semi-annually, and annually.

Preventive maintenance is the responsibility of the station operators and the supervisory staff. It is important that the supervisor reviews the preventive maintenance work, and continually checks the schedule. The supervisor is responsible for making sure that the preventive maintenance is being accomplished in a timely manner. Preventive maintenance is not a static process. Procedures must be updated for many reasons, including but not limited to, new models or types of instruments and new or updated methods.

The preventive maintenance schedule is changed whenever an activity is moved or is completed. For instance, if a multipoint calibration is performed in February instead of the March date, then the six-month due date moves from September to August. The schedule is constantly in flux because repairs must be followed by calibrations or verifications.

Instrumentation Repair Log

Each instrument and support equipment (with the exception of the instrument racks) should have an instrumentation repair log. The log can be a folder or bound notebook that contains the repair and calibration history of that particular instrument. Whenever multipoint calibrations, instrument maintenance, repair, or relocation occur, detailed notes should be recorded in the instrumentation log. The log contains the most recent multipoint calibration report, a preventive maintenance sheet, and the acceptance testing information. If an instrument is malfunctioning and a decision is made to relocate that instrument, the log travels with that device. The log can be reviewed by staff for possible clues to the reasons behind the instrument malfunction. In addition, if the instrument is shipped to the manufacturer for repairs, the log always travels with the instrument. This helps non-agency repair personnel troubleshoot instrument problems.



La Jolla Band of Luiseno Indians

Met One Instruments, BAM-1020 $PM_{2.5}$ Maintenance Form

Date: ______ Time: ______ Sheet #: ______

Bi-Weekly Maintenance

☐ 1)Error Check Last Error: ______ ☐ 2)1-Point QC Check See QC form # ______ for results.

☐ 3)Leak Check See QC form # ______ for results. ☐ 4)Downloaded Data Data File Name: ______

Monthly Maintenance

☐ 1) Nozzle & Vane Cleaning ☐ 2) Clean Capstan Shaft & Pinch Roller Tires ☐ 3) Clean the PM10 Inlet and PM2.5 SCC Particle Trap

☐ 4) Check or Set Real Time Clock BAM Clock: ______ NIST Clock: ______

☐ 5) Multipoint Flow Rate Verification See QC form # ______ for calibration and leak check results.

Every 2 Months Maintenance

☐ 1) Replace Glass Fiber Filter Tape Date Replaced: ______ Leak Check Results ______ < 1.0 L/Min

☐ 2) Run the Self-Test Function Self-test Passed? ☐ Yes ☐ No Reason for Failure: ______

Quarterly Maintenance

☐ 1) Download and Verify the Settings File Data File Name: ______

☐ 2) Completely Disassemble & Clean the PM10 Inlet and the PM2.5 SCC Leak Check Results ______ < 1.0 L/Min

Semi-Annual Maintenance

☐ 1) Replace or Clean Pump Muffler ☐ 2) Test Filter Humidity &Temperature Sensor Filter Temp & RH Passed? ☐ Yes ☐ No

Shelter Temp	Filter Temp	Difference	Shelter RH	Filter RH	% Difference

A portion of La Jolla's Maintenance Form for their continuous PM2.5 monitor.

Station Log

The station log is a chronology of the events that occur at the monitoring station, as such, the log book should be paginated. The log is an important part of the equation because it contains the narrative of problems and solutions to problems. While the technical details are recorded in the instrumentation log, the station log notes should be written in a narrative style. Additional items that belong in the station log are:

- the date, time, and initials of the person(s) who arrived at the site,
- brief description of the weather (i.e., clear, breezy, sunny, raining),
- brief description of exterior of the site.
- any changes that might affect the data, for instance, if someone is parking a truck or tractor near the site, this may explain high NO_x values, etc.,
- any unusual noises, vibrations or anything out of the ordinary,
- description of the work accomplished at the site (i.e., calibrated instruments, repaired analyzer), and
- information about the instruments that may need repairs or troubleshooting.

Station Maintenance

Station maintenance is a portion of preventive maintenance that does not have to occur on a routine basis. These tasks usually occur on an "as needed" basis. The station maintenance items are checked monthly or whenever an agency knows that the maintenance needs to be performed. Examples of some station maintenance items include:

- floor cleaning
- shelter inspection
- air conditioner repair
- AC filter replacement
- weed abatement
- roof repair
- general cleaning.

Routine Operations

Routine operations are the checks that occur at specified periods of time during a monitoring station visit. The duties are the routine day-to-day operations that must be performed in order to operate a monitoring network at optimal levels. A few typical routine operations are detailed in Table 5.4.

Table 5.4 Routine Operations.

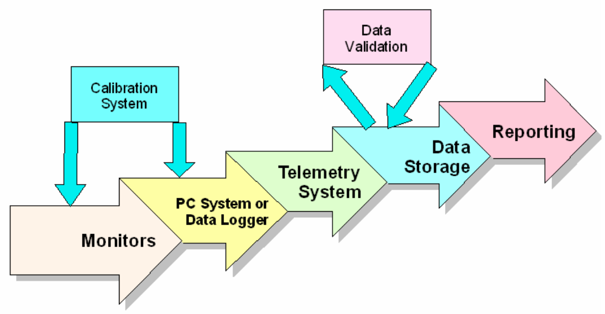
Item	Each Visit	Weekly	Monthly
Print Data	X		
Mark Charts	X		
Check Exterior		X	
Change Filters		X	
Drain Compressor		X	
Leak Test		X	
Check Desiccant			X
Inspect tubing			X
Inspect manifold and cane			X
Check electrical connections			X

In addition to these items, the exterior of the building, sample cane, meteorological instruments and tower, entry door, electrical cables, and any other items deemed necessary to check should be inspected for wear, corrosion, and weathering. Costly repairs can be avoided in this manner.

Routine maintenance of a weather station on the Morongo Indian Reservation.

Section 6

Data Acquisition, Management and Transfer



The ambient pollutant data generated by air monitors must be captured, organized, and verified in order to be useful. The process of capturing the data is known as data acquisition. The organization of the data is known as data management.

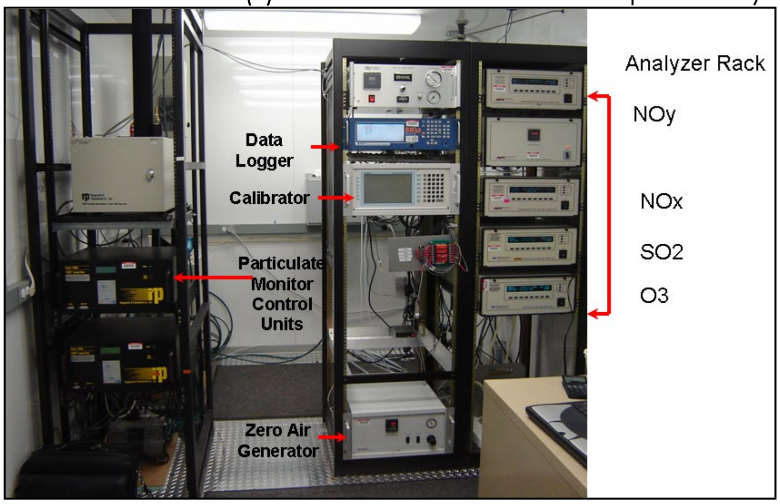
This section provides guidance in these areas, including identification of advanced equipment and procedures that are recommended for implementation. The recommended procedures rely on digital communication by the data acquisition system (DAS) to collect a wide variety of information from the monitors, to control instrument calibrations, and to allow for routine, automated, and thorough data quality efforts. The section will discuss:

1. **Data acquisition-** collecting the raw data from the monitor/sampler, storing it for an appropriate interval, aggregating or reducing the data, and transferring this data to final storage in a local data base (tribal monitoring organizations database).

2. **Data management-** ensuring the integrity of the data collection systems.

3. **Data transfer-** preparing and moving data to external data bases such as AirNow or the Air Quality System (AQS).

Some tribal organizations may have one or more monitoring sites and may collect data by visiting the monitoring site(s) at a prescribed frequency to download raw data from the monitor(s) with the use of data acquisition systems as simple as a laptop computer. What is most important in any data acquisition process is that the raw data values that are stored in the monitor are transferred to other media in a manner that does not affect data integrity. This means the value that the mnitor records is the value that should be in the final database. Although some of this information may not be applicable to all monitoring programs, it is included to provide information on the technologies available and the advantages that they offer.



Typical monitoring and data acquisition system.

6.1 Data Acquisition

Data acquisition system (DAS) is a term that describes any method that collects, stores, summarizes, reports, prints, calculates, or transfers data. The transfer is usually from a digital format to a digital medium. In addition, this section will discuss limitations of data collected with DAS Including uncertainty and how to ascertain the quality of the data.

Air quality professionals have used DAS since the early 1980s. The first systems were single- and multi-channel methods that collected data on magnetic media. This media was usually hand transferred to a central location or laboratory and uploaded to a central computer. The need to hand transfer data has diminished with the advent of digital data transfer from the monitoring stations to a central location. However, errors in data reporting can occur with any data transfer, including digital data.

Many data loggers have the capability to not only simply acquire data in digital format but to also automate various tasks such as calibrations and analyzer operation. DAS and their software may be utilized to automatically flag data during calibrations, flag data above a set threshold, or alert an operator to events such as power outages. It may be cost-effective for tribal agencies to adopt a DAS that provides such automated options. For example, many gas analyzers are capable of being calibrated under remote control. The opportunity to reduce travel and personnel costs through automated calibrations is a strong motivator for tribes to make greater use of the capabilities of new or existing data acquisition systems. These capabilities greatly reduce the time and effort needed to organize and quantify calibration results. The NCore multi-pollutant sites are taking advantage of the newer DAS technologies.

DAS Layout and Collection

Figure 6.1 shows the basic transfer of data from the instrument to the final product- a hard copy report, or transfer to a central computer. The instrument has a voltage potential that generally is a DC voltage. This voltage varies directly with the concentration collected. Most instruments' output is a DC voltage in the 0-1 or 0-5 volts range.

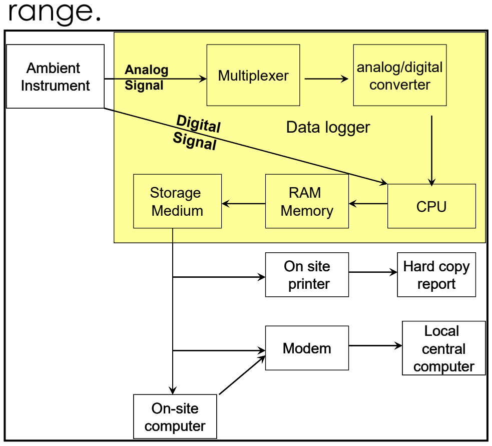


Figure 6.1 DAS data flow

Voltage is translated into a concentration by the CPU

- CPU sends to the random access memory (RAM), which stores the short-term data until the end of a pre-defined time period.
- CPU then shunts the data from the RAM to the storage medium which can be a data logger, computer hard-drive or portable memory or off site server.
- Computer storage medium can be accessed remotely, or at the monitoring location.

The data can be transferred to a central computer storage area or printed out as hard copy.

Figure 6.2 illustrates the recommended digital data acquisition approach for the NCore sites. It presents the data flow from the gas monitors, through a local digital data acquisition system, to final reporting of the data in various public databases. This schematic shows several of the key capabilities of the recommended approach. A basic capability is the acquisition of digital data from multiple analyzers and other devices, thereby reducing noise and minimizing the effort needed in data processing. Another capability is two-way communication, so that the data acquisition system can interrogate and/or control the local analyzers, calibration systems, and even sample inlet systems, as well as receive data from the analyzers. Data transfer to a central location is also illustrated, with several possible means of that transfer shown. Monitoring organizations are urged to take advantage of the latest technology in this part of the data acquisition process, as even technologies such as satellite data communication are now well established, commercially available, and inexpensive to implement for monitoring operations.

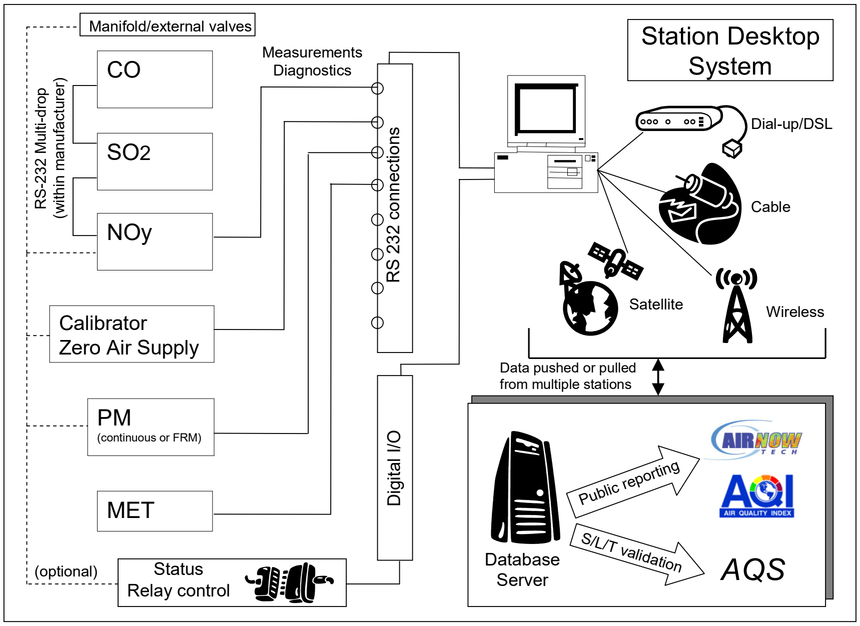


Figure 6.2 Flow of data from gas analyzers to final reporting.

Depending on the monitoring objective and, if applicable, grant requirements it may be important that data are reported in formats of immediate use in public data bases such as AQS, and Air Quality Index sites such as the multi-agency AirNow sites. An advantage of DAS software is the ability to facilitate the assembly, formatting and reporting of monitoring data to these databases.

Thus, flagging of calibration data to distinguish them from ambient monitoring data is conducted automatically during data acquisition with no additional effort or post-analysis.

Purchasing of DAS Systems

There are a number of vendors supplying data logger technologies for ambient air monitoring. Some of these organizations have the expertise to set up the DAS systems to produce final concentration values in the formats necessary for data transfers to external data bases like AirNow or AQS. As part of the acquisition process, tribal monitoring organizations may want to consider adding this feature to the bid since it could save in DAS set-up time down the road. In addition, ITEP[35] can offer a mini training course and/or professional assistance on data loggers. ITEP's course list can be found at: http://www4.nau.edu/itep/trainings/aiaqtp.asp.

DAS Quality Assurance

Quality assurance of the DAS is based on the system being operated within some range of performance; i.e., that the data collected on the DAS and reported to the central database is the same as that generated by the monitoring equipment. For DAS, there are two sources of error between the instrument (sensor) and the recording device: (1) the output signal from the sensor, and (2) the errors in recording by the data logger. This section will provide ways to ascertain quality data from DAS. Among the practices used to document DAS performance are routine calibration checks of the data acquisition system itself, data trail audits and performance audits.

The Bishop Paiute Tribe in the Eastern Sierras of California conducts data quality tests by comparing the data between their monitors and the datalogger. Annually, they plot and graph data derived directly from their ozone and particulate matter monitors. Then, on the same graph, they plot the values from the same time from their datalogger (Fig 6.3). By visualizing this 1-hour data, it enables the tribe to check several days' worth of data by "overlaying" them on a graph as well as looking at overall statistical differences; any considerable discrepancies between the monitor and data logger are quickly noticed.

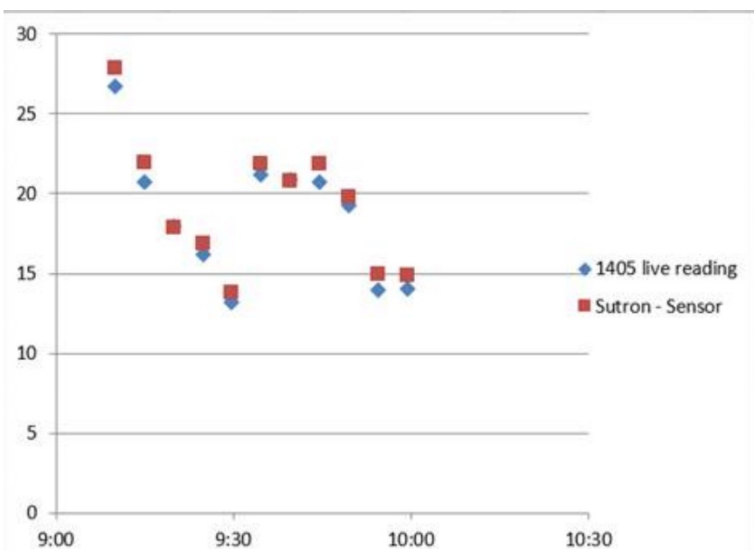


Figure 6.3 Datalogger and ozone monitor data

DAS Calibration

To calibrate the DAS, known voltages are supplied to each of the input channels and the corresponding measured response of the DAS is recorded. Specific calibration procedures in the DAS owner's manual should be followed when performing such DAS calibrations. The DAS should be calibrated at least once per year. Appendix F provides a simple approach for calibration of the DAS.

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[35] http://www7.nau.edu/itep/main/Home/

In addition, gas analyzers typically have an option to set output voltages to full scale, or to ramp the output voltages supplied by the analyzer over the full output range. Such a function can be used to check the recording process from the analyzer through the DAS.

Data Trail Audit

A data trail audit consists of following one or more data values from the analyzer through collection by the DAS, through data processing, to reporting to the central data repository. This audit should be conducted by those personnel assigned to manage the data acquisition hardware and software and should be conducted at least annually. The procedure to be followed is that one or more data points or data averages reported from the analyzer (e.g., hourly values) should be collected by the DAS and checked on the DAS storage medium, and, in the final format, reported to the data repository. The same values must be traceable through all steps of the data acquisition and reporting process.

Performance Audit- The performance audit consists of challenging the instrument and DAS to a known audit source gas and observing the final response. The response should correspond to the value of the audit source gas. Although the performance audit may indicate that the analyzer is malfunctioning, it could also indicate DAS malfunction.

Initialization Errors- All data acquisition systems must be initialized. The initialization consists of an operator "setting up" the parameters so that the voltages produced by the instruments can be read, scaled correctly and reported in the correct units. Errors in initializations can create problems when the data is collected and reported. Read the analyzer manufacturer's literature before parameters are collected. If the manufacturer does not state how these parameters are collected, request this information. The following should be performed when setting up the initializations:

- Check the full scale outputs of each parameter.
- Calibrations should be followed after each initialization (each channel of a DAS should be calibrated independently). Appendix F provides an example of a DAS calibration technique.
- Review the instantaneous data stream, if possible, to see if the DAS is collecting the data correctly.
- Save the initializations to a storage medium; if the DAS does not have this capability, print out the initialization and store it at the central computer location and at the monitoring location.
- Check to see if the flagging routines are performed correctly; data that are collected during calibrations and down time should be flagged correctly.

- Check the DAS for excessive noise (variability in signal). Noisy data that are outside of the normal background are a concern. Noisy data can be caused by improperly connected leads to the multiplexer, noisy AC power, or a bad multiplexer. Refer to the owner's manual for help on noisy data.
- Check to see that the average times are correct. Some DAS consider 45 minutes to be a valid hour, while others consider 48 minutes. Agency guidelines should be referred to before setting up averaging times.

After setting up a monitor, or placing it back online, the Bishop Pauite Tribe plots 5-minute readings to confirm that the incoming voltages and channels are set up correctly. Observing the charted linearity and running an R-square calculation will also help to identify any issues. Bishop Paiute observed that the values may be slightly off due to different display refresh times, but the linearity is consistent.

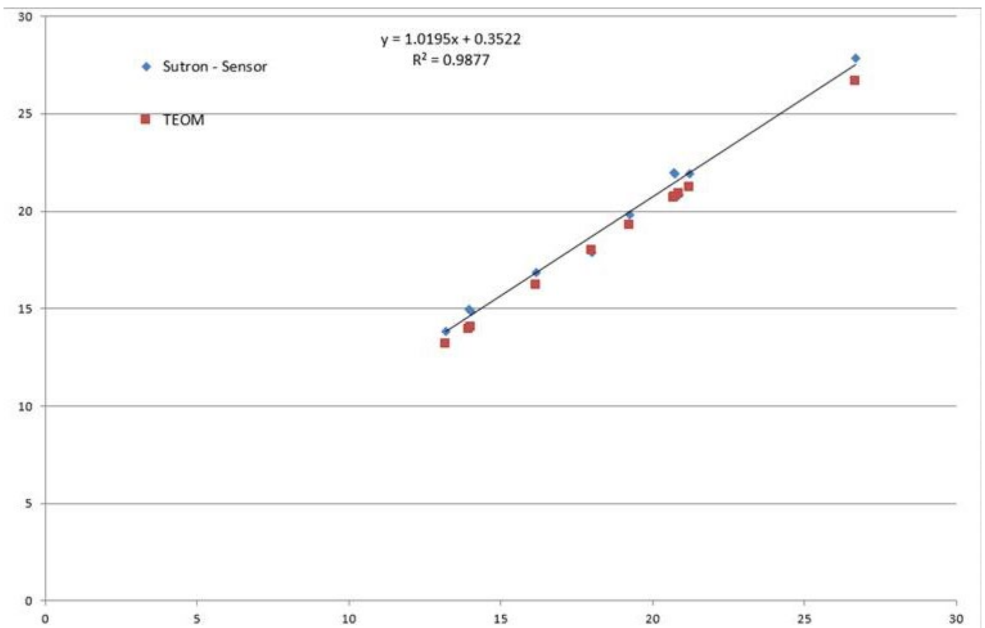


Figure 6.4 Regression anlaysis and R-square showing little variation between monitor and DAS

6.2 Data Management

The following sections provide guidance when managing the data in a monitoring program.

Security

Data management systems need to be safeguarded against accidental or deliberate:

1. **Modification or destruction of data-** This relates to maintaining the integrity of the data, which includes developing policy/procedures for computer use (password protection and authorization), data entry (i.e., double entry, verification checks, etc.), editing, and transfer.

2. **Unavailability of data or services-** Ensuring that data do not get lost (i.e., data backup policies and storage on more than one media or system in more than one place) or that services are not interrupted (maintenance of hardware, surge protection, backup systems).

3. **Unwanted disclosure of data-** This relates to confidentiality and ensuring that secured or confidential data cannot accidentally or deliberately be disclosed physically or through remote transfers.

Standard Operating Procedures

Standard operating procedures (SOPs) are protocols for routine activities involved in a data collection activity that generally involve repetitious operations performed in a consistent manner. SOPs should be established for:

- maintaining system security
- defining raw data (distinction between raw and processed data)
- entry of data
- verification of manually or electronically input data
- interpretation of error codes/flags and corrective action
- changing data
- data analysis, processing, transfer, storage, and retrieval
- backup and recovery
- electronic reporting (if applicable).

Software

Software, either developed internally or "off-the-shelf" must accurately perform its intended function. Tests of the software prior to implementation should occur and be documented. Algorithms should be checked and source code reviewed as part of the process. Source code, including processing comments, should be archived. Procedures for reporting and documenting both software problems and corrective action should be in place.

Data Entry and Formatting

Electronic DAS can record, average, and compile the monitoring data in a variety of reporting formats. If the tribal monitoring organization transfers data to an external database (i.e., AIRNOW, AQS etc.), the personnel responsible for the DAS should assure that the reported data are in the formats required for such reporting to databases. Information on the requirements of major databases such as AQS can be found at https://www.epa.gov/aqs.

In many cases, monitoring data are reported as hourly average values. However, it is suggested that the tribal monitoring organizations consider recording and archiving data with shorter time resolution (e.g., as five minute averages). Such data can be used to compute averages over longer time periods and are valuable for diverse data analyses. For example, short time period data can be used to assess the variability and uncertainty in hourly or longer time period data, to evaluate temporal trends or source impacts, and be used in special research projects. The availability of high time resolution data is valuable to the data-user community, and is likely to foster analyses of air quality that could not be attempted with hourly or longer data periods.

Data Review

The review of collected data is the most important means to assure data quality in ambient monitoring. The review process has multiple stages, beginning with observations in the field, continuing through the analysis of electronic data, and ending with the reporting of final data. Data review should be the subject of a SOP that defines the criteria an agency will apply in processing and reporting the monitoring data.

Data review in the field should involve the observations and records of site operators on topics such as the operational status of analyzers, the need for maintenance or repair, the occurrence of unexpected or unexplained readings, the existence of difficult or unusual meteorological conditions, and the observation of ambient data outside the normal range for the site. At a minimum, such observations must be recorded in a paginated station/instrument logbook, a template form, or other document. Preferably, such observations should also be recorded electronically. These records should be associated with the ambient data through the data acquisition system. Data review in the field is the first step in flagging suspect data for subsequent review.

Staff view a plume of gypsum near the Pueblo of Jemez.

Data review is a key component of the data analysis process. Electronic data acquisition systems allow automatic flagging of data based on the status (i.e., alarms, internal diagnostics, calibration results) of the analyzer, or based on other criteria such as expected data ranges. However, review of the data by experienced personnel is still necessary. This review should be carried out promptly after data collection and should take into account any field observations such as those noted above. The aim of this review is to identify and flag suspect data, and to validate data based on the variety of information recorded. Software associated with an electronic data acquisition system can be used to assist in comparing various types of data to flag or confirm the validity of the ambient measurements.

The final step of data review is conducted to ensure that data is appropriately reduced (aggregated, averaged etc.) and formatted for reporting. The usefulness of data is dependent on the consistency and accuracy of the processed data. Careful review of the data should take place to assure complete and correct submission of formatted data sets.

6.3 Data Management Tools to Assist the Tribes

As is the case with most tribal monitoring organizations that are running a small number of monitors, personnel can not be devoted to single tasks like data management, and therefore, it is not always easy to keep up with the data management load. In addition, the data management function in tribal organizations requires knowledge of the analyzers and samplers (raw data retrieval), data loggers, communication services (modems, satellite telemetry etc.) data storage, and transfer to external data bases. Realizing the burdens that are placed on the tribal monitoring organizations, tools have been developed that should make the data management job easier.

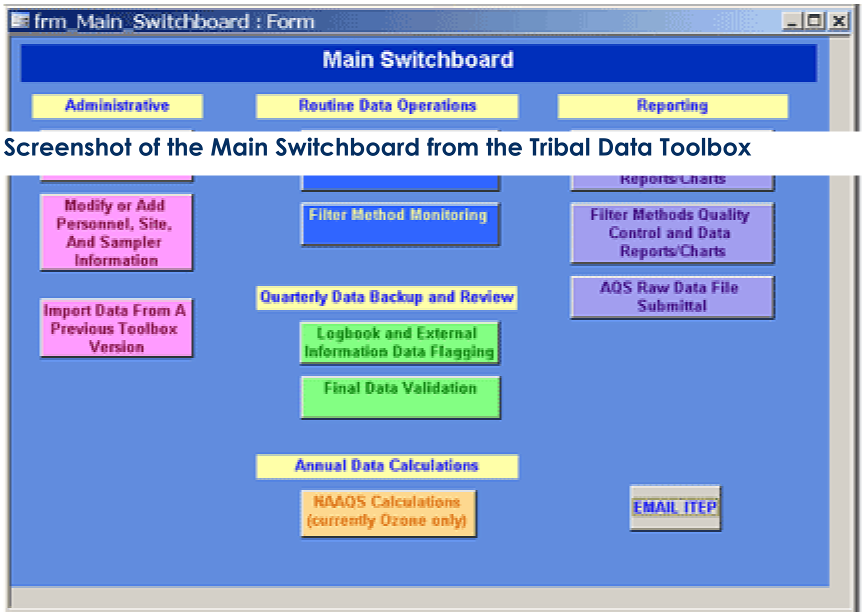
The Tribal Data Toolbox

The Institute for Tribal Environmental Professionals (ITEP) developed the Tribal Data Toolbox[36]. This data management tool offers tribes a comprehensive MS Access database that can house all operational data from air monitoring operations, including administration (site, sampler, QC equipment, and personnel data), operations (importing and flagging continuous met and pollutant data and PM filter data), analysis (QC reports, summary reports, charts, ozone NAAQS calculations), and reporting (AQS-format file generation for all pollutant and met data). The Toolbox is form-driven so

[36] https://www7.nau.edu/itep/main/air/air_aqt_tdt

users do not need to know Access programming to use it. Results of QC checks are entered into the database and used to validate data.

The Toolbox has been pilot tested at a number of tribal programs and against a wide variety of instruments, methods, and dataloggers. Three phases of data review and validation are incorporated into the Toolbox, so that data is sent through a "pipeline" of:



Screenshot of the Main Switchboard from the Tribal Data Toolbox

1. data review and flagging (qualification) at the time of initial import,

2. quarterly data flagging based on logbooks and audit reports, and

3. final data validation to determine data acceptability for AQS data entry, final report generation, and the assignment of AQS null value codes.

The database provides functions for backing up and archiving data. All data tables, charts, and reports can be exported to MS Word, Excel or Adobe. The User Guides are hyperlinked from within the database, and provide over 100 pages of operation-specific help. The Toolbox is ideal as a stand-alone data management system or in conjunction with other software. An advantage of the Toolbox is that it can be a repository for all the tribe's air data, enabling queries such as parameter-to-parameter comparisons by date, site, or other factors. Existing databases, text files, or Excel files can be easily imported.

An instructor-led on-line course on the Toolbox will be ready for students in 2017. This course will provide example data from met sensors, gas analyzers, PM continuous instruments, and PM filter data and provide specific exercises for each function. In addition to the Toolbox, ITEP staff can, as resources allow, assist tribal programs in utilizing Toolbox including importing existing data and modifying the database for their particular needs. As ITEP continues to improve the Toolbox, new versions will be released and each version will include an import-previous-version function so that no data is lost.

Tribal Environmental Exchange (TREX) Network

Under a series of EPA grants, Sutron Air Quality Divison, in partnership with the Walker River Paiute Tribe (in its capacity as grant coordinator), and NAU (providing server hosting and tribal outreach) has designed, implemented and provided continuing training and support for an environmental monitoring system created specifically for tribes. This project is referred to as the TRibal Environmental Exchange (TREX) Network[37]. The TREX Network is currently composed of twenty tribes, Northern Arizona University's Institute for Tribal Environmental Professionals (NAU ITEP), the Tribal Air Monitoring Support (TAMS) Center, and Sutron AQD.

TREX uses the Sutron Leading Environmental Analysis and Display System (LEADS) software, which is a web-enabled data management system for continuous environmental monitoring parameters including meteorological data, air quality data and water quality data. This software system resides on a group of TREX owned servers originally purchased and installed at the NAU Flagstaff IT facilities in June of 2007. The TREX hardware and software systems were both upgraded in 2014 with new servers, updated OS, and the newest version LEADS software. TREX is currently collecting air, water and met data. Using the LEADS software, data is available in real time (streaming from the data logger) and near-real time as data is polled from the individual tribal monitoring sites every fifteen minutes, and ingested into the LEADS central server at NAU.

Petroglyph at Buffalo Eddy, part of the ancestral area of the Nez Perce.

Originally, five tribes (Walker River Paiute Tribe, Lone Pine Paiute Shoshone Reservation, Bishop Paiute Tribe, Pyramid Lake Paiute Tribe, Salt River Pima Maricopa Indian Community), and the TAMS Center participated in the initial pilot project under a U.S. Environmental Protection Agency (EPA) National Environmental Information Exchange Network (NEIEN) grant managed by ITEP. During the following years, the Fort McDowell Yavapai Nation, Fort Independence Paiute Tribe, Big Pine Paiute Tribe, and the Confederated Salish and Kootenai Tribes joined the network at their own expense. Under a series of follow-on grants awarded to the TREX network,

[37] http://trexwww55.ucc.nau.edu/

numerous other tribes have been added to TREX: the Pleasant Point Passamaquoddy Tribe of Maine, Alabama-Coushatta tribe of Texas, St Regis Mohawk Tribe of NY, Warm Springs Tribe of Oregon, Hoopa Valley Tribe of California, Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians, the Inter-Tribal Council of Michigan, Nez Perce Tribe, Shoshone Bannock Tribe, Eastern Band of Cherokee Indians, Cortina Rancheria Band of Wintun Indians, the Yerington Paiute Tribe and the Las Vegas Paiute Tribe.

Data Analysis and Reporting Tool (DART)

DART is a web-based application that provides tools for data validation and analysis of air pollutant data collected as part of the ozone precursor, particulate matter, and air toxics monitoring networks. DART users can upload their data sets, or request data from EPA's AQS, and perform quality control tasks on the data (e.g., visually inspect data, apply screening criteria, and run validation checks that are tailored for different compounds), perform exploratory data analysis, and prepare data sets that are ready to submit to AQS.

DART is also the portal for accessing and reviewing data that are processed by the laboratory for monitoring sites in the Chemical Speciation Network (CSN). Data are automatically imported into DART from the laboratory; staff at air monitoring agencies are alerted when new data become available for their review and download.

With these tools, monitoring organizations can rapidly validate and release data. DART is freely available and can be accessed under the "Tools" menu within AirNow-Tech: https://www.airnowtech.org/ by using an existing AirNow-Tech account or requesting a new one (https://www.airnowtech.org/requestAccnt.cfm).

Technical Assistance for Data Management

ITEP Technical Specialists are available to assist tribes one-on-one with using the Tribal Data Toolbox[38], or, to a more limited extent, their own systems to prepare valid, AQS-submission ready files. Most assistance will be provided by phone or online. The American Indian Air Quality Training Program's (AIAQTP) Professional Assistance (PA) Program provides some funds to cover travel as available. Funds are allocated each year based on requests and specific needs but travel funds for this service can not be guaranteed. Tribes may want to consider securing travel funds for a one-on-one technical specialist visit, if needed and as TAMS staff are available

[38] http://www7.nau.edu/itep/main/air/air_aqt_tdt

The Tribal Exchange Network[39] (not to be confused with the TREX) offers tools and a resources that assists within the context of EPA's Environmental Information Exchange Network[40] (EN). The EN is an internet based approach for exchanging environmental data among partners. Tribes that are working to develop the capacity to collect and manage environmental data can partner with a more experienced tribe and propose a capacity building project. Additionally, the Exchange Network offers grants to streamline data reporting to EPA and/or to share data with other partners.

6.4 Data Transfer to External Databases

Depending on the monitoring objectives, tribes may be participating/supporting national monitoring programs like IMPROVE, CASTNET, NCore or SLAMS. These programs have databases that accept data under particular formats and requirements. As mentioned earlier, developing DAS systems to capture the data in the specific formats is very advantageous and may alleviate many data processing steps. Since the AQS system is one of the major systems that the tribes will report data to, the next few sections will be devoted to a discussion of this system.

Air Quality System (AQS)

AQS is the system administered by the EPA and is used by many different groups to assess the status of the Nation's air quality. The Office of Air Quality Planning and Standards (OAQPS) and other AQS users rely upon the system's data to assess air quality, assist in attainment/non-attainment designations, assess trends, evaluate state implementation plans (SIPs) for non-attainment areas, perform modeling for permit review analysis, and other air quality management functions. AQS information is also used to prepare

TRIBES & AQS

Many tribes are required to submit data to AQS as part of their grant conditions, other tribes do it voluntarily. Entering ambient, meteorological, toxics and or special study data helps to complete a bigger picture of our Nation's air.

The Confederated Tribes of the Colville Reservation, together and as part of their PQAO with the Washington Department of Ecology, submit data to AQS.

Cherokee Nation has been submitting data to AQS for as long as they have been collecting data since 1998.

[39] http://www.tribalexchangenetwork.org/home.html

[40] http://www.exchangenetwork.net/

reports for Congress as mandated by the Clean Air Act. Certain data needs to be uploaded to the EPA's AQS or AirNow databases if funded with EPA grants.

The AQS includes a repository of ambient concentrations of air pollution data collected by EPA, tribal, state, and local air pollution control agencies from thousands of monitoring stations. AQS also contains meteorological data, descriptive information about each monitoring station (including its geographic location and its operator), and quality assurance/quality control information.

Using AQS

In order to use AQS, monitoring organization representatives must be registered AQS users. AQS registration forms and procedures are available on the AQS website[41]Registration forms should be submitted to the appropriate EPA Regional Office (also listed on the website) for processing and approval. Once approved, an AQS user identification and password will be provided.

Agencies can either designate the agency representatives for data entry or data retrieval (or both). Only individuals designated for data entry can add or modify the agency's data within AQS. All registered users can retrieve any data (i.e., their agency's data or any other agency's data) in many different formats from AQS.

Getting Data into AQS

In order to report data to or access data from AQS, you will need the following:

- An internet connection.
- Java Runtime Engine (JRE) - AQS will prompt for installation if it is not present.
- A browser that allows for Java applets to be run and PDF files to be displayed.
- A display of 1024 x 768 resolution or better.

The AQS User's Guide provides excellent details on how to submit data and/or retrieve data from AQS. This manual, along with other useful AQS guides, can be found on the AQS website[42].

AQS Data Submission Requirements

EPA regulations, for data used in comparison the NAAQS, require monitoring organizations to report air monitoring data at least quarterly. Data for one calendar quarter are due to EPA by the end of the following quarter. However, some values may be absent due to incomplete reporting, and some values subsequently may be changed due to quality assurance activities. Today, monitoring organizations can submit data directly to AQS via a web application. Users will need access to the

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[41] https://www.epa.gov/aqs.

[42] https://www.epa.gov/aqs/aqs-manuals-and-guides

AIR NOW

AirNow recently celebrated its 20th Anniversary. During that time, many air quality agencies, including tribes, started participating and submitting their data.

Currently, there are over 20 tribal partners from 13 different states stretching from coast-to-coast.

internet in order to access AQS. Registered users may also retrieve data through the reports functionality within the AQS application. In addition, the data submitted to AQS is certified as valid on an annual basis. This normally occurs 6 months (by May 1) after the end of the calendar year (i.e., 2016 data is certified by May 1, 2017). It should be noted that not all data is/must be certified; 40 CFR 58 Appendix A lists what must be certified.

Who has Access to Data Once Submitted to AQS?

Registered users have direct access to all data in AQS and they typically make over 60,000 data retrievals from AQS a year. AQS data can be retrieved in over 30 different fixed format reports and/or work files. Although the public has access to retrieve data, only tribal personnel with rights (through AQS passwords), and the EPA AQS administrator have the authority to change data in AQS for a particular tribe's monitors.

AQS data are also available to non-registered users, including the general public through a number of web-based systems including:

AirData– The website provides access to air pollution data for the entire United States.
A naps of air pollution data based on specific criteria. The
si ll of the data in AQS. The site is very popular amongst
h tists, and air quality analysts. Billions of rows of AQS data
c m the site! https://www.epa.gov/outdoor-air-quality-data

AirNow- EPA, NOAA, NPS, tribal, state, and local agencies developed the AirNow website to provide the public easy access to national air quality information for $PM_{2.5}$ and ozone. The website offers daily AQI forecasts, as well as real-time AQI conditions for over 300 cities across the U.S. and provides links to more detailed air quality websites http://airnow.gov/.

How AQS can be used to Retrieve Tribal Monitoring Data in Useful Forms?

EPA modified AQS to allow the use of tribal codes in the place of state/county codes for data loading and retrieval. This change allows tribal users to submit and retrieve tribal data without using a reference to geo-political FIPS State and County codes, and thus reinforces EPA's commitment to recognizing tribal sovereignty. In Type Code "Tribal Monitor". It is suggested that monitors under the tribe's responsibility.

Data and Forecasts courtesy of:
Leech Lake Band of Ojibwe, Minnesota Pollution Control Agency (in cooperation with Fond du Lac Band of Lake Superior Chippewa, Grand Portage Band of Lake Superior Chippewa and Mille Lacs Band of Ojibwe), Red Lake Band of Chippewa Indians

There are a number of ways that tribes can get assistance in using AQS. The following lists some sources of assistance.

AQS Application Online Help

The AQS application features online help from the AQS Users Guide[43]. This User Guide and other user manuals should be the first source for help. The User Guide includes screen prints of most menus, definitions of icons and a glossary of terms.

AQS Website

The AQS website https://www.epa.gov/aqs is an important resource for AQS users. The website contains a wide range of information for the AQS users including:

- AQS registration procedures
- All AQS related manuals and documents, including the AQS Data Dictionary, the AQS Coding Manual, the AQS User Guide and AQS Training materials
- Descriptions of codes used in AQS
- Copies of important memos related to AQS, including all those issued with the release of AQS enhancements (i.e., "release memos")
- List of AQS contacts in EPA and in monitoring agencies
- Access to hundreds of data files, primarily nationwide data files by pollutant, by year (via AirData)

The AQS Helpdesk

The EPA Call Center is available at 1-866-411-4EPA (4372) or via email at epacallcenter@epa.gov . Hours are Monday-Friday 6:00am – 6:30pm Eastern Time. The helpdesk should also be your initial contact for any user problems. There are basically two levels to the help desk. All calls initially go to the EPA Call Center in Washington which might be considered Level 1. The Level 1 personnel can handle most simple questions or issues related to passwords or problems associated with AQS access. If the problem is more complicated it will be forwarded to specially trained call center staff in RTP, NC (Level 2) who are more knowledgeable about the AQS system. If

[43] https://www.epa.gov/aqs/aqs-users-guide-0

they cannot resolve it, it will be sent to the AQS team (Level 3). Call center personnel will log and track the problem and contact the user with a resolution or any other necessary follow-up. When calling the helpdesk, the user must identify his/herself as an "AQS user" because Level 1 personnel support multiple applications. This helpline covers all aspects of AQS, from simple questions such as changing passwords, modifying reports and retrieving specific data, to changing/correcting monitoring data. Also, EPA's ten regional offices each have an AQS representative that assist tribes in using AQS.

If the problem relates directly to the Exchange Network Services Center (ENSC) – the file transfer facility to submit data to AQS – contact the Node Helpdesk Support at 1-888-890-1995 or via email at nodehelpdesk@epacdx.net. They can assist with problems such as invalid/expired ENSC passwords and on understanding the reason for a failed file transfer. Hours are Monday-Friday 8:00am – 6:00pm Eastern Time.

AQS User Notices from EPA

AQS users should remember to keep their e-mail address and other contact information current. If users need to make changes or updates to their contact information, they should log onto AQS and select "Admin", then "Security" from the toolbar, and update information. For tracking all changes to the AQS website and system, subscribe to the RSS feed at https://www.epa.gov/feed/37577/rss.xml.

Tribal Q&A Web Conferencing Sessions

Another avenue to seek help is through the Tribal Q&A web conferencing session, which allows all participants to follow a briefing or demonstration on each user's desktop PC screen. These sessions include personnel from EPA, ITEP and any tribe that would like to participate and/or needs help solving an AQS problem. The goal of the Group is "to work together to solve each others problems". Tribes that have been successful in getting the data management systems to report into AQS are invited to participate in order to help others be successful in this process. Calls are run by Call Center level 2 staff and take place every two months on the second Wednesday.

AQS Orientation Training

Each month, EPA invites new registered users to participate in an AQS orientation training session. The orientation session is presented by the AQS Call Center level 2 staff that AQS users work with if they have problems using the AQS system. This session uses a web conferencing system which allows all participants to follow a briefing or demonstration on each user's desktop PC screen. The orientation session provides a new user with:

- a brief demo of how to navigate through AQS screens,
- a walkthrough of available resources (manuals, training materials) on the AQS Website, and

- an introduction of the AQS Support Team and functions.

The presentation for this orientation session are on the AQS website at: https://www.epa.gov/aqs/aqs-training

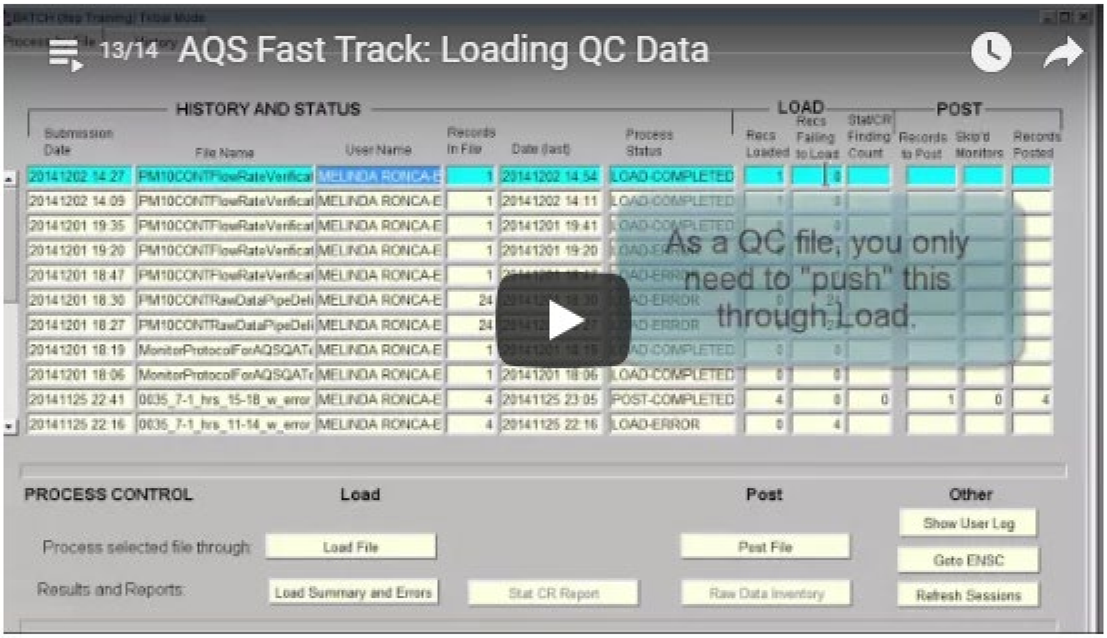
AQS Introductory Training Courses

EPA sometimes offers in-person AQS Introductory training. The 2 day hands-on computer training course teaches students how to navigate through the AQS software, including how to load and retrieve data. Topics include:

- Components of AQS
- AQS user registration
- Data management & formatting
- Data submission
- Data editing
- Generating reports from AQS

Visit the AQS website for information on the next training course http://www.epa.gov/ttn/airs/airsaqs/training/training.htm. This site also posts online training materials.

ITEP has developed a series of videos explaining AQS and how to use it; you can view the videos at http://www7.nau.edu/itep/main/tams/Tools/tools_aqs. The videos are short, and placed in an order such that each one demonstrates one specific functionality of AQS. Although not a comprehensive guide to all parts and functions of AQS, they cover the main activities needed to properly navigate through AQS.



A screenshot of just one of the instructional videos available for AQS through ITEP.

Section 7

Data Interpretation-Understanding Monitoring Data and Its Implications

There are many approaches to data interpretation ranging from a simple data summary to complex statistical procedures. The range of possibilities can be overwhelming, but is easily narrowed by asking a simple question: "Why was monitoring conducted in the first place?" The appropriate use of monitoring data is intimately linked with the monitoring objective(s). Assuming that the tribe has followed the procedures outlined in previous sections of this document, the existing or proposed monitoring plan has a purpose in mind and steps have been taken to ensure that the final data product is adequate for its intended purpose.

For example, a tribe located in a potential high ozone area may set up an ozone monitor to determine attainment of the National Ambient Air Quality Standards (NAAQS). Quality assurance measures must be put in place to collect reliable data for a 3-year period. If the dataset is found to meet data quality objectives, then it may be used as the basis for NAAQS attainment designation for the area. If the data are incomplete or otherwise compromised, then an attainment determination may not be possible.

Aerial view of the Cherokee Nation's Stillwell monitoring site near the Dahlonegah School.

Similarly, there are data quality requirements for hazardous air pollutant (HAP) monitoring which is intended for use in exposure assessment and health risk interpretation. It is not uncommon for an agency to collect ambient HAP data only to later discover that the wrong target compounds were reported or that detection limits were too high to allow comparing the data against cancer risk benchmarks. These problems can be minimized by effective planning which identifies the intended use of monitoring data and delineates specific monitoring quality objectives.

The main goal of this section is to help tribal staff achieve monitoring program objectives through an effective use of monitoring data. The section will provide an overview of data uses and links to relevant guidance documents and examples. Possible data uses include: determining attainment status of NAAQS for criteria pollutants; characterizing population exposure to HAPs, also known as "air toxics"; assessing air pollutant trends over time; and attributing source contribution to air pollution.

Basic data summary and statistical techniques allow tribes to effectively communicate project results. These methods are important for a variety of purposes: to inform tribal members and other stakeholders about local air quality; to summarize monitoring results in final project report or grant related documents; and to describe prior air quality findings as part of the justification for new or continued funding in a grant application.

This section will be useful to an agency that has already collected a dataset and needs help understanding it. However, it may be even more valuable to a program manager who is in the stages of planning an air quality study as it will provide a clear understanding of what an ambient monitoring program can do for them and what questions it can answer. Depending on the technical capabilities of tribal staff, some of the techniques described here may be performed in-house, while others may require partnering with other tribes, agencies or hiring a contractor.

7.1 Specific Data Uses

Criteria pollutants

Tribal agencies that conduct ambient air quality monitoring most frequently collect data for one of, or a combination of the six common pollutants (also referred to as "criteria" pollutants): carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2). PM falls into two categories: particles that are 10 micrometers in diameter and smaller (PM_{10}) and particles that are 2.5 micrometers in diameter and smaller ($PM_{2.5}$). This section will describe how criteria pollutant monitoring data may be interpreted and used as part of an air quality management program. For more information on criteria pollutants, visit https://www.epa.gov/criteria-air-pollutants.

NAAQS Attainment

EPA has set NAAQS for the six criteria pollutants. The NAAQS include both primary and secondary standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. Table 7.1 below lists the current NAAQS for criteria pollutants. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (μg/m^3). Appendix H provides additional information about the NAAQS.

"Designation" is the term EPA uses to describe the air quality in a given area for any of the criteria pollutants. Geographic areas are designated as "attainment", "nonattainment", or "unclassifiable" based on ambient air monitoring data (or lack thereof) collected in that area and reported to the AQS national database. Tribes and states submit recommendations to EPA as to whether or not an area is attaining the NAAQS for a criteria pollutant. After working with the tribal and state agencies and considering the air quality data, EPA officially designates an area as attainment or nonattainment. If an area is designated as nonattainment, state, local and tribal governments can develop and implement control plans to reduce pollution. A Tribal Implementation Plan (TIP) is a set of regulatory programs that a tribe can choose to develop and adopt in order to help attain or maintain national air quality standards. EPA designates an area as a "maintenance area" once a nonattainment area meets the standards and additional redesignation requirements in the CAA [Section 107(d)(3)(E)].

Table 7.1. National Ambient Air Quality Standards.

Pollutant		Primary/Secondary	Averaging Time	Standards
Carbon Monoxide (CO)		primary	8 hours	9 ppm
			1 hour	35 ppm
Lead (Pb) [44]		primary and secondary	Rolling 3 month average	0.15µg/m3
Nitrogen Dioxide (NO2) [45]		primary	1 hour	100 ppb
		primary and secondary	1 year	53 ppb
Ozone (O3) [46]		primary and secondary	8 hours	0.070 ppm
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 µg/m^3
		secondary	1 year	15.0 µg/m^3
		primary and secondary	24 hours	35 µg/m^3
	PM_{10}	primary and secondary	24 hours	150 µg/m^3
Sulfur Dioxide (SO2) [47]		primary	1 hour	75 ppb
		secondary	3 hours	0.5 ppm

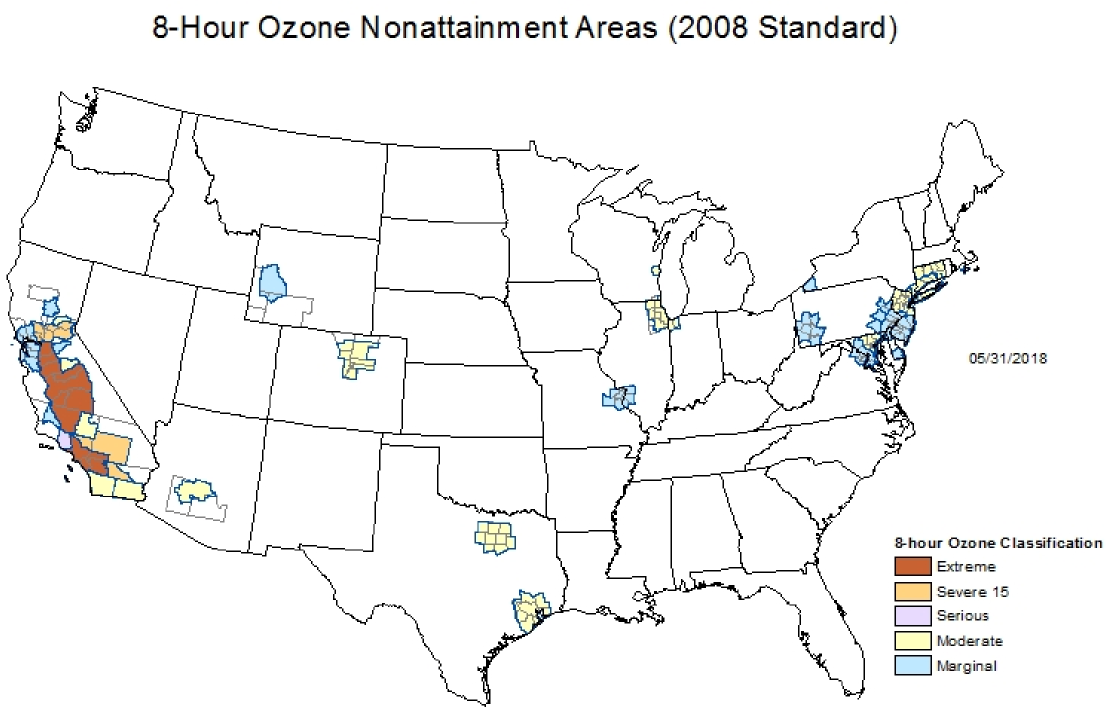
[44] In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.

[45] The level of the annual NO2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

[46] Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

[47] The previous SO2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO2 standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

The EPA Green Book[48] provides detailed information about area National Ambient Air Quality Standards (NAAQS) designations, classifications and nonattainment status. Information is current as of the Green Book posted date and is available in reports, maps and data downloads.



National Map of 2008 Ozone Nonattainment Area from the Green Book.

Detailed instructions on how to determine attainment status based on ambient monitoring data may be found in the Code of Federal Regulations (CFR) Title 40 Part 50. The relevant passages for each criteria pollutant is included in the appendices and may also be accessed on the web at https://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr50_main_02.tpl

Understanding the Air Quality Index (AQI) and AIRNow

The AQI is an index for reporting daily air quality. It tells how clean or polluted the air is and what associated health effects might be a concern for the public. The AQI focuses on health effects that may be experienced within a few hours or days after breathing polluted air. EPA calculates the AQI for five of the criteria pollutants: O_3, PM, CO, SO_2, and NO_x. The AQI scale runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an

48 https://www.epa.gov/green-book

AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality.

An AQI value of 100 generally corresponds to the national air quality standard (see Table 7.1) for the pollutant, which is the level EPA established set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy – at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Raw ambient air monitoring data is converted into AQI values using standard formulas developed by EPA. An AQI value is calculated for each pollutant in an area. The highest AQI value for the individual pollutants is the AQI value for that day. For example, if a certain date had AQI values of 90 for ozone and 88 for sulfur dioxide, the AQI value would be 90 for that area on that day.

The purpose of the AQI is to help the public understand what local air quality means to their health. To make it easier to understand, the AQI is divided into six categories, each of which corresponds to a different level of health concern. The six levels of health concern and what they mean are:

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health alert: everyone may experience more serious health effects.
Hazardous	301 to 500	Health warnings of emergency conditions. The entire population is more likely to be affected.

TRIBES & AIRNOW

Tribes started providing data to AirNow in 2002, beginning with Cherokee Nation. The valuable partnership shares particulate matter and ozone that stretches from tribal lands in California all the way to Maine.

Pyramid Lake Paiute Tribe provides their continuous PM10 data to AirNow.

From the AirNow website at: http://www.airnow.gov/ delivers daily AQI forecasts as well as real-time AQI conditions for most cities across the US as well as over 15 embassies and consulates. EPA developed the AirNow program together with the National Oceanic and Atmospheric Administration (NOAA), National Park Service (NPS), and tribal, state, and local agencies to provide the public with easy access to national air quality information. AQI data are presented in maps which are generated based on "real-time" ambient monitoring data using either federal reference or equivalent monitoring techniques or techniques approved by the state, local or tribal monitoring agencies. Although some preliminary data quality assessments are performed, the data are not fully verified and validated through the quality assurance procedures that monitoring organizations use to officially submit and certify data in AQS. Therefore, data that are used on the AIRNow website are for the purpose of reporting the AQI. Information on the AIRNow website is not used to formulate or support regulation, guidance or any other Agency decision or position.

There are nearly 30 tribes in 13 states that are participating in AirNow. Tribes interested in joining the AirNow network should visit the publications site[49] at the AirNow website. There is a guidance document entitled *Technical Assistance Document for the Reporting of Daily*

[49] https://www.airnow.gov/index.cfm?action=pubs.index

Air Quality - Air Quality Index (AQI)[50] which is designed to aid local agencies in reporting the air quality using the AQI as required in 40 CFR Part 58.50 and according to 40 CFR Appendix G to Part 58. Tribes wishing to submit data to AirNow use the password protected AirNow Tech[51] website. Additional data management analysis and tools are also available on AirNow Tech.

Air quality characterization for non-criteria pollutants

The previous section focused on criteria pollutants and interpreting data in terms of the NAAQS rules. Beyond the six criteria pollutants, however, there are hundreds of other pollutants and indices that a monitoring agency may wish to address. These non-criteria pollutants and measures include ambient air toxics, wet/dry mercury deposition, visibility data, and even biomonitoring of ozone injury to sensitive plants. These types of data do not have corresponding national air quality standards that help guide data summary and interpretation. Instead, monitoring results should be described using basic summary statistics. The data may also be visualized using simple graphic techniques. The national monitoring network fact sheets in Appendix A provide additional details about these important national air programs and include weblinks to areas that describe the uses of the data.

7.2 Basic Data Interpretation Summary Statistics

The first step in summarizing air quality data is to take inventory of the number of samples collected, the range of measurements, and to provide related information about the monitoring schedule. It is important to specify the measurement units of the pollutant. If any of the samples are below detection limits (called "nondetects"), then it becomes necessary to state the method detection limit (MDL), as well as the number or percent of samples below the MDL. An example in table 7.2 is shown below.

[50] https://www3.epa.gov/airnow/aqi-technical-assistance-document-may2016.pdf

[51] https://www.airnowtech.org/

Table 7.2 Example of Monitoring Data Summary

Pollutant	Sampling schedule	Sampling period	Total samples	Unit	MDL	Min. value	Max. value	Percent samples <MDL
Benzene	1-in-6 days	Jan. Dec. 2016	107	ppbC	0.01	0.02	1.3	0
1,3-butadiene	1-in-6 days	Jan. 2015 – Dec. 2016	107	ppbC	0.01	Below MDL	0.8	78%
Arsenic (PM_{10})	Monthly	Jan. 2015 – June. 2016	18	ug/m^3	0.002	Below MDL	0.012	65%
Cadmium(PM_{10})	Monthly	Jan. 2015 – June. 2016	18	ug/m^3	0.01	Below MDL	0.02	21%
Lead (PM_{10})	Monthly	Jan. 2015 – June. 2016	18	ug/m^3	0.005	0.008	0.31	0

If any of the monitored pollutants has nondetect values, then this issue must be resolved before moving on to data analysis. There are a number of ways to handle data that is below some level of detection and guidance should be sought on the best way to handle this information. It is generally not recommended to delete nondetects from the dataset because this will cause an upward bias in the results; similarly nondetects should not be replaced by zeroes because this biases the results downward.

Note that a high percentage of nondetects results in less reliable data summary statistics. Although there is no definite cut-off, a pollutant with greater than 50% nondetects should be treated with care and one with more than 80% nondetects may be removed from further analysis or may need to be summarized in a different manner. Depending on the importance of a specific pollutant to the monitoring study, the data analyst has a few choices: state that the pollutant has a very high rate of nondetects and remove it from the data analysis; include the pollutant and point out potential problems related to nondetects; or include the pollutant and use advanced statistical techniques developed for datasets with a high rate of nondetects. Statistical techniques that may be useful in handling datasets with a high rate of nondetects are described in the following article: *Less Than Obvious: Statistical Treatment of Data Below the Detection Limit*[52].

Additional information including equations and examples of statistical measurements can be found in Appendix J, *Statistical Measurements*.

7.3 Putting Monitoring Data into Context

Criteria pollutants

In addition to determining NAAQS attainment and AQI values, tribal monitoring agencies may benefit from putting monitoring data into a broader context. There are a few ways to do this. Tribes may look up data for the same pollutant at other monitoring sites located in the same state or region to see how the values compare. It may also be helpful to look at a nation-wide summary of data or a list of nonattainment areas. A broader context may also be obtained by learning about national trends in air quality data.

EPA's AirData[53] website provides access to air pollution data for the entire U.S. as submitted to AQS. AirData produces reports and maps of air pollution data based on user-specified queries. For example, a tribal agency located in Arizona may wish to look up last year's ozone data for all monitoring sites in the state. The link below is the interface where the user selects the geographic area for the data search. Subsequent web pages narrow the search to the desired pollutant, year, and report format.

The EPA AQS Data Mart[54] is a database containing all of the information from AQS. It has every measured value the EPA has collected via the national ambient air monitoring program. It also includes the associated aggregate values calculated by EPA (8-hour, daily, annual, etc.). The AQS Data Mart is a copy of AQS made once per week and made accessible to the public through web-based applications. The intended users of the Data Mart are air quality data analysts in the regulatory, academic, and health research communities. It is intended for those who need to download large volumes of detailed technical data stored at EPA and does not provide any interactive analytical tools.

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52 Dennis R. Helsel (USGS), Environmental Science and Technology, Vol. 24, No. 12, 1990. https://water.usgs.gov/admin/memo/BSA/BSA90.01.pdf

53 https://www.epa.gov/outdoor-air-quality-data

54 https://aqs.epa.gov/aqsweb/documents/data_mart_welcome.html

EPA's Global Change Explorer[55] is a collection of web tools that allow visualization, comparison, and access to spatial data that describe potential future environmental change. These data can serve as a starting point to assess the vulnerability of air, water, ecosystems, and human health to climate change, land use change, and other large-scale environmental stressors. The data and tools in the Global Change Explorer are relevant across multiple scientific disciplines and environmental media, providing a foundation for integrated assessments of global change.

EPA's Green Book[56] lists all nonattainment areas in the U.S. The user can access a variety of maps and reports for each criteria pollutant at this website The Green Book provides detailed information about area National Ambient Air Quality Standards (NAAQS) designations, classifications and nonattainment status. Information is current as of the Green Book posted date and is available in reports, maps and data downloads.

EPA tracks air pollution trends using two main indicators: ambient air monitoring data and pollutant emissions. EPA estimates national emissions of criteria pollutants and air toxics based on many factors, including actual measurements, levels of industrial activity, fuel consumption, vehicles miles traveled, and other estimates of activities that cause pollution. For EPA's most recent evaluation of air pollution trends, see: https://www.epa.gov/air-trends/.

The Technical Support System[57] is an online exchange of air quality data, research, and ideas originally designed to understand the effects of air pollution on visibility in support of the Regional Haze Rule. It is an online decision support system developed to help states, tribes, federal land managers (FLMs), scientists, planners, and students evaluate air quality and visibility in federally-protected ecosystems. As of this writing the TSS website is currently under heavy development and is not ready for final review or use. The content, navigation, styling, layout, and all other aspects of the website are currently preliminary, unfinished, and subject to change at any time

Air toxics, deposition, and other monitoring data-

Air toxics monitoring data from other sites in the U.S., as submitted to AQS, may be accessed through the AirData website. Additionally, some materials are available from nation-wide air toxics data analyses. The following links may be useful for putting toxics data into context:

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55 https://globalchange.epa.gov/

56 https://www.epa.gov/green-book

57 http://views.cira.colostate.edu/tssv2/

- National, Regional, Between-City, and Within-City Spatial Variability in Air Toxics[58]
- Temporal Trends in Air Toxics[59]

The Clean Air Status and Trends Network CASTNET[60] is the nation's primary source for data on dry acidic deposition and rural, ground-level ozone. CASTNET consists of over 90 sites across the eastern and western United States and is cooperatively operated and funded by the National Park Service. Data are available for download for ambient air pollutants and wet/dry deposition on their website.

The National Atmospheric Deposition Program NADP[61] is a program consisting of five national networks that monitor precipitation chemistry; it is a cooperative effort between many different groups, including federal, state, local governmental agencies, educational institutions, private companies, non-governmental agencies and fourteen tribal agencies. Networks (and their respective data and websites) are housed within the NADP include the:

National Trends Network (NTN)

Measures only during precipitation events and provides a long-term record of precipitation chemistry across the United States.

Mercury Deposition Network (MDN)

A database of weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition for the United States and Canada.

MERCURY DEPOSITION

Mercury monitoring has been performed at the Makah National Fish Hatchery since May 2007 and continues today. Funding for the monitoring throughout the years has been provided through various sources including: Washington State Department of Ecology, the Mercury Deposition Network, and the TAMS Center. Current operation and maintenance of the site is performed by the Makah Air Quality Specialist through CAA 105 funding.

Makah mercury monitoring.

[58] https://www3.epa.gov/ttnamti1/files/ambient/airtox/2005workshop/spatial.pdf

[59] https://www3.epa.gov/ttnamti1/files/ambient/airtox/2005workshop/temporal.pdf

[60] https://www.epa.gov/castnet

[61] http://nadp.sws.uiuc.edu/

Atmospheric Integrated Research Monitoring Network (AIRMoN)

Wet-only, single-storm data facilitate studies of atmospheric processes and the development and testing of computer simulations of these processes.

Atmospheric Mercury Network (AMNet)

Measures atmospheric mercury fractions which contribute to dry and total mercury deposition.

Ammonia Monitoring Network (AMoN)

Provides a consistent, long-term record of ammonia gas concentrations across the United States.

EPA established the National Dioxin Air Monitoring Network[62] (NDAMN) to determine the temporal and geographical variability of atmospheric CDDs, CDFs and coplanar PCBs at rural and nonimpacted locations throughout the United States. Summary reports are available from 1998 through 2004 at the website.

The Integrated Atmospheric Deposition Network[63] (IADN) was established by the United States and Canada for conducting air and precipitation monitoring in the Great Lakes Basin. PAHs, PCBs, and organochlorine compounds are measured in air and precipitation samples in the U.S. and Canada.

The USDA Forest Service's Forest Health Monitoring[64] (FHM) is a national program designed to determine the status, changes, and trends in indicators of forest condition on an annual basis. The FHM program uses data from ground plots and surveys, aerial surveys, and other biotic and abiotic data sources and develops analytical approaches to address forest health issues that affect the sustainability of forest ecosystems.

The USDA Forest Service's Forest Inventory and Analysis[65] (FIA) uses biomonitoring to monitor the potential impact of tropospheric ozone (smog) on forests. This program uses bioindicator plants to detect and quantify ozone stress in the forest environment. A nationwide network of ozone biomonitoring sites has been established across the forested landscape. Each year, these sites are evaluated for the amount and severity of ozone injury on sensitive plants. The foliar injury data is used to monitor changes in

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[62] https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=254526

[63] https://www.epa.gov/great-lakes-monitoring/great-lakes-integrated-atmospheric-deposition-network

[64] https://fhm.fs.fed.us/

[65] https://www.fia.fs.fed.us/

relative air quality over time and to examine relationships between ozone stress and tree health.

Source apportionment

In the absence of air monitoring, pollutant emissions data may be used to help characterize air quality. The following focuses on evaluating air monitoring data in the context of emissions sources that may be impacting the monitor site. Different approaches are described to identify pollution sources and to estimate the potential to affect local air quality.

Using emissions inventories

If monitoring data show that a specific pollutant is exceeding air quality standards, or is otherwise causing concern, then emission inventories can identify potential sources. National Emissions Inventory (NEI) data are most easily accessed on EPA's website[66]. By searching in the state or county of interest in AirData[67], the user can then access the NEI data for point, nonpoint, and mobile sources. The NEI contains information about sources that emit criteria air pollutants and their precursors, and hazardous air pollutants. The AirData website generates reports based on facility-specific and county aggregate emissions data.

Tribal agencies can contact their respective state environmental agency to get more detailed information on sources (smaller sources) that might not be included in the NEI.

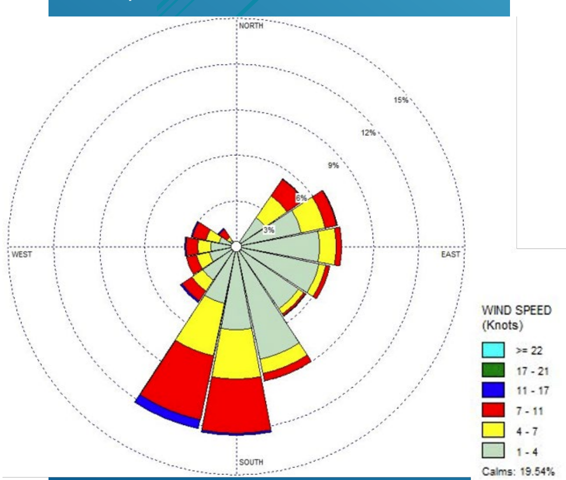
Meteorological Data

Meteorological data collected at an air monitoring site can be used to further interpret pollutant measurements and potential impact

THE WIND BLOWETH WHERE IT LISTETH

Cherokee Nation wind rose generated from WRPLOT View. CNEP has used wind roses in their mobile monitoring reports to indicate the wind speed and direction distribution in the host area.

The below shows the latest report from Wyandotte, OK.



66 https://www.epa.gov/air-emissions-inventories

67 https://www.epa.gov/outdoor-air-quality-data

from emissions sources. Wind data can be summarized over a year or multiple years to show prevailing wind patterns at a given site. A diagram called a "wind rose" (Fig 7.8) characterizes the wind conditions over time. The example below is a wind rose produced for the Bishop International Airport in Flint Michigan. The figure shows the frequency of winds coming from each direction, categorized by wind speed ranges.

If a major pollution source is identified near tribal land, then a wind rose can show whether the air monitor site is likely to be downwind of the emission source on an occasional or frequent basis. An industrial facility that is predominantly upwind of tribal land is more likely to impact the air monitor than a facility that is generally downwind. A wind rose program called WRPLOT View is available for free from Lakes Environmental[68].

To investigate further, the data analyst may conduct a wind-direction analysis. This approach requires finding daily wind data that is reported concurrently with air sampling events. Monitoring data may be divided into "high pollution days" and "low pollution days", and the meteorological data consulted to see whether higher concentrations occur on days when the winds come from a certain direction. Alternatively, each hourly or daily pollutant measurement can be divided into one of sixteen categories according to the predominant wind sector (north, north-northeast, northeast, east-northeast, etc.) and the average concentrations for all sectors compared with one another.

Tribal agencies may generate wind roses or conduct wind-direction data analysis using on-site meteorological data. If the tribe does not have a meteorological station, data may be obtained from other agencies that have a nearby meteorological station. In some cases, the data may be downloaded from AQS. Technical staff at the TAMS Center, neighboring tribes, EPA and state agencies may have insights on how to locate data from other sources. Historic wind data for many communities (useful for wind roses) is available for free download at this website: http://www.webmet.com. Recent meteorological data is increasingly available on the internet.

If long-range transport of pollutants is a concern, then another approach to consider is the HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) model developed by NOAA. HYSPLIT (Fig 7.1) can map a back trajectory (a track showing where an air parcel passed before reaching the air monitor). The example below

[68] https://www.weblakes.com/products/wrplot/index.html

shows the back trajectory of different air parcels that may have reached a monitor in western Michigan over a 24-hour period. The air parcels originated in several different states (Iowa, Missouri, Illinois and Indiana); however they all passed through northern Illinois before reaching the monitor in Michigan. If this particular date had been a high ozone day, then the Hysplit results would suggest that precursor pollutants from the greater Chicago area contributed to ozone formation. HYSPLIT can be downloaded for free or used on-line on the [National Oceanic and Atmospheric Administration's](http://ready.arl.noaa.gov/HYSPLIT.php) (NOAA) website[69].

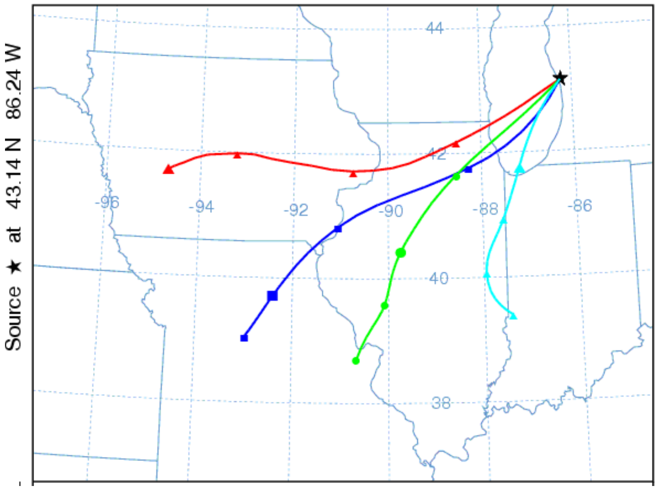


Figure 7.1 Example of Hysplit backward wind trajectory.

NOAA's Real-time Environmental Applications and Display sYstem (READY) accesses and displays meteorological data and runs trajectory and dispersion model products. READY[70] brings together dispersion models, meteorological display programs and textual weather forecast programs generated over many years at ARL into a form that is easy to use by anyone.

Exposure assessment for hazardous air pollutants

Air toxics, or HAPs, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. Examples of toxic air pollutants include benzene, which is found in gasoline; perchlorethlyene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries. As indicated in a previous sidebar, the Morongo Band of Mission Indians conducted air toxics monitoring in years 2014 & 2016 to determine correlation between toxics and possible nearby sources. Other listed air toxics include dioxin, asbestos, toluene, and metals such as cadmium, mercury, chromium, and lead compounds.

Links to more information about air toxics are provided below.

- EPA's Health Effects Notebook provides fact sheets about the current 187 HAPs: https://www.epa.gov/haps/health-effects-notebook-hazardous-air-pollutants
- Air Pollution and Health Risk

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[69] http://ready.arl.noaa.gov/HYSPLIT.php

[70] http://ready.arl.noaa.gov/index.php

https://www3.epa.gov/airtoxics/3_90_022.html

- Evaluating Exposures to Toxic Air Pollutants: A Citizen's Guide
  http://www.epa.gov/ttn/atw/3_90_023.html

- Risk Assessment for Toxic Air Pollutants: A Citizen's Guide
  http://www.epa.gov/ttn/atw/3_90_024.html

Risk assessment is a tool used by environmental specialists to estimate the increased risk of health problems in people who are exposed to different amounts of toxic substances over a long period of time. The risk assessment process has four steps:

- Hazard assessment – what health problems are caused by the pollutant?
- Dose-response assessment – what are the health problems at different exposures?
- Exposure assessment – how much of the pollutant do exposed people inhale?
- Risk characterization – what is the extra risk of health problems in the exposed population?

Air toxics monitoring data may be used in the exposure assessment step of risk assessment. If sufficient data exist for the pollutants of concern, then monitoring data may be used instead of, or in addition to, dispersion modeling outputs.

Using monitoring data in a risk assessment can be a very complex process, requiring assistance from a statistician and toxicologist, among other specialists. To decide whether a full-blown risk assessment is warranted, EPA Region 4 scientists developed a screening procedure that can help monitoring staff do a preliminary evaluation of their air toxics data. The document, *A Preliminary Risk-Based Screening Approach for Air Toxics Monitoring Data Sets*[71] is available through the National Service Center for Environmental Publications website[72].

EPA has also developed a *Community Air Screening How-to Manual*[73] for use by groups that includes non-technical community residents and leaders, as well as technical experts. The manual describes a process that uses input from a wide variety of community stakeholders.

[71] https://www.fdlp.gov/file-repository/about-the-fdlp/gpo-projects/web-harvesting/sample-publications-from-pilot/1813-a-preliminary-risk-based-screening-approach-for-air-toxics-monitoring-data-sets

[72] https://www.epa.gov/nscep

[73] https://www.epa.gov/tsca-screening-tools/community-air-screening-how-manual

If the tribal agency has determined that a complete technical risk assessment is needed, then EPA guidance documents are available for use by tribal staff or contractors at the Air Toxics Risk Assessment Reference Library[74]. The library provides information on the fundamental principles of risk-based assessment for air toxics and how to apply those principles in different settings, as well as strategies for reducing risk at the local level.

EPA has compiled dose-response data for air toxics for use in risk assessments, including values for long-term (chronic) inhalation and short-term (acute) inhalation exposures. This information is regularly updated as new information becomes available about the toxicity of specific HAPs. The dose-response values provided as Excel tables at this site[75] are recommended by EPA as the most appropriate for use in air toxics risk assessments.

Multi-media risk assessment using ambient and deposition monitoring data-

For a limited subset of HAPs, it is important to consider deposition from air to soil, vegetation, or water bodies. Many studies indicate that some pollutants emitted into the atmosphere (e.g., mercury) are passed to humans or wildlife through non-inhalation pathways (e.g., an air pollutant deposited from the air onto the soil, followed by ingestion of the soil by people or by other living things in an ecosystem). These air pollutants typically are persistent in the environment, have a strong tendency to bioaccumulate, and exhibit moderate to high toxicity.

A variety of computer models are available to describe the multimedia transport and fate of pollutants released to the atmosphere. EPA developed TRIM.FaTE[76], a model that can estimate pollutant concentrations in multiple environmental media and biota, for use in ecological risk assessment. Other multi-media models are available here[77].

Air Sensor Technology

The new generation of low-cost, highly portable air quality sensors opens an exciting opportunity for people to use this technology for a wide range of applications beyond traditional regulatory or regulatory-equivalent monitoring. Air pollution sensors are still in an early stage of technology development, and many sensors have not yet

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[74] https://www.epa.gov/fera/risk-assessment-and-modeling-air-toxics-risk-assessment-reference-library

[75] https://www.epa.gov/fera/dose-response-assessment-assessing-health-risks-associated-exposure-hazardous-air-pollutants

[76] https://www.epa.gov/fera/total-risk-integrated-methodology-trim-trimfate

[77] https://www.epa.gov/fera/multimedia-fate-and-transport-modeling-links-other-models-and-related-information

been evaluated to determine the accuracy of their measurements. EPA has specific guidelines it must use in establishing regulatory-grade air monitors. No lower cost sensors currently meet these strict requirements or have been formally submitted to EPA for such a determination. The table below summarizes some potential non-regulatory application areas for air sensors and provides brief descriptions and examples.

Table 7.3 Descriptions of potential uses for low cost air sensors

Application	Description	Example
Research	Scientific studies aimed at discovering new information about air pollution.	A network of air sensors is used to measure particulate matter variation across a city.
Personal Exposure Monitoring	Monitoring the air quality that a single individual is exposed to while doing normal activities.	An individual having a clinical condition increasing sensitivity to air pollution wears a sensor to identify when and where he or she is exposed to pollutants potentially impacting their health.
Supplementing Existing Monitoring	Data Placing sensors within an existing state/local regulatory monitoring area to fill in coverage.	A sensor is placed in an area between regulatory monitors to better characterize the concentration gradient between the different locations.
Source Identification and Characterization	Establishing possible emission sources by monitoring near the suspected source.	A sensor is placed downwind of an industrial facility to monitor variations in air pollutant concentrations over time.

Application	Description	Example
Education	Using sensors in educational settings for science, technology, engineering, and math lessons.	Sensors are provided to students to monitor and understand air quality issues.
Information/Awareness	Using sensors for informal air quality awareness.	A sensor is used to compare air quality at people's home or work, in their car, or at their child's school.

Quapaw Criteria Pollutant Shelter Site with Aeroqual sensor evaluation.

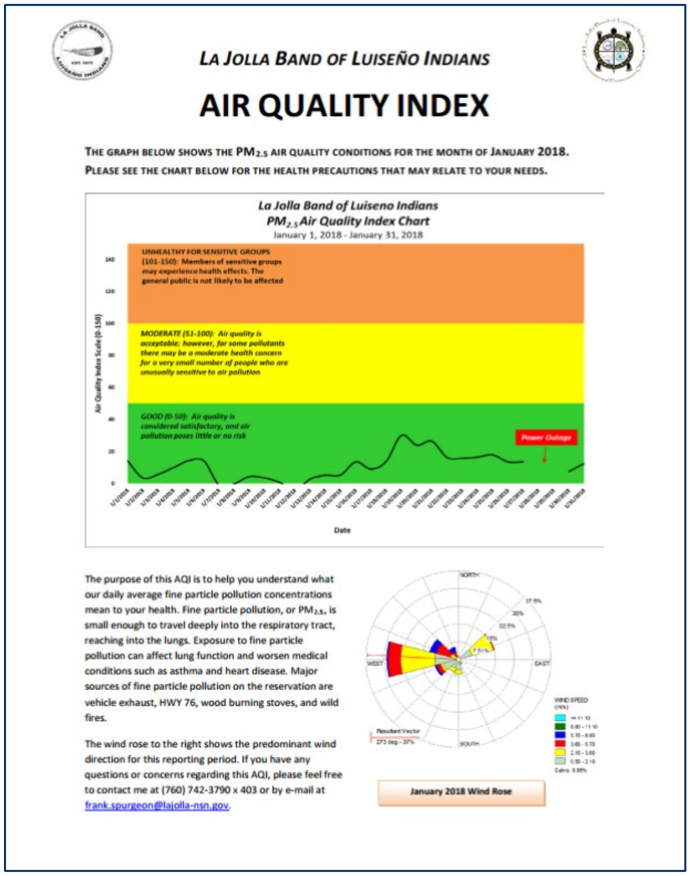
Tribes have engaged in sensor use and assessment, including the Cherokee Nation and the Quapaw Nation. Following their 3 month study, they were able to examine, interpret and compare the results against FRM ozone monitors. This coincides with EPA's *Air Sensor Guidebook*[78] which has been developed by the U.S. EPA to assist those interested in potentially using lower cost air quality sensor technologies for air quality measurements. As the *Air Sensor Guidebook* discusses interpretation, one should do the following:

78 https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=277996&simpleSearch=1&searchAll=air+sensor+guidebook

Analyze, Interpret, and Communicate Your Results. The way you present your results to your audience is critical to successfully sharing your understanding of the data and achieving the objectives of sensor-based air quality data collections. Common ways of visualizing data are: graphs of pollutant concentrations over time to show daily, weekly, seasonal, or yearly variation in concentrations; charts of wind direction and/or pollution to identify sources, and maps plotting data from several sensors to illustrate patterns in concentrations. Generally, simply showing the measurements that you have collected will not be sufficient; your audience will want to know about all the steps that you took to ensure data quality:

- Quality Assurance – Adequate planning to ensure that sensor design and use met the performance requirements of your specific application. Depending on your intended use of the data you collect, you might consider data quality assurance at various levels. For instance, data intended for a direct comparison with State or Federal monitoring would require significantly more quality assurance than a general survey of pollutant concentrations for informational purposes only (such as an educational event for a grammar school).
- Quality Control – Sensor calibrations, precisions and bias checks, maintenance, and data audits required for your application during data collection to identify and correct potential issues such as sensor degradation, problems with sensor location, etc.
- Quality Assessment – Determination of the quality of your measurements and sufficient analysis of the data prior to reaching final conclusions.
- Regardless of whether you present your results as a written report, a presentation, or in conversation, you should be able to describe your approach, the measurements you made, the quality checks you had in place (calibrations, etc.), and your interpretation of the data. If any one of these components is missing or not well executed, the usefulness of your data will be compromised.

Keep in mind that using sensors to answer a question about air quality is often an iterative step-by-step process. You may find that your measurements do not satisfactorily answer your question, or you may find yourself with many more questions after analyzing your data. Reevaluate your approach and repeat the steps described above as needed.



La Jolla Band of Luiseño Indians monthly AQI notice sent out to the community.

Section 8

Assessment of Ambient Air Quality in Indian Country in the Absence of Air Monitoring

In tribal lands where air monitoring has not been conducted, tribes may want to use non-monitoring methods to determine approximate concentrations of air pollutants in order to assess the air quality and/or decide if air monitoring is necessary. Several methods, requiring various degrees of technical expertise and financial resources, are identified in this section. These methods include:

- internet-based tools for accessing and analyzing ambient data,
- air quality models, including near-field dispersion models, regional photochemical models, and receptor models,
- modeling frameworks and assessments, and
- spatial interpolation of modeling and ambient data.

Internet-based tools that access observed concentration data can be useful because some air pollutants concentrations typically do not vary sharply across fairly large distances. As a result, data collected at monitoring sites off the tribal land can be informative of what the situation is within the tribal boundary. This approach is best suited to ozone, $PM_{2.5}$, and a few air toxics that have such long residence times in the atmosphere and have relative constant concentrations over a large scale (e.g., carbon tetrachloride and chloroform). Relying on data from monitors in other areas is less reliable for other pollutants such as PM_{10}, CO, and most air toxics. The internet-based tools provide ways to see data from individual monitoring sites of interest. In addition to monitoring data available through the Internet, industrial sources sometimes monitor for certain pollutants to fulfill permit conditions or to meet prevention of significant deterioration (PSD) requirements. The purpose of this monitoring is for sources to verify modeling predictions that fenceline concentrations of these pollutants will not exceed a certain level. Sources may be willing to share this monitoring data with local tribes. These data could give tribes a rough idea of the pollutant concentrations that exist in the area. These data may also be available through the permitting agency to whom the data is reported.

Air quality models and tools are ways to estimate air pollutant concentrations if emissions are known or can at least be estimated. Dispersion models are appropriate when the emission sources are relatively close to the area where estimates of concentrations are needed, for example, when an industrial plant is on tribal land or near its border. Larger-scale photochemical models are used to estimate the combined effects of mobile, area, and stationary point sources over a large area, and are referred to as "regional scale" models. They are most useful for estimating reactive pollutants such as ozone and $PM_{2.5}$, as well as impacts of air pollutants on visibility. Using these models rather than monitoring data from sites off the tribal land allows users to make future predictions to see how future emissions controls may improve air quality compared to the current concentration.

In addition, there are national or regional assessments that provide estimated results based on air quality models and tools that can be used to characterize concentrations on tribal lands. These assessments rely upon modeling tools and techniques that are made available to tribes. In addition, there are statistical techniques that can combine model-predicted and observed data to provide an improved and more complete characterization of concentrations on tribal lands when limited or no monitoring data exist.

8.1 Internet-Based Tools for Ambient Air Quality Assessment

There are internet-based tools that can be useful when conducting ambient air quality assessments in Indian country. These tools provide information on the locations and types of current and historical ambient air monitoring networks, monitoring data, emissions data from point and area sources, and meteorological data. In addition, internet tools are available that assist with interpreting data. Websites include a wide variety of interactive maps and graphs. These tools are accessible to the public and are fairly easy to use. Becoming familiar with these tools enables the tribal environmental professional to better understand the local and surrounding airsheds and helps to assess the potential for pollution transport into Indian country. Much of the data obtained from these tools have associated geospatial information available on the websites. When data are downloaded with coordinates or other spatial data, they can be integrated into a geographic information system (GIS) map. GIS integration allows for a more comprehensive and visual assessment and is encouraged for ambient air quality assessments. GIS software is available free to federally recognized tribes through the Bureau of Indian Affairs[79].

[79] https://www.bia.gov/WhatWeDo/ServiceOverview/Geospatial/

This section provides information to help tribal environmental professionals determine issues that may be of concern in the absence of monitoring data obtained directly from the jurisdictional area. The information in this section is not intended to be comprehensive. This section does not provide all the information available from a particular website, or list all websites that may be useful in assessing ambient air quality. Tribal professionals are encouraged to explore beyond what is listed in this document.

An initial air quality web-based assessment should include:

- Identifying existing and historical ambient air monitoring networks and their locations, as well as areas where data gaps exist
- Obtaining all available air monitoring data from the surrounding areas
- Identifying criteria and toxic emissions from area and point sources, and understanding the potential for transport of primary and secondary pollutants from those sources
- Characterizing prevailing and seasonal wind patterns for both local and surrounding areas
- Determining wind transport paths on days when high pollutant concentrations were observed at monitoring sites (backward trajectories as discussed in Section 7)
- Determining pollutant dispersion from sources in the transport path on days when high concentrations were observed at monitoring sites
- Identifying any health data that may indicate air quality problems
- Integrating data into a GIS

Recommended Websites

For modeling, a key website to consider is the EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM[80]). This website is maintained by EPA's Air Quality Modeling Group (AQMG). The AQMG conducts modeling analyses to support policy and regulatory decisions in the Office of Air and Radiation (OAR) and provides leadership and direction on the full range of air quality models and other mathematical simulation techniques used in assessing control strategies and source impacts.

80 https://www.epa.gov/scram

Documentation and guidance for these air quality models can be found on this website, including downloadable computer code, input data, and model processors.

Another important website is the National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory (ARL) web server. This site has a web-based system called the Real-time Environmental Applications and Display sYstem (READY[81]) that has been developed for accessing and displaying meteorological data and running trajectory and dispersion model products.

Many of the multi-jurisdictional organizations (MJOs) provide more local information on modeling and reports associated with regional specific modeling activities. The following table identifies these organizations along with the web sites for obtaining information and data available from each organization.

Multi-Jurisdictional Organizations	Website
Northeast States for Coordinated Air Use Management (NESCAUM)	www.nescaum.org
Ozone Transport Commission (OTC)	www.otcair.org
Mid-Atlantic Regional Air Management Association (MARAMA)	www.marama.org
Metro 4, Inc. Southeastern Air Pollution Control Agencies (SESARM)	www.metro4-sesarm.org
Lake Michigan Air Directors Consortium (LADCO)	www.ladco.org
Central States Air Resource Agencies (CenSARA)	www.censara.org
Western States Air Resources Center (WeStAR)	www.westar.org

For ambient data and emissions EPA and other agencies maintain a variety of websites where these data are available. These websites are listed in the table below.

AirData[82]	Air quality data collected at outdoor monitors across the United States, Puerto Rico, and the U. S. Virgin Islands.
AirNow[83]	Air quality forecasts and real-time data in a visual format for public health protection
AirCompare[84]	AQI summaries for comparison of counties
AirTrends[85]	Trends of air quality and emissions

81 http://ready.arl.noaa.gov/index.php

82 https://www.epa.gov/outdoor-air-quality-data

83 https://www.airnow.gov/

84 https://www3.epa.gov/aircompare/

85 https://www.epa.gov/air-trends

Air Emissions Sources[86]	Emissions - national, state, and county-level summaries for criteria pollutant emissions
The National Emissions Inventory[87]	Emissions - a comprehensive and detailed estimate of air emissions of both Criteria and Hazardous air pollutants from all air emissions sources
Air Quality System (AQS)[88]	Monitored ambient air quality data from AQS; for those who need large volumes of data
CASTNET[89]	The Clean Air Status and Trends Network is the nation's primary source for data on dry acidic deposition and rural, ground-level ozone
Remote Sensing Information Gateway (RSIG)[90]	Air quality monitoring, modeling, and satellite data
Radiation Monitoring Data[91]	Air quality and emissions; Links to databases and maps
EPA Data Finder[92]	Air, Water, other EPA data
Visibility Information Exchange Web System (VIEWS)[93]	Air quality monitoring, modeling, emissions, and satellite data
Data.Gov[94]	Air, Water, other U.S. Federal Executive Branch datasets

86 https://www.epa.gov/air-emissions-inventories/air-emissions-sources

87 https://www.epa.gov/air-emissions-inventories

88 https://www.epa.gov/aqs

89 https://www.epa.gov/castnet

90 https://www.epa.gov/hesc/remote-sensing-information-gateway

91 https://www.epa.gov/radnet

92 https://developer.epa.gov/category/data/

93 https://views.cira.colostate.edu/web/About/Overview.aspx

94 https://www.data.gov/

8.2 Air Quality Modeling

Air quality models use mathematical and numerical techniques to simulate the physical and chemical processes that affect air pollutants as they disperse and react in the atmosphere. Based on inputs of meteorological data and source information like emission rates and stack height, these models are designed to characterize primary pollutants that are emitted directly into the atmosphere and, in some cases, secondary pollutants that are formed as a result of complex chemical reactions within the atmosphere. These models are important to our air quality management system because they are widely used by agencies tasked with controlling air pollution to both identify source contributions to air quality problems and assist in the design of effective strategies to reduce harmful air pollutants. For example, air quality models can be used during the permitting process to verify that a new source will not exceed ambient air quality standards or, if necessary, determine appropriate additional control requirements. In addition, air quality models can also be used to predict future pollutant concentrations from multiple sources after the implementation of a new regulatory program, in order to estimate the effectiveness of the program in reducing harmful exposures to humans and the environment.

The most commonly used air quality models include the following:

1) Dispersion Models—These models are typically used in the permitting process to estimate the concentration of pollutants at specified ground-level receptors surrounding an emissions source.

2) Photochemical Models—These models are typically used in regulatory or policy assessments to simulate the impacts from all sources by estimating pollutant concentrations and deposition of both inert and chemically reactive pollutants over large spatial scales.

3) Receptor Models—These models are observational techniques which use the chemical and physical characteristics of gases and particles measured at source and receptor to both identify the presence of and to quantify source contributions to receptor concentrations.

8.3 Dispersion Models: Local and Near-Field Applications

Dispersion modeling uses mathematical formulations to characterize the atmospheric processes that disperse a pollutant emitted by a source. Based on emissions and meteorological inputs, a dispersion model can be used to predict concentrations at selected downwind receptor locations. These air quality models are used to determine compliance with National Ambient Air Quality Standards (NAAQS), and other regulatory requirements such as New Source Review (NSR) and Prevention of

Significant Deterioration (PSD) regulations. Preferred/Recommended models[95] are addressed in Appendix A of EPA's *Guideline on Air Quality Models* (also published as Appendix W of 40 CFR Part 51, herein referred to as the *Guideline*), which was originally published in April 1978 to provide consistency and equity in the use of modeling within the U.S. air quality management system. These guidelines are periodically revised to ensure that new model developments or expanded regulatory requirements are incorporated. The most recent revisions to the *Guideline*, published in January 2017, replaced the California Line Source Dispersion Model (CALINE) and the California Puff (CALPUFF) model as preferred models in Appendix A. CALINE, used exclusively to model mobile sources, was replaced with AERMOD (see A.1 of the *Guideline*). CALPUFF, previously a preferred model for long range transport (LRT) for NAAQS and PSD increments assessments, was replaced with a LRT screening approach, for which CALPUFF can be used as screening technique without alternative model approval (see Section 4.2 of the *Guideline*).

These types of models can be useful to tribes in estimating the concentrations of inert pollutants impacting air quality on tribal lands from local sources such as nearby large stationary sources. In order to run these models, a tribe needs to know the emission rates of pollutants of concern (e.g., NOx, SO2, and PM) from each source and needs to have the appropriate meteorological data required by the model. These models can also be used to determine the improvements in air quality, which can be achieved by placing physical emission controls or administrative/process limits on inert pollutants at stationary sources.

AERMOD Modeling System

Preferred air quality models for use in regulatory applications are addressed in Appendix A of the EPA's *Guideline on Air Quality Models*. If a model is to be used for a particular application, the user should follow the guidance on the preferred model for that application. Further recommendations for the application of these models to specific source problems are found in Appendix W. In 2005, the EPA promulgated the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) as the Agency's preferred near-field dispersion model for a wide range of regulatory applications in all types of terrain based on extensive developmental and performance evaluation.

The AERMOD modeling system includes the following components:

- AERMOD: the dispersion model (U.S. EPA, 2016a);
- AERMAP: the terrain processor for AERMOD (U.S. EPA, 2016b,); and

[95] https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models

- AERMET: the meteorological data processor for AERMOD (U.S. EPA, 2016c;).

Other components that may be used, depending on the application, are:

- BPIPPRIME: the building input processor (U.S. EPA, 2004);
- AERSURFACE: the surface characteristics processor for AERMET (U.S. EPA, 2008);
- AERSCREEN: a screening version of AERMOD (U.S. EPA, 20116d; U.S. EPA, 2011); and
- AERMINUTE: a pre-processor to calculate hourly average winds from ASOS 2-minute observations (U.S. EPA, 2015).

Before running AERMOD, the user should become familiar with the user's guides associated with the modeling components listed above and the AERMOD Implementation Guide (AIG). The AIG lists several recommendations for applications of AERMOD that would be applicable for SIP and PSD permit modeling.

The AERMOD system simulates transport and dispersion for point, area, volume sources, and more recently, the buoyant line algorithm from the Buoyant Line and Point Source (BLP) Dispersion model was incorporated. AERMOD has been extensively evaluated across a wide range of scenarios based on numerous field studies. These evaluations included several long-term field studies associated with operating plants, as well as several intensive tracer studies.

AERSCREEN is EPA's recommended screening-level air quality model which interfaces with AERMOD, utilizing AERMOD's SCREEN option to predict worst case 1-hour concentrations. AERSCREEN consists of two main components: 1) the MAKEMET program which generates a site-specific matrix of meteorological conditions in a format compatible with AERMOD; and 2) the AERSCREEN command-prompt interface program. It also interfaces with AERMAP and BPIPPRM to automate the processing of terrain and building information respectively. The AERSCREEN program includes averaging time factors to predict worst-case 3-hour, 8-hour, 24-hour and annual averages.

8.4 Photochemical Air Quality Models: National and Regional Applications

Photochemical air quality models have become widely recognized and routinely utilized tools for regulatory analysis and attainment demonstrations by assessing the effectiveness of control strategies. These photochemical models are large-scale air quality models that simulate the changes of pollutant concentrations in the atmosphere using a set of mathematical equations characterizing the chemical and physical processes in the atmosphere. These models are applied at multiple spatial scales from local, regional, national, and global.

There are two types of photochemical air quality models commonly used in air quality assessments: the Lagrangian trajectory model that employs a moving frame of reference, and the Eulerian grid model that uses a fixed coordinate system with respect to the ground. Earlier generation modeling efforts often adopted the Lagrangian approach to simulate the pollutants formation because of its computational simplicity. The disadvantage of Lagrangian approach, however, is that the physical processes it describes are somewhat incomplete. Most of the current operational photochemical air quality models have adopted three-dimensional Eulerian grid modeling mainly because of its ability to better and more fully characterize physical processes in the atmosphere and predict the species concentrations throughout the entire model domain.

These large-scale, multi-pollutant models are used to estimate the combined effects of many emission, mobile, area, and stationary point sources over a large area, and are referred to as "regional scale" models. They are most useful for estimating ozone, $PM_{2.5}$, and impacts of air pollutants on visibility. These types of models require large amounts of source emissions data and meteorological data, and require specialized technical expertise. More relevant to the tribes is that these models have been used by the Multi-Jurisdictional Organizations, EPA, and some individual states. As an alternative to running these models, tribes should consider accessing the modeling results generated by other agencies that cover the reservations.

Community Multi-scale Air Quality (CMAQ) Model and Comprehensive Air quality Model with eXtensions (CAMx)

Two Eulerian photochemical models commonly applied by the EPA are the Community Multi-scale Air Quality (CMAQ) model and the Comprehensive Air quality Model with eXtensions (CAMx). These modeling systems have been designed to simulate air quality with a "one-atmosphere" manner by including state-of-the-science capabilities for modeling multiple air quality issues, including tropospheric ozone, fine particles, toxics, acid deposition, and visibility degradation. Hence, CMAQ combines the scientific expertise from each of these areas into one "community model". In addition to being a multi-pollutant model, CMAQ and CAMx also were designed to have multi-scale capabilities so that separate models are not needed for urban and regional scale air quality modeling. The target grid resolutions and domain sizes for CMAQ range spatially and temporally over several orders of magnitude. With the temporal flexibility of the model, simulations can be performed to evaluate longer term pollutant transport, as well as short-term transport from localized sources. With the model's ability to handle a large range of spatial scales, CMAQ and CAMx can be used for urban, regional, and nationalscale model simulations. In addition, CMAQ has the capability to be run in "hemispheric" mode simulating the entire Northern hemisphere.

The CMAQ modeling system simulates various chemical and physical processes that are thought to be important for understanding atmospheric trace gas transformations and distributions. The modeling systems utilizes three separate modeling components: a meteorological model (typically the Weather Research and Forecasting -WRF model)) for the characterization of atmospheric states and air mass motions, an emissions data processor (typically the Sparse Matrix Operator Kernel Emissions – SMOKE modeling system) for man-made and natural emissions that are injected into the atmosphere, and a chemistry-transport model for simulation of the chemical transformation and fate (i.e., the CMAQ and CAMx models). Hourly gridded meteorological and emissions model outputs are required inputs into the CMAQ chemistry-transport model, hence this is viewed as a modeling system.

Typically, the CMAQ and CAMx modeling systems are run on a multi-processor Linux or UNIX computer cluster environment and usually requires, at minimum, over 1 terabyte of storage capacity. Current CMAQ and SMOKE model codes and training are available from the Community Modeling and Analysis System CMAS Center at: http://www.cmascenter.org/. Current CAMx model code is available at: http://www.camx.com/ WRF model code and training is available at: https://www.mmm.ucar.edu/weather-research-and-forecasting-model.   :

8.5 Receptor Models: Source Contributions

Receptor models are mathematical or statistical procedures for identifying and quantifying the sources of air pollutants at a receptor location. Unlike photochemical and dispersion air quality models, receptor models do not use pollutant emissions, meteorological data and chemical transformation mechanisms to estimate the contribution of sources to receptor concentrations. Instead, receptor models use the chemical and physical characteristics of gases and particles measured at source and receptor to both identify the presence of and to quantify source contributions to receptor concentrations. These models are therefore a natural complement to other air quality models and are used as part of State Implementation Plans (SIPs) for identifying sources contributing to air quality problems. EPA has developed the Chemical Mass Balance (CMB) and UNMIX models, as well as the Positive Matrix Factorization (PMF) method for use in air quality management. CMB fully apportions receptor concentrations to chemically distinct source-types depending upon the source profile database, while UNMIX and PMF internally generate source profiles from the ambient data. A useful overview of these approaches is provided in a 2016 JAWMA article[96] by Phillip Hopke, *Review of receptor modeling methods for source apportionment*.

Chemical Mass Balance (CMB)—The EPA-CMB Version 8.2 uses source profiles and speciated ambient data to quantify source contributions. Contributions are quantified from chemically distinct source-types rather than from individual emitters. Sources with similar chemical and physical properties cannot be distinguished from each other by CMB.

UNMIX—The EPA UNMIX model "unmixes" the concentrations of chemical species measured in the ambient air to identify the contributing sources. Chemical profiles of the sources are not required, but instead are generated internally from the ambient data by UNMIX, using a mathematical formulation based on a form of factor analysis. For a given selection of species, UNMIX estimates the number of sources, the source compositions, and source contributions to each sample.

Positive Matrix Factorization (PMF)—The PMF technique is a form of factor analysis where the underlying co-variability of many variables (e.g., sample-to-sample variation in PM species) is described by a smaller set of factors (e.g., PM sources) to which the original variables are related. The structure of PMF permits maximum use of available data and better treatment of missing and below-detection-limit values. Also available is a document which discusses the PMF methodology: "A Guide to Positive Matrix Factorization" available at: http://www.epa.gov/ttn/amtic/files/ambient/pm25/workshop/laymen.pdf.

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96 http://www.tandfonline.com/doi/full/10.1080/10962247.2016.1140693?utm_source=TrendMD&utm_medium=cpc&utm_campaign=Journal_of_the_Air_%2526_Waste_Management_Association_TrendMD_0

8.6 Modeling Tools and Assessments

There are a number of modeling tools and assessments that are available and provide useful information on concentrations of air pollutants including air toxics and criteria pollutants. This section provides a selection of readily available tools and assessment results.

National Air Toxics Assessment (NATA): 2011

The purpose of NATA is to identify and prioritize air toxics, emission source types and locations that are of greatest potential concern in terms of contributing to population risk. The most recent 2011 NATA assessment (https://www.epa.gov/national-air-toxics-assessment/2011-national-air-toxics-assessment) included emissions, ambient concentrations, and exposure estimates for 180 of the 187 Clean Air Act air toxics plus diesel particulate matter. EPA uses the results of these assessments in many ways, including:

1. to work with communities in designing their own local-scale assessments;
2. to set priorities for improving data in emissions inventories; and
3. to help direct priorities for expanding and improving the network of air toxics monitoring.

The 2011 assessment utilized the multi-pollutant version of the CMAQ photochemical model and the AERMOD dispersion model to inform a hybrid approach that addressed mass conservation, atmospheric transformation (formation and decay), and long-range transport to improve the characterization of toxics concentration in predicting toxics risks across the nation. Forty HAPs were modeled using CMAQ for the 2011 NATA. A 2011 NATA Technical Support Document provides more information on the CMAQ use in 2011 NATA assessment.

BlueSky Modeling Framework

BlueSky http://www.airfire.org/bluesky/ is a modeling framework which brings together the latest state-of-the-science for modeling fuels, fire, smoke, and weather into one centralized processing system. It makes sophisticated emission, dispersion and weather prediction models and model output easily accessible to the operational fire and air quality management communities. The modeling framework is designed to predict cumulative impacts of smoke from forest, agricultural, and range fires, including both prescribed fire and wild fire. The BlueSky system was designed as a tool to aid land managers using fire on the landscape in making go/no-go/go slow decisions with regard to smoke management.

HYSPLIT Trajectory Model-

The National Oceanic and Atmospheric Administration (NOAA), Air Resources Laboratory (ARL), Real-Time Applications and Display System (READY) website provides access to the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model, which is capable of generating backward trajectories to a user-provided latitude and longitude at the ground surface and at elevations above the ground. The backward trajectories can be integrated into GIS by downloading the endpoints file, modifying the file slightly and using the right-click "Create Feature Class from XY Table" function in ArcCatalog. Specific instructions are available at the TAMS Center Website. Backward trajectories are useful in understanding transport issues by mapping the path air took prior to entering the monitor.

The Quapaw Tribe of Oklahoma has used HYSPLIT as part of their participation in EPA's Advance Program[97]. The Advance Program promotes local actions in attainment areas to reduce ozone and/or fine particle pollution (PM2.5) to help these areas continue to maintain the National Ambient Air Quality Standards (NAAQS).

8.7 Spatial Interpolation of Modeling and Ambient Data

The need for spatial (geostatistical) interpolation models in the regulatory environment has grown in the past few years. Spatial interpolation as applied to air monitoring data is loosely defined as the procedure for estimating ambient air concentrations at unmonitored locations in a certain area based on available observations within the proximity of the area. The justification underlying spatial interpolation is the assumption that points closer together in space are more likely to have similar values than points more distant. EPA uses spatial interpolation to review decisions on monitoring network design and to predict the efficacy of emission control programs. Due to the limited number of monitoring sites across the country, especially for pollutants that cover a large area, such as ozone and fine particles, there is a need to use spatial interpolation to predict ambient concentrations in unmonitored locations.

Geostatistical interpolation methods are stochastic methods, with kriging being the most well-known representative of this category. Conceptually, the goal of kriging is to find linear combinations of the data that are optimal and consistent with the observed data points. In particular, kriging is a statistical model that produces both a spatial surface of predictions for the process of interest as well as the uncertainty associated with those estimates. Kriging calculates weights for measured points in deriving predicted values for unmeasured locations. With kriging, however, those weights are based not only on distance between points, but also on the variation in measured concentrations as a function of distance. A major benefit of the various

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[97] https://www.epa.gov/advance

forms of kriging is that estimates of the model's prediction uncertainty can be calculated, considered in the analysis, and plotted along with the predicted values. Such uncertainty information is an important tool in the spatial decision making process.

A more detailed description of the kriging process can be found in the EPA report titled "Developing Spatially Interpolated Surfaces and Estimating Uncertainty", EPA-454/R-04-004, November 2004 or on the web at: http://www.epa.gov/oar/oaqps/pm25/docs/dsisurfaces.pdf.

8.8 Data Fusion

Since 2002, EPA has collaborated to provide air quality monitoring data and model estimates to the Centers for Disease Control and Prevention (CDC) for use in their Environmental Public Health Tracking (EPHT) Network. On September 30, 2003, the Secretary of Health and Human Services (HHS) and the Administrator of EPA signed a joint Memorandum of Understanding (MOU) with the objective of advancing efforts to achieve mutual environmental public health goals[98]. HHS, acting through the CDC and the Agency for Toxic Substances and Disease Registry (ATSDR), and EPA agreed to expand their cooperative activities in support of the CDC EPHT Network and EPA's Central Data Exchange Node on the Environmental Information Exchange Network in the following areas:

- Collecting, analyzing and interpreting environmental and health data from both agencies (HHS and EPA).
- Collaborating on emerging information technology practices related to building, supporting, and operating the CDC EPHT Network and the Environmental Information Exchange Network.
- Developing and validating additional environmental public health indicators.
- Sharing reliable environmental and public health data between their respective networks in an efficient and effective manner.
- Consulting and informing each other about dissemination of results obtained through work carried out under the MOU and the associated Interagency Agreement (IAG) between EPA and CDC.

To meet these needs, EPA has used the best available statistical fusion model, air quality data, and photochemical air quality model output to develop spatially

[98] HHS and EPA agreed to extend the duration of the MOU, effective since 2002 and renewed in 2007, until June 29, 2017. The MOU is available at www.cdc.gov/nceh/tracking/partners/epa_mou_2007.htm.

fused estimates of ozone and $PM_{2.5}$ concentrations for the continental U.S. that are intended for use by statisticians and environmental scientists interested in the daily spatial distribution of ozone and $PM_{2.5}$. EPA uses the "downscaler model" (DS) to "fuse" daily ozone (8-hr max) and fine particulate air (24-hr average) monitoring data from the National Air Monitoring Stations/State and Local Air Monitoring Stations (NAMS/SLAMS) with 12 km gridded output from the EPA's Community Multiscale Air Quality (CMAQ) model. The theory, development, and initial evaluation of DS can be found in the earlier papers of Berrocal, Gelfand, and Holland (2009, 2010, and 2011).

Daily predictions for 8-hour ozone and 24-hour $PM_{2.5}$ are available at the 2010 US Census Tract centroid locations for 2002-2012 from the Remote Sensing Information Gateway (RSIG) downloadable data files page[99].

A Morongo particulate matter monitor collecting data in the presence of a wildfire.

[99] https://www.epa.gov/hesc/rsig-related-downloadable-data-files#faqsd

Appendix A

National Air Monitoring Networks Fact Sheets

State or Local Air Monitoring Stations (SLAMS) Network

Background

The SLAMS make up the ambient air quality monitoring sites that are operated by State or local agencies for the primary purpose of comparison to the National Ambient Air Quality Standards (NAAQS), but may serve other purposes such as:

- provide air pollution data to the general public in a timely manner;
- support compliance with air quality standards and emissions strategy development; and
- support air pollution research studies.

The SLAMS network includes stations classified as NCore, PAMS, and Speciation, and formerly categorized as NAMS, and does not include Special Purpose Monitors (SPM) and other monitors used for non-regulatory or industrial monitoring purposes.

In order to support the objectives, the monitoring networks are designed with a variety of monitoring sites that generally fall into the following categories which are used to determine:

1. the highest concentrations expected to occur in the area covered by the network;
2. typical concentrations in areas of high population density;
3. the impact on ambient pollution levels of significant sources or source categories;
4. the general background concentration levels;
5. the extent of regional pollutant transport among populated areas, and in support of secondary standards; and
6. air pollution impacts on visibility, vegetation damage, or other welfare- based impacts.

The monitoring aspects of the SLAMS program are found in the Code of Federal Regulations, Title 40, Parts 50, 53 and 58.

SLAMS must use approved Federal reference method (FRM), Federal equivalent method (FEM), or Approved Regional Method (ARM) monitors for ambient pollutant levels being compared to the NAAQS.

Reference Category	References	Comments
Program References	40 CFR Part 50, 53 and 58 https://www.epa.gov/amtic	
Pollutants Measured	O_3, CO, SO_2, NO_2 $PM_{2.5}$, PM_{10}, Pb	
Methods References	40 CFR Part 50 and 58 Appendix C https://www3.epa.gov/ttn/amtic/criteria.html	Must be FRM, FEM, or ARM for NAAQS comparisons. Website lists designated methods
Network Design	40 CFR Part 58 Appendix D, E	
Siting Criteria	40 CFR Part 58 Appendix E	
Quality System References	40 CFR Part 58 Appendix A https://www3.epa.gov/ttn/amtic/quality.htmlhttps://www3.epa.gov/ttn/amtic/met.html	Website for QA Handbook Vol II
Data Management	https://www.epa.gov/aqs	Air Quality System

National Core (NCore) Network

Background

NCore is a multi-pollutant network that integrates several advanced measurement systems for particles, pollutant gases and meteorology. Most NCore stations have been operating since the formal start of the network on January 1, 2011. The NCore Network addresses the following objectives:

- Timely reporting of data to 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 to scientific studies ranging across technological, health, and atmospheric process disciplines; and
- Support to ecosystem assessments recognizing that national air quality networks benefit ecosystem assessments and, in turn, benefit from data specifically designed to address ecosystem analyses.

The objective is to locate sites in broadly representative urban (about 55 sites) and rural (about 20 sites) locations throughout the country to help characterize regional and urban patterns of air pollution.

In many cases, states will collocate these new stations with STN sites measuring speciated $PM_{2.5}$ components, PAMS sites already measuring O_3 precursors, and/or NATTS sites measuring air toxics. By combining these monitoring programs at a single location, EPA and its partners will maximize the multi- pollutant information available. This greatly enhances the foundation for future health studies, NAAQS revisions, validation of air quality models, assessment of emission reduction programs, and studies of ecosystem impacts of air pollution.

Reference Category	References
Program References	https://www3.epa.gov/ttn/amtic/monitor.html
Pollutants Measured	SO_2, CO, NO and NO_x, and O_3, $PM_{2.5}$, $PM_{10\text{-}2.5}$, basic meteorological parameters
Methods References	https://www3.epa.gov/ttn/amtic/precur.html https://www3.epa.gov/ttnamti1/ncoreguidance.html
Network Design References	https://www3.epa.gov/ttn/amtic/monstratdoc.html
Siting Criteria	https://www3.epa.gov/ttnamti1/ncoreguidance.html
Quality System References	https://www3.epa.gov/ttnamti1/ncoreguidance.html
Data Management References	https://www3.epa.gov/ttnamti1/ncoreguidance.html

Photochemical Assessment Monitoring Stations (PAMS)

Background

Section 182(c)(1) of the 1990 Clean Air Act Amendments (CAAA) require the Administrator to promulgate rules for the enhanced monitoring of ozone, oxides of nitrogen (NOx), and volatile organic compounds (VOC) to obtain more comprehensive and representative data on ozone air pollution.
Immediately following the promulgation of such rules, the affected states were to commence such actions as were necessary to adopt and implement a program to improve ambient monitoring activities and the monitoring of emissions of NOx and VOC. Each State Implementation Plan (SIP) for the affected areas must contain measures to implement the ambient monitoring of such air pollutants. The subsequent revisions to Title 40, Code of Federal Regulations, Part 58 (40 CFR 58) required states to establish Photochemical Assessment Monitoring Stations (PAMS) as part of their SIP monitoring networks in ozone nonattainment areas classified as serious, severe, or extreme.

The chief objective of the enhanced ozone monitoring revisions is to provide an air quality database that will assist air pollution control agencies in evaluating, tracking the progress of, and, if necessary, refining control strategies for attaining the ozone NAAQS. Ambient concentrations of ozone and ozone precursors will be used to make attainment/nonattainment decisions, aid in tracking VOC and NOx emission inventory reductions, better characterize the nature and extent of the ozone problem, and prepare air quality trends. In addition, data from the PAMS will provide an improved database for evaluating photochemical model performance, especially for future control strategy mid-course corrections as part of the continuing air quality management process. The data will be particularly useful to states in ensuring the implementation of the most cost-effective regulatorycontrols.

Reference Category	References
Program References	https://www3.epa.gov/ttn/amtic/pamsmain.html
Pollutants Measured	Ozone, Nitrogen Oxides, VOCs, upper air and surface meteorology https://www3.epa.gov/ttn/amtic/pamsmain.html
Network Design References	https://www3.epa.gov/ttn/amtic/pamssites.html https://www3.epa.gov/ttn/amtic/pamsguidance.html
Siting Criteria	https://www3.epa.gov/ttn/amtic/pamsguidance.html
Quality System References	https://www3.epa.gov/ttn/amtic/pamsdata.html
Data Management References	https://www3.epa.gov/ttn/amtic/pamsdata.html

PM2.5 Chemical Speciation Network

Background

As part of the PM2.5 National Ambient Air Quality Standards (NAAQS) review completed in 1997, EPA established a PM2.5 Chemical Speciation Network (CSN) consisting of Speciation Trends Network (STN) sites and supplemental speciation sites. The CSN is a component of the National PM2.5 Monitoring Network. Although the CSN is intended to complement the activities of the much larger gravimetric PM2.5 measurements network component (whose goal is to establish if the NAAQS are being attained), CSN data is not used for attainment or nonattainment decisions. CSN data is used for multiple objectives, which include:

- The assessment of trends;
- The development of effective State Implementation Plans (SIPs) and determination of regulatory compliance;
- The development of emission control strategies and tracking progress of control programs;
- Aiding in the interpretation of health studies by linking effects to PM2.5 constituents;
- Characterizing annual and seasonal spatial variation of aerosols;
- Comparison to chemical speciation data collected from the IMPROVE network.

As of 2012, the PM2.5 Chemical Speciation Network includes about 50 STN sites and about 150 State and Local Air Monitoring Stations (SLAMS) supplemental sites. All STN sites operate on a one-in-three day sample collection schedule. The majority of the SLAMS supplemental sites operate on a one-in-six day sample collection schedule. CSN sites collect aerosol samples over 24 hours on filters that are analyzed for PM2.5 mass, a number of trace elements, major ions (sulfate, nitrate, ammonium, sodium and potassium), and organic and elemental carbon.

CSN data users include those at EPA seeking to determine concentration trends of PM2.5 chemical species over a period of 3 or more years and decision-makers at tribal, state and local levels who use the data as input to models and for development of emission control strategies and determination of their long-term effectiveness. Other users include public health officials and epidemiological researchers.

Reference Category	References
Program References	https://www3.epa.gov/ttn/amtic/speciepg.html
Pollutants Measured	Mass, trace elements, ions, and organic and element carbon
Methods References	https://www3.epa.gov/ttn/amtic/specsop.html https://www3.epa.gov/ttn/amtic/spectraining.html
Network Design References	https://www3.epa.gov/ttn/amtic/specgen.html
Siting Criteria	https://www3.epa.gov/ttn/amtic/specgen.html
Quality System References	https://www3.epa.gov/ttn/amtic/specguid.html
Data Management References	https://www3.epa.gov/ttn/amtic/specdat.html https://aqsdr1.epa.gov/aqsweb/aqstmp/airdata/download_files.html https://www.epa.gov/outdoor-air-quality-data

National Toxics Trends Network (NATTS)

Background

The National Air Toxics Trends Station (NATTS) Network was developed to fulfill the need for long-term HAP monitoring data of consistent quality. Among the principle objectives are assessing trends and emission reduction program effectiveness, assessing and verifying air quality models (e.g., exposure assessments, emission control strategy development, etc.), and as direct input to source-receptor models. The current network configuration includes 27 sites (20 urban, 7 rural) across the United States; thirteen sites were established in 2003, ten sites in 2004, and two sites each in 2007 and 2008. There are typically over 100 pollutants monitored at each NATTS (though only 19 of those are required; included are VOCs, carbonyls, PM10 metals, hexavalent chromium, and PAHs. Specifically, it is anticipated that the NATTS data will be used for:

- tracking trends in ambient levels to facilitate tracking progress toward emission and risk reduction goals, which is the major objective of this program;
- directly evaluating public exposure & environmental impacts in the vicinity of monitors;
- providing quality assured data AT for risk characterization;
- assessing the effectiveness of specific emission reduction activities; and
- evaluating and subsequently improving air toxics emission inventories and model performance.

Currently the NATTS program is made up of 27 monitoring sites; representing urban (20) communities and rural (7) communities.

Reference Category	References	Comments
Program References	https://www3.epa.gov/ttn/amtic/natts.html	
Pollutants Measured	33 HAPS which include metals, VOCs and carbonyls https://www3.epa.gov/ttnamti1/files/ambient/airtox/nattsworkplantemplate.pdf	
Methods References	https://www3.epa.gov/ttn/amtic/airtox.html hhttps://www3.epa.gov/ttnamti1/files/ambient/airtox/nattsworkplantemplate.pdf	
Network Design References	https://www3.epa.gov/ttnamti1/files/ambient/airtox/nattsqmp.pdf	National Air Toxics Trends Stations – Quality Management Plan –final 09/09/05
Siting Criteria		40 CFR part 58 Appendix E, PAMS Probe and Path Siting
Quality System References	https://www3.epa.gov/ttn/amtic/airtoxqa.html	
Data Management References	https://www3.epa.gov/ttn/amtic/toxdat.html	

Interagency Monitoring of Protected Visual Environments (IMPROVE)

Background

The Interagency Monitoring of Protected Visual Environments (IMPROVE) program is a cooperative measurement effort governed by a steering committee composed of representatives from federal and regional-state organizations. The IMPROVE monitoring program was established in 1985 to aid the creation of Federal and State Implementation Plans for the protection of visibility in Class I areas as stipulated in the 1977 amendments to the Clean Air Act.

The objectives of IMPROVE are:

1. to establish current visibility and aerosol conditions in mandatory class I areas;
2. to identify chemical species and emission sources responsible for existing man-made visibility impairment;
3. to document long-term trends for assessing progress towards the national visibility goal;
4. and with the enactment of the Regional Haze Rule[100], to provide regional haze monitoring representing all visibility-protected federal class I areas where practical.

IMPROVE has also been a key participant in visibility-related research, including the advancement of monitoring instrumentation, analysis techniques, visibility modeling, policy formulation and source attribution field studies. In addition to 110 IMPROVE sites at visibility-protected areas, IMPROVE Protocol sites are operated identically at locations to serve the needs of state, tribes and federal agencies.

Reference Category	References	Comments
Program References	http://vista.cira.colostate.edu/improve/	
Pollutants Measured	PM10 & PM2.5 mass concentration, and PM2.5 elements heavier than sodium, anions, organic and elemental carbon concentrations. Optical & met. parameters at select sites http://vista.cira.colostate.edu/Improve/improve-program/	All sites have aerosol speciation monitoring by one day in three 24-hour duration sampling
Methods References	http://vista.cira.colostate.edu/Improve/sops/E_SOPs.htm http://vista.cira.colostate.edu/Improve/reconstructed-fine-mass/	
Network Design References	http://vista.cira.colostate.edu/Improve/sops/E_SOPs.htm	
Siting Criteria	http://vista.cira.colostate.edu/Improve/sops/E_SOPs.htm	
Quality System References	http://vista.cira.colostate.edu/Improve/?s=quality+assurance ranch.htm	
Data Management References	http://vista.cira.colostate.edu/Improve/data-page/	

100 https://www.epa.gov/visibility

Clean Air Status and Trends Network (CASTNET)

Background

The Clean Air Status and Trends Network (CASTNET) is a national air quality monitoring network designed to provide data to assess trends in air quality, atmospheric deposition, and ecological effects due to changes in air pollutant emissions. CASTNET began collecting measurements in 1991 with the incorporation of 50 sites from the National Dry Deposition Network, which had been in operation since 1987. CASTNET provides long-term monitoring of air quality in rural areas to determine trends in regional atmospheric nitrogen, sulfur, and ozone concentrations and deposition fluxes of sulfur and nitrogen pollutants in order to evaluate the effectiveness of national and regional air pollution control programs.
CASTNET operates more than 80 regional sites throughout the contiguous United States, Alaska, and Canada. Sites are located in areas where urban influences are minimal. Ozone measurements became CFR 40 Part 58, Appendix A compliant in 2011. Meteorological measurements are made at approximately 30 sites, and are available for all sites prior 2010. Modeled dry deposition velocities are also provided.

The main objectives of the network are to:

1) track the effectiveness of national and regional scale emission control programs;
2) report high quality, publicly available data on the temporal and geographic patterns of air quality and atmospheric deposition trends; and
3) provide the necessary information for understanding the environmental effects in sensitive terrestrial and aquatic receptor areas associated with atmospheric loadings

Reference Category	**References**
Program References	CASTNET Main Webpage https://www.epa.gov/castnet CASTNET Annual Report https://java.epa.gov/castnet/documents.do
Pollutants Measured	sulfate, nitrate, ammonium, sulfur dioxide, nitric acid, base cations, ozone CASTNET Factsheet https://www3.epa.gov/castnet/docs/CASTNET-Factsheet-2015.pdf
Methods References	CASTNET Quality Assurance Project Plan (QAPP) Main Body https://java.epa.gov/castnet/documents.do
Network Design References	CASTNET QAPP Main Body https://java.epa.gov/castnet/documents.do
Siting Criteria	CASTNET QAPP Main Body https://java.epa.gov/castnet/documents.do
Quality System References	CASTNET QAPP Main Body https://java.epa.gov/castnet/documents.do
Data Management References	CASTNET QAPP Appendix 6: CASTNET Data Operations Standard Operating Procedures https://java.epa.gov/castnet/documents.do

National Atmospheric Deposition Network (NADP)

Background

The National Atmospheric Deposition Program (NADP) provides quality-assured data and information in support of research on the exposure of managed and natural ecosystems and cultural resources to acidic compounds, nutrients, base cations, and mercury in precipitation. The NADP also provides data on ambient concentrations of speciated mercury and gaseous ammonia. NADP data serve science and education and support informed decisions on air quality issues related to precipitation and atmospheric chemistry.

The NADP operates three precipitation chemistry networks: the 250-station National Trends Network (NTN), 7- station Atmospheric Integrated Research Monitoring Network (AIRMoN), and 100-station Mercury Deposition Network (MDN) and two ambient monitoring networks: the 20-station Atmospheric Mercury Network (AMNet) and the 50-station Ammonia Monitoring Network. The NTN provides the only long-term nationwide record of the wet deposition of acids, nutrients, and base cations. NTN stations collect one-week precipitation samples in 48 states, Puerto Rico, the Virgin Islands, and Quebec Province, Canada. Complementing the NTN is the 7-station AIRMoN. The daily precipitation samples collected at AIRMoN stations support continued research of atmospheric transport and removal of air pollutants and the development of computer simulations of these processes. The 100-station MDN offers the only regional measurements of mercury (Hg) in North American precipitation. MDN data are used to quantify Hg deposition to water bodies that have fish and wildlife consumption advisories due to this toxic chemical. The AMNet compliments the MDN by measuring speciated hourly samples of ambient Hg at 25 monitoring stations. AMNet measurements are made using a Tekran instrument which analyzes ambient samples for elemental, gaseous and particulate bound Hg fractions. The AMoN is the only national monitoring network measuring ambient ammonia (NH3) concentrations. Bi-weekly measurements of NH3 compliment the NTN and CASTNET networks by filling a gap in the total nitrogen budget. Work continues on developing routine model estimates for Hg and NH3 bi-directional dry deposition velocities.

Reference	**References**
Program References	NADP http://nadp.isws.illinois.edu/ NTN http://nadp.isws.illinois.edu/NTN/ AIRMoN http://nadp.isws.illinois.edu/AIRMoN/ MDN http://nadp.isws.illinois.edu/MDN/ AMNet http://nadp.isws.illinois.edu/amn/ AMoN http://nadp.isws.illinois.edu/AMoN/
Pollutants Measured	In precipitation: sulfate, nitrate, chloride, ammonium, calcium, magnesium, sodium, potassium, pH, mercury. Ambient concentrations: speciated mercury, ammonia
Methods References	http://nadp.isws.illinois.edu/lib/manualsSOPs.aspx
Network Design References	http://nadp.isws.illinois.edu/lib/qaPlans.aspx
Siting Criteria	http://nadp.isws.illinois.edu/lib/manualsSOPs.aspx
Quality System References	http://nadp.isws.illinois.edu/lib/qaReports.aspx http://nadp.isws.illinois.edu/lib/qaPlans.aspx
Data Management References	http://nadp.isws.illinois.edu/lib/qaPlans.aspx http://nadp.isws.illinois.edu/lib/qaplans/NADP_Network_Quality_Assurance_Plan.pdf

National Air Toxics Assessment (NATA)

Background

The National-Scale Air Toxics Assessment (NATA) is EPA's ongoing comprehensive evaluation of air toxics in the U.S. EPA developed the NATA as a state-of-the-science screening tool for State/Local/Tribal Agencies to prioritize pollutants, emission sources and locations of interest for further study in order to gain a better understanding of risks. NATA assessments do not incorporate refined information about emission sources, but rather, use general information about sources to develop estimates of risks which are more likely to overestimate impacts than underestimate them. NATA provides estimates of the risk of cancer and other serious health effects from breathing (inhaling) air toxics in order to inform both national and more localized efforts to identify and prioritize air toxics, emission source types and locations which are of greatest potential concern in terms of contributing to population risk. This in turn helps air pollution experts focus limited analytical resources on areas and or populations where the potential for health risks are highest. Assessments include estimates of cancer and non-cancer health effects based on chronic exposure from outdoor sources, including assessments of non-cancer health effects for Diesel Particulate Matter (PM). Assessments provide a snapshot of the outdoor air quality and the risks to human health that would result if air toxic emissions levels remained unchanged.

NATA identifies those air toxics which are of greatest potential concern, in terms of contribution to population risk. This information is relevant and useful in assessing risk for tribal programs.

Reference Category	References	Comments
Program References	https://www.epa.gov/national-air-toxics-assessment	
Pollutants Measured	https://www.epa.gov/national-air-toxics-assessment/2011-nata-assessment-results	
Methods References	https://www.epa.gov/national-air-toxics-assessment/2011-nata-technical-support-document	Downloadable ZIP file
Network Design References	https://www.epa.gov/national-air-toxics-assessment/2011-nata-technical-support-document	Downloadable ZIP file
Siting Criteria	https://www.epa.gov/national-air-toxics-assessment/2011-nata-technical-support-document	Downloadable ZIP file
Quality System References	https://www.epa.gov/national-air-toxics-assessment/2011-nata-technical-support-document	Downloadable ZIP file
Data Management	https://www.epa.gov/national-air-toxics-assessment/2011-nata-technical-support-document	Downloadable ZIP file

Appendix B

Monitoring Cost Sheets

Every 3 years, OAQPS develops a survey called an Information Collection Request (ICR) that is used to estimate the costs of implementing ambient air monitoring activities for the State and Local Monitoring Station (SLAMS) network. A number of monitoring organizations are contacted and requested to fill out the ICR. The values received from these organizations are then compiled and national cost estimates developed. The following site costs and work-hours are based on the 2013 Information Collection Request (ICR) estimate for the ambient air quality network and are meant to provide general estimates of costs to implement the various types of monitors and samplers for the criteria pollutants implemented in the SLAMS. The full ICR and concluding documents, including the spreadsheet from which the following tables were made, is available at https://www.reginfo.gov/public/do/PRAViewICR?ref_nbr=201309-2060-010

NOTE: The following tables should be used to provide general categories of activities and "ballpark" estimates of hours and costs. They were developed using data from 2013 so costs for products may have changed. The tables can help a Tribe to estimate their own costs and should not be used as definitive costs and hours.

Additional information on the ICR can be found at the following site: https://www.epa.gov/icr/

Category	Equipment	Supplies	Spare Parts Supplies	Lab Analysis
O3	$8,626	$958	$1,198	
PM25	$8,386	$479	$1,138	$2,396
PM25 Sequential Sampler	$13,178	$599		$2,396
PM 25 Speciation Sampler	$14,376	$1,198		$9,584
PM25 Continuous Sampler	$21,923	$599		
PM10	$6,589	$479	$1,138	$2,396
PM10 Continuous Sampler	$21,085	$599	$665	
NO2	$14,017	$958	$1,198	
NOx	$24,559	$958	$1,198	
CO	$11,980	$958	$1,198	
VOC	$35,940	$19,168	$42,729	
Pb	$2,396	$509	$359	$1,929
SO2	$11,980	$958	$1,198	
Meteorological	$20,707	$899	$2,396	
Datalogger	$8,985			
Datalogger software	$9,584			
Multigas calibrator	$16,772			
Zero air supply	$4,792			
Ambient air intake manifold assembly	$1,797			
Shelter (large, temp controlled)	$30,549			
Shelter (small, temp controlled)	$15,574			
Shelter delivery charges	$599			
Sampling Platform	$2,396			
Other shelter equipment/accessories	$4,792			
Site preparation	$5,391			
Power drop	$839			
Land/Lease	$3,594			
Rent	$340			
Miscellaneous equipment	$2,396			
Utilities	$1,198			
Data acquisition (laptop/PDA)	$479			

Element	Work Hours per Year (estimated)							
	O3	PM25	PM10	NO2	CO	VOC	Pb	SO2
1 - Network Design	38	21	40	38	38	38	25	38
2 - Site Installation	20	44	8	20	20	23	16	20
3 - Supplies & site visits	120	677	380	120	120	88	90	120
4 - Maintenance	68	138	160	86	68	96	16	68
5 - Data Managment	39	467	347	50	39	184	21	39
6 - Quality Assurance	91.5	162	124	151	92.5	77	32.5	92.5
7 - Supervision	42	193	34	42	42	44	10	42
Total	419	1702	1093	507	420	550	211	420

Appendix C

Graded Approach for QMPs and QAPPs in Ambient AQ Monitoring

The following information is from the original March 22nd 2007 Memorandum from OAQPS to Regional Tribal Air Coordinators on the *Development and Approval of QAPPs and QMPs for Tribal Monitoring Programs* and is available at: https://www3.epa.gov/ttnamti1/files/ambient/monitorstrat/gradeapp.pdf

Using the Graded Approach for the Development of QMPs and QAPPs in Ambient Air Quality Monitoring Programs

EPA policy requires that all organizations funded by EPA for environmental data operations (EDOs) develop quality management plans (QMPs) and quality assurance project plans (QAPPs). In addition, EPA has provided flexibility to EPA organizations on how they implement this policy, allowing for use of a graded approach. The following proposal explains the graded approach for data collection activities related to ambient air monitoring. OAQPS proposes a graded approach for the development of QAPPs and QMPs.

The Graded Approach

The QMP describes the quality system in terms of the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, and assessing activities involving EDOs. Each program should provide appropriate documentation of their quality system. Here are a few ways that this could be handled.

Concept - Small organizations may have limited ability to develop and implement a quality system. EPA should provide options for those who are capable of making progress towards developing a quality system. If it is clear that the EDO goals are understood and that progress in quality system development is being made, a non-optimal quality system structure, for the interim, is acceptable. The concept is to work with the small organization to view the QMP as a long-term strategic plan with an open ended approach to quality system development that will involve continuous improvement. The graded approach to QMP development is described below and is based on the size of the organization and experience in working with EPA and the associated QA requirements.

1. Small organization that just received its first EPA grant or using a grant for a discrete, small, project-level EDO. Such organizations could incorporate a description of its quality system into its QAPP.
2. Small organization implementing EDOs with EPA at more frequent intervals or implementing long-term monitoring programs with EPA funds. If such an organization demonstrates capability of developing and implementing a stand-alone quality system, it is suggested that an appropriate separate QMP be written.
3. Medium or large organization. Develop QMP to describe its quality system and QAPPs for specific EDOs. Approval of the recipient's QMP by the EPA Project Officer and the EPA Quality Assurance Manager may allow delegation of the authority to review and approve Quality Assurance Project Plans (QAPPs) to the grant recipient based on acceptable procedures documented in the QMP.

Quality Assurance Project Plans

The QAPP is a formal document describing, in comprehensive detail, the necessary QA/QC and other technical activities that must be implemented to ensure that the results of work performed will satisfy the stated performance criteria, which may be in the form of a data quality objective (DQO). The quality assurance policy of the EPA requires every EDO to have written and approved quality assurance project plans (QAPPs) prior to the start of the EDO. It is the responsibility of the EPA Project Officer (person responsible for the technical work on the project) to adhere to this policy. If the Project Officer gives permission to proceed without an approved QAPP, he/she assumes all responsibility. If a grantee's QMP is approved by EPA and provides for delegation of QAPP approval to the grantee, the grantee is responsible to ensuring approval of the QAPP prior to the start of the EDO.

The Ambient Air Monitoring Program recommends a four-tiered project category approach to the Ambient Air QA Program in order to effectively focus QA. Category I involves the most stringent QA approach, utilizing all QAPP elements as described in EPA R5[wwww] (see Table 2), whereas category IV is the least stringent, utilizing fewer elements. In addition, the amount of detail or specificity required for each element will be less as one moves from category I to IV. Table 1 provides information that helps to define the categories of QAPPs based upon the data collection objective. Each type of ambient air monitoring program EDO will be associated with one of these categories. The comment area of the table will identify whether QMPs and QAPPs can be combined and the type of data quality objectives (DQOs) required (see below). Table 2 identifies which of the 24 QAPP elements are required for each category of QAPP. Based upon a specific project, the QAPP approving authority may add/delete elements for a particular category as it relates to the project but in general, this table will be applicable based on the category of QAPP.

Flexibility on the systematic planning process and data quality objective (DQO) development

Table 1 describes 4 QAPP/QMP categories which require some type of statement about the program or project objectives. Three of the categories use the term data quality objectives (DQOs), but there should be flexibility with the systematic planning process on how these DQOs are developed based on the particular category. For example, a category 1 project would have formal DQOs. Examples of category I projects, such as the State and Local Monitoring Stations (SLAMS), have DQOs developed by OAQPS. Category II QAPPS may have formal DQOs developed if there are national implications to the data (i.e., Speciation Trends Network) or less formal DQOs if developed by organizations implementing important projects that are more local in scope. Categories 3 and 4 would require less formal DQOs to a point that only project goals (category 4) may be necessary.

Standard Operating Procedures- (SOP)

SOPs are an integral part of the QAPP development and approval process and usually address key information required by the QAPP elements. Therefore, SOPs can be referenced in QAPP elements as long as the SOPs are available for review or are part of the QAPP.

[wwww] EPA Requirements for QA Project Plans (QA/R-5) https://www.epa.gov/quality/epa-qar-5-epa-requirements-quality-assurance-project-plans

Appendix C, Table 1. Ambient Air Monitoring Program QAPP/QMP categories

Categories	Programs	QAPP/QMP Comments
Category 1 Projects include EDOs that directly support rulemaking, enforcement, regulatory, or policy decisions. They also include research projects of significant national interest, such as those typically monitored by the Administrator. Category I projects require the most detailed and rigorous QA and QC for legal and scientific defensibility. Category I projects are typically stand-alone; that is, the results from such projects are sufficient to make the needed decision without input from other projects.	SLAMS PSD NCore IMPROVE CastNet	Most agencies implementing Ambient Air Monitoring Networks will have separate QMPs and QAPPs. However, a Region has the discretion to approve QMP/QAPP combination for small monitoring organizations (i.e., Tribes).
Category 2 Projects include EDOs that complement other projects in support of rulemaking, regulatory, or policy decisions. Such projects are of sufficient scope and substance that their results could be combined with those from other projects of similar scope to provide necessary information for decisions. Category II projects may also include certain high visibility projects as defined by EPA management.	Speciation Trends Toxics Mon.	Most agencies implementing Ambient Air Monitoring Networks will have separate QMPs and QAPPs. However, a Region has the discretion to approve QMP/QAPP combination for small monitoring organizations (i.e., Tribes).
Category 3 Projects include EDOs performed as interim steps in a larger group of operations. Such projects include those producing results that are used to evaluate and select options for interim decisions or to perform feasibility studies or preliminary assessments of unexplored areas for possible future work.	SPM One time Studies Local Scale Air Toxics Grants	EDOs of short duration. QMP and QAPP can be combined.
Category 4 Projects involving EDOs to study basic phenomena or issues, including proof of concepts, screening for particular analytical species, etc. Such projects generally do not require extensive detailed QA/QC activities and documentation.	Education Outreach	

Appendix C, Table 2. QAPP Elements

QAPP Element	Category Applicability

A1 Title and Approval Sheet	I, II, III, IV
A2 Table of Contents	I, II, III
A3 Distribution List	I
A4 Project/Task Organization	I, II, III
A5 Problem Definition/Background	I, II, III
A6 Project/Task Description	I, II, III, IV
A7 Quality Objectives and Criteria for	I, II, III, IV
Measurement Data	I
A8 Special Training Requirements/Certification	I, II, III
A9 Documentation and Records	
	I, II, III, IV
B1 Sample Process (Network) Design	I, II, III
B2 Sampling Methods Requirements	I, II, III
B3 Sample Handling and Custody Requirements	I, II, III, IV
B4 Analytical Methods Requirements	I, II, III, IV
B5 Quality Control Requirements	I, II, III
B6 Instrument/Equipment Testing, Inspection &	I, II, III
Maintenance	I,
B7 Instrument Calibration and Frequency	I, II, III
B8 Inspection/Acceptance Requirements for	I, II
Supplies and Con.	
B9 Data Acquisition Requirements for Non-direct	I, II,
Measurements	I, II,
B10 Data Management	
	I, II, III
C1 Assessments and Response Actions	I, II
C2 Reports to Management	I, II
D1 Data Review, Validation, and Verification	
Requirements	
D2 Validation and Verification Methods	
D3 Reconciliation and User Requirements	

Appendix D

Grant Funding Information

1. ***Tips on Writing a Grant Proposal*** available at https://www.keepoklahomabeautiful.com/tips-on-writing-a-grant-proposal/.

2. A summary of EPA grants and websites, identifying specific and general resources one can use for funding information and assistance.

Tips On Writing a Grant Proposal

Grants are sums of money awarded to finance a particular activity or facility. Generally, these grant awards do not need to be paid back. Federal agencies and other organizations sponsor grant programs for various reasons. Before developing a grant proposal, it is vitally important to understand the goals of the particular Federal agency or private organization, and of the grant program itself. This can be accomplished through careful analysis of the Catalog of Federal Domestic Assistance (CFDA), Request for Initial Proposals (RFIP) or Request for Applications (RFA) and discussions with the information contact listed in each resource description. Through these discussions an applicant may find that, in order for a particular project to be eligible for funding, the original concept may need to be modified to meet the criteria of the grant program. In allocating funds, programs base their decisions on the applicant's ability to fit its proposed activities within the program's interest areas.

It is important for an applicant to become familiar with eligibility requirements and other criteria related to the organization and grant program from which assistance is sought. Applicants should remember that the basic requirements, application forms, information,
deadlines and procedures will vary for each grant maker.

Before You Begin Writing the Grant Proposal:

- Rule #1: Believe that someone wants to give you the money!
- Project your organization into the future.
- Start with the end in mind...look at your organization's big picture. Who are you? What are your strengths and priorities?
- Create a plan not just a proposal.
- Do your homework: Research prospective funders. Try and search locally first. Target funding source that has interest in your organization and program.

If you need the money now, you have started too late.

A successful grant proposal is one that is thoughtfully planned, well prepared, and concisely packaged. There are nine basic components in a solid proposal package:

1. Proposal Summary

The proposal summary appears at the beginning of the proposal and outlines the project. It can be a cover letter or a separate page. It should be brief: no longer than two or three paragraphs. It is often helpful to prepare the summary after the proposal has been developed. This makes it easier to include all the key points necessary to communicate the objectives of the project. The summary document becomes the foundation of the proposal. The first impression it gives will be critical to the success of the venture. It very possibly could be the only part of the package that is carefully reviewed before the decision is made to consider the project further.

2. Introduction of the Organization

Most proposals require a description of an applicant's organization and its past, present, and projected operations. Be concise, specific and compelling. Use the description to build credibility for your organization. (Start a "credibility" file.) Reinforce the connection between you and the grantor. Establish a context for your problem statement.

IN BRIEF: Who, what, when, why, and how much!

Some features to consider are:

- A brief biography of board members and key staff members,
- The organization's goals, philosophy, and record with other grantors,
- any success stories. The data should be relevant to the goals of the granting organization and its grant program, and should establish the applicant's credibility.

<u>3. Problem Statement</u>

The problem statement (or needs assessment) is a key element of a proposal. It should be a clear, concise, well-supported statement of the problem to be overcome using the grant funding. An applicant could include data collected during a needs assessment that would illustrate the problems to be addressed. The information provided should be both factual and directly related to the problem addressed by the proposal.

Zero in on a specific problem you want to solve or an issue you want to address;

Do not make assumptions of the reviewers,

Use statistics to support the existence of your problem or issue,

Make a connection between the issue and your organization,

Make a case for your project locally, not just nationally,

Demonstrate your knowledge of the issue or problem and,

Set-up the milestones of your goals and objectives, address the outcomes you wish to achieve.

<u>4. Project Objectives</u>

The project objectives should clearly describe the goals of the project. Applicants should explain the expected results and benefits of each objective. They should also list the specific criteria of the grant program. Then, describe how the proposal meets each criterion. Goals are general and offer the evaluator an understanding of the thrust of your program. Objectives are specific, measurable outcomes. They should be realistic and attainable. Objectives help solve the problem or address the issue. If your objectives make reference to a number -- make sure it is do-able. Do not confuse objectives with methods. Always be realistic.

5. Project Methods or Design

The project method outlines the tasks that will be accomplished with the available resources. It is helpful to structure the project method as a timeline. Early in the planning process, applicants should list the tasks that will have to be completed to meet the goals of the project. They can then break these into smaller tasks and lay them out in a schedule over the grant time period. This will provide a chance to consider what personnel, materials, and other resources will be needed to carry out the tasks.

Describe in detail the activities that will take place in order to achieve desired results. Make sure your methods are realistic. Describe WHY you have chosen these activities. Justify them over all other approaches your organization could have taken. Show your knowledge of the bigger picture. Include a timetable of major milestones.

6. Project Evaluation

Applicants should develop evaluation criteria to evaluate progress towards project goals. It is important to define carefully and exactly how success will be determined. Applicants should ask themselves what they expect to be different once the project is complete. If you are having a problem developing your evaluation process, you better take another look at your objectives. Be ready to begin evaluation as you begin your project.

Summative and Formative Evaluation:

Summative Evaluation is a plan to evaluate the project that measures how you will have met your objectives.

Formative Evaluation is a plan to evaluate the project during and after its execution. It can be used as a tool to make appropriate changes along the way.

7. Future Funding

Applicants may be asked to list expected sources of continuing funding after the conclusion of the grant. The applicant may also be required to list other sources and amounts of funding obtained for the project.

8. The Proposal Budget

Funding sources require different amounts of detail in the budget. Most Federal funding sources require a large amount of detail. Also, they usually provide budget forms with instructions. The budget format presented here is designed to match what most Federal agencies request. If the funding source requires a specific format, you must provide a budget in that format.

Your Budget is an Estimate

Your budget is an estimate. Still, you may not exceed the total amount for the grant. Do not feel you must spend the money to the penny. Your funding source will allow some freedom in spending the money. They might permit requests to change the budget. Such requests must be in writing. A written response becomes a formal "budget modification." The budget modification changes the conditions of the grant. Careful planning will decrease the number of changes that may be required. Also, careful planning shows honesty. This honesty will be necessary to get permission for future changes.

Be Specific

The numbers should be specific. Rounding an item to nearest thousand dollars does not inspire confidence. It also suggests you have not done much work preparing the budget. The reviewer will do a lot of work studying your budget. They expect you to you a lot of work planning the budget. If you round at all, round to dollars, or tens at most. Along the same lines, there is no place in the budget for miscellaneous or contingency items. Your planning should allow for contingencies. For example, a cost of living increase will happen before the grant begins. In this case, you should base salaries on the increased salaries. If you plan to buy equipment, contact the distributor to find out the cost of the equipment when you plan to purchase it. The amount of thought you give to preparing the budget will produce a better program. It will also increase your chances of receiving the grant.

This Format

This budget format is useful for planning both governmental and private grants. It has two basic parts: (I) Personnel costs, and (II) Non-Personnel costs. There is an optional third part called "Indirect Costs" that pertains to some grant applications. There is also a "Budget Summary." This is written after the budget is complete and is presented at the start of the budget.

The Proposal Budget Budget Summary

	Total	Total Requested	Total Match
Total this Grant	$100,671.12	$78,362.62	$22,308.50
Personnel			
Salaries and Wages	44,950.00	43,200.00	6,750.00
Fringe Benefits	12,148.62	10,479.12	1,669.50
Non-Personnel	$38,572.50	$24,683.50	$13889.00
Consultants and Contract Services	15,664.00	4,800.00	10,864.00
Equipment	7,710.00	7,085.00	625.00
Supplies	1,287.00	1,287.00	- 0 -
Travel	1,761.00	1,761.00	- 0 -
Other Costs	12200.00	9,800.00	2400.00

Costs are divided into two columns: "requested" and "match." The "requested" column is for items we are asking the funding source to pay for. The "match" column represents those items that are either to be paid for from some other source of funds, or which are actually donated or contributed to the project. In the case of a federal grant proposal, these two columns represent the "federal share" and the "non-federal share." Let's look at each of these budget components separately. To the funding source, this will be done in what is called the "budget detail." This is where each section of the budget is broken down. Budget calculations also appear here. If the funding source provides forms, much of the following information will fit into the appropriate space on the form.

Budget Detail - Personnel: Salaries and Wages

	Requested	Match
Personnel		
Salaries and Wages		
(1) Exec. Dir. @ $1,500/mo x 10% x 12 mos.		1,800.00
(1) Proj. Dir. @ $1,200/mo x 100% x 12 mos.	14,400.00	
(2) Counselors @ $900/mo x 100% x 11 mos.	19,800.00	
(1) Counselor* @ $900/mo x 50% x 11 mos.		4,950.00
(1) Secretary @ $750/mo x 100% x 12 mos.	9,000.00	
Total	$ 43,200.00	$ 6,750.00

*This half-time counselor position is contributed to this program by another social service agency.

First, enter the number of persons at the same salary and same job. Second, enter the title of the position. Third, enter the full monthly salary for that position. Do this whether the position is full-time or part-time. Pro-rating salaries for part-time positions can be very confusing. Clarify this by entering the percentage time that this person will be working on your project. Then, enter the number of months this person will be employed during the grant period. Next multiply the three numbers (number of people, salary, number of months working) to obtain totals. Enter these totals in one of two columns. Which column depending upon whether the funds are being requested of this funding source or coming from elsewhere.

Indicate personnel contributed by other agencies with an asterisk (*). Note the source of these additional personnel.

It is wise to have salary ranges for most, if not all, of the positions within your organization. If you do, then you may make an additional note to this section. For example: "All salaries within this budget item represent the middle step of the salary range for the position, except for those instances where a person is presently filling that position." You would then attach a copy of your salary schedule to the budget. This procedure can keep you from becoming locked into an exact salary. This also depends on your personnel policies. Your policies may allow the employment of a new person at any step within the salary range. By using the middle step for budget purposes, you allow for the averaging of the salary of a new employee. Some may come in at the first step, some at the top step. If the funding source advises another way of presenting salaries (for example, at the top step), then follow instructions.

When jobs are created that do not currently exist within your organization, conduct a survey to determine proper salaries. Find local agencies similar in size and mission. Try to identify positions in those agencies close to the new jobs in your agency. Salaries for these positions should be your guide. Save this survey information. The funding source might ask how you decided the salary of a new job.

In the salaries and wages section, enter only those positions where salaries are paid. These salaries can either be paid by the proposed grant, your regular budget, or by some other source of funding. Volunteers, who are not paid, will be entered in the "Consultants and Contract Services" item as other personnel.

Budget Detail - Personnel: Fringe Benefits

	Requested	Match
Personnel:		
Fringe Benefits		
SUI - 3.2% x $24,000 (California Rates)	768.00	
Workers Comp. Policy	350.00	
FICA - 6.13% x $43,200	2,648.16	
Health Insurance - 2 single employees @ $35/mo; 2 employees with dependents @ $98/mo; x12 mos. (employer pays 100%)	3,192.00	
Extended Disability Ins. -		
4 employees @ $4.02/mo x 12 mos.	192.96	
Vacation and Sick Leave - 16 wks.		
@ avg. salary of $208.00/wk.	3,328.00	
Fringe benefits for donated executive director, based on agency's total fringe benefit percentage (24%) of salary ($1,800)		432.00
Fringe benefits for donated counselor, based on donating agency's total fringe benefit percentage (25%) of salary ($4,950)		1,237.50
Total	$ 10,479.12	$1,669.50

Fringe benefits require a separate category in your budget. They should not be combined with staff salaries. Some funding sources will accept a fringe benefit as a percentage of payroll (for example, "22 percent of the above"). However, it is desirable to carefully explain all of the benefits covered by the grant. Do not do this if the funding source asks differently. Donated fringe benefits can be entered as payroll percentages. There are three kinds of fringe benefits that apply:

1.<u>Mandated benefits</u> - those required by the state in which you are located. Examples of required benefits are Workers Compensation Insurance and State Unemployment Insurance (SUI).

2.<u>Security (FICA)</u> - from which many public and private nonprofit agencies are exempt but in which most agencies voluntarily participate.

3.Voluntary benefits - vary from organization to organization. They include medical, dental, disability and life insurance, private retirement programs, reimbursement for work-related education expenses, reimbursement for parking, sabbatical leave, etc.

All organizations have some provisions for vacation and sick leave. Sometimes these are not written into the budget. Smaller organizations often omit this item from the fringe benefit description. If grant-supported staff does not take their vacations during the period of a grant, at the end of the grant, they may wind up with a financial burden for unused vacation time. Then they must find a source of funds to compensate staff for this earned vacation. Avoid this situation by including a figure for vacation and sick leave. Do this only if allowed for by the funding source.

Perform your actual calculations within the budget detail. For example, in California, the rate for State Unemployment Insurance during 1998 ranged from 0.4 percent to 4.9 percent (depending on the history of unemployment claims of the applicant) of the first $6,000 of each person's salary. The I999 Social Security rate was 6.43 percent of the first $22,900 of any salary.

Budget Detail - Consulting and Contract Services

	Requested	Match
1. Contractual Personnel		
C. Consulting and Contract Services		
Consulting Psychologist (Dr. Goodge, NY		
Physiological Assn.) 4 hrs/wk x $40 x 52 wks.		8,320.00
Evaluation Consultant (Dr. Fastback, Uni.		
Evaluation Center) 10 hrs/wk x $25/hr x 12 mos.	3,000.00	
Bookkeeping Services by Fold, Spindle, & Mutilate, Inc. $150/mo x 12 mos.	1,800.00	
(4) Volunteer tutors @ 5 hrs/wk each x 48 wks x $2.65/hr.		2,544.00
Total	$ 4,800.00	$10,864.00

Paid and unpaid (volunteer) consultants are listed in this section of your budget. Rather than employing a bookkeeper, you may use paid consultant time. If services are volunteered, that goes in here as well. Volunteer time may be allowed by some government funding sources. This occurs when they require some portion of the grant be matching funds, or in-kind contributions by the applicant. This raises the question of how to place a value on a volunteer's time. Gather written statements from the volunteers testifying to their commitment to volunteer services to your program. Remember, these must be like services. For an attorney to be valued at $40.00/hr. in your program, he/she must be providing legal services to you - not driving children to football games every Saturday. These statements establish the value of the volunteered time. They also are good credibility letters from persons sufficiently impressed with you to volunteer.

Volunteers who have not the needed skills to qualify for a specific role, and who have not been paid a salary in that role, must be rated at the current minimum wage. This happens no matter how well they perform.

Budget Detail - Non-Personnel: Rental, Lease, or Purchase of Equipment

	Requested	Match
Rental, Lease or Purchase of Equipment		
(1) Secretarial Desk @ $150	150.00	
(1) Secretarial Chair @ $65	65.00	
(2) Desks @ $100	200.00	
(2) Chairs @ $65	130.00	
(2) Desks donated by applicant @ rental value of $5/ea/mo x 12 mos.		120.00
(8) Chairs donated @ rental value of $5/ea/mo x 12 mos.		480.00
(1) File Server @ $5,220	5220.00	
(2) Spendthrift computers @ $30/mo leased x 12 mos.	720.00	
(1) Dynamite Copying machine leased @ $50/mo x 12 mos.	600.00	
Total	$ 7,085.00	$ 600.00

The second non-personnel item is for rental, lease or purchase of equipment. This will include computers, tables, chairs, desks, filing cabinets, copying equipment, etc. Unused equipment your agency now owns can be applied to this project. Attach an approximate rental value to the unused equipment. For example, rather than buying a new desk for a new person, use one you already have but are not now using. Find out what it would cost to rent the desk for a year, and put that value into your budget as a contribution from your agency.

Budget Detail - Non-Personnel: Supplies

	Requested	Match
Desktop supplies for 6.5 staff @ $125/ea/yr	812.50	
100 reams copy paper @ $2.75/ea and 5 toner refills @ $40/ea	475.00	
Total	$ 1,287.50	- 0 -

There are three separate kinds of consumables that might appear in your budget:

1. Desk top supplies. These include the normal pens, erasers, stationery, paper clips, etc. A reasonable cost for these items is $100 to $125 per year per person in your office unless these items are included in your indirect cost rate in which case you would not direct charge them. Experience should indicate whether this will be sufficient.

2. Copying supplies. Since copying has become universal, and since paper and toner are such expensive items, these should be separated from the above unless you are advised otherwise or these items are included in your indirect cost rate in which case you would not direct charge them.

3. Direct program-related consumables. These might be arts and crafts supplies provided to children in a child care program, etc.

Budget Detail - Non-Personnel: Travel

	Requested	Match
Local mileage for Project Director:		
100 mi/mo @ $0.17/mi x 12 mos.	204.00	
Local mileage for (2) Counselors:		
200 mi/mo @ $0.17/mi x 12 mos.	816.00	
Travel expenses for Project Director to attend Grantsmanship Center Training Program in Los Angeles, July 11-15, 19 - $325 tuition plus $218 round-trip air plus 6 days per diem @ $33/day	741.00	
Total	$ 1,761.00	- 0 -

<u>Be specific</u>. For local mileage, project the number of miles you expect each person to drive on the job each month. Multiply this by the accepted rate in your geographic area. Multiply again by the number of months in the grant period. For out-of-town travel, you must anticipate the travel that will be required during the grant. This may be easy for program-related travel (e.g., visiting remote program sites), but is more difficult in planning training and conference attendance. These items in your budget should be supported by a statement in your program narrative describing the need for and benefits of whatever travel is budgeted. You might include fees for training, as well as per diem and air travel expenses, in this category.

Budget Detail - Non-Personnel: Other Costs

This is the category for items that do not fit naturally into another category. Examples of items that might be:

1. Postage
2. Fire, theft, and liability insurance
3. Dues in professional associations paid for by the applicant
4. Subscriptions to periodicals
5. Publications costs

Other Costs

	Requested	Match
Telephone Installation @ $260	260.00	
(6) Instruments @ $45/ea/mo x 12 mos.	3,240.00	
Postage	600.00	
Insurance (Fire, Theft, Liability)	750.00	
Space Costs		
Office rent - 1,200 sq. ft. @ $6.00/ft/yr	7,200.00	
Tutoring space - contributed by local school: one classroom 20 hrs/wk x $50/wk x 48 wks.		2,400.00
Office janitorial @ $100/mo x 12 mos.	1,200.00	
Office Utilities @ $125/mo x 12 mos.	1,500.00	
Total	$ 11,200	$2,400

If you will be installing new telephones, get an estimate from the phone company (or other vendor) of the cost of installation. Then estimate the average monthly cost per instrument times the number of instruments times the number of months of the project. The first non-personnel item is space costs. That includes office rent, space used outside your office, utilities, maintenance, janitorial services, and essential renovations. As with all other budget items, you must be aware of "comparability" of costs. If you propose to pay much more for rent than the current rent in your community, be prepared to explain your choice.

Budget Detail - Indirect Cost

Organizations that operate several different funded projects face a problem. The cost to the organization of housing a project may drain the resources of the institution. Indirect costs are an attempt to compensate the organization for these costs. Indirect costs are also to provide a basis for sharing the costs of running a large institution among the various programs and projects within the institution.

Indirect costs are those costs of an institution which are not readily identifiable with a particular project or activity but nevertheless are necessary to the general operation of the institution and the conduct of its activities. The costs of operating and maintaining buildings, grounds and equipment, depreciation, general and departmental administrative salaries and expenses and library costs are types of expenses usually considered as indirect costs. In theory, all such costs might be charged directly; practical difficulties, however, preclude such an approach. Therefore, they arc usually grouped into common pool(s) and distributed to those institutional activities benefited through a cost allocation process. The end product of this allocation process is an indirect cost rate(s) which is then applied to individual grant and contract awards to determine the amount of indirect costs chargeable to the award.

Indirect costs may or may not be provided by a funding source. Generally, those sources that support higher educational institutions do provide them. Some funding sources place a ceiling upon indirect costs allowed in a given grant situation. Be sure to find out what
percentage, if any, the funding source will allow for indirect costs, and determine which portion of your budget the percentage applies to. Sometimes indirect costs are a percentage of the total direct costs, or of the personnel costs, or of the salary and wages item alone.

Appendices

<u>Resumes</u>:

- Shows qualifications
- Shows work ethic and commitment
- Sometime can be a few paragraphs
- List other grants you have managed

<u>Letters of Support or Endorsement</u>:

- They are DIFFERENT
- Support implies partners
- Keep endorsement to a minimum
- Should be sent to you, the applicant. Do not send separately to the funder.

Other attachments: Do not include unless they are requested

A SUMMARY OF SOME EPA GRANTS

The following list provides some helpful websites related to the development of grant applications and environmental programs.

To assist tribes in writing effective grant applications and work plans, EPA has developed the **"Tribal Air Grants Framework: A Menu of Options",** available at: https://www.epa.gov/tribal-air/tribal-air-grants-framework-menu-options

Federal Application Forms and OMB Circulars
http://www.whitehouse.gov/omb/circulars/index.html

EPA Application Forms
http://www.epa.gov/ogd/AppKit/application.html

EPA GAP Guidance
http://www.epa.gov/indian/laws3.htm

EPA Region 10 Tribal Office
http://yosemite.epa.gov/r10/tribal.NSF

EPA Region 10 Grants
http://yosemite.epa.gov/r10/omp.nsf/webpage/Region+10+Grants+Administration+Unit

Government Performance and Results Act (GPRA) of 1993
www.epa.gov/budget/planning/gpra.htm

EPA Strategic Plan
www.epa.gov/ocfopage/plan/plan.htm

EPA Environmental Results Order (EPA Order 5700.7)
www.epa.gov/ogd/

EPA provided information and tutorials on Logic Model planning at:
http://yosemite.epa.gov/R10/ECOCOMM.NSF/webpage/measuring+environmental+results

Catalog of Federal Domestic Assistance
http://www.cfda.gov/

Applying for an Indirect Cost Rate
http://www.nbc.gov/icshome.html

Understanding, Managing, and Applying for EPA Grants from the EPA website**:**
https://www.epa.gov/grants

The **Indian Environmental General Assistance Program (GAP)** lists some helpful guidance and training related to the development of GAP applications and environmental programs - https://www.epa.gov/tribal/indian-environmental-general-assistance-program-gap

Also available in hard copy are the ***"IGAP Supplemental Guide to the Application Kit for Financial Assistance", "Tools and Resources for EPA Assistance Applicants and Recipients"****, and* ***"Supplement to Tools and Resources".*** *If you would like a copy of any of these documents, please contact your EPA Tribal Coordinator, or Robert Woodman, Alaska Tribal Liaison, at 1-800-781-0983.*

Appendix E

Sample Manifold Design for Precursor Gas Monitoring

The following information is extracted from the document titled: *Technical Assistance Document for Precursor Gas Measurements in the NCore Multi-pollutant Monitoring*

Network – Ver. 4; which can be found on the AMTIC website at:
https://www3.epa.gov/ttnamti1/ncoreguidance.html

Sample Manifold Design for Precursor Gas Monitoring

Many important variables affect sampling manifold design for ambient precursor gas monitoring: residence time of sample gases, materials of construction, diameter, length, flow rate, and pressure drop. Considerations for these parameters are discussed below.

Residence Time Determination: The residence time of air pollutants within the sampling system (defined as extending from the entrance of the sample inlet above the instrument shelter to the bulkhead of the precursor gas analyzer) is critical. Residence time is defined as the amount of time that it takes for a sample of air to travel through the sampling system. This issue is discussed in detail for NO_x monitoring in Section 4.2, and recommendations in Section 4 for the arrangement of the molybdenum converter and inlet system should be followed. However, residence time is also an issue for other precursor gases, and should be considered in designing sample manifolds for those species. For example, Code of Federal Regulations (CFR), Title 40 Part 58, Appendix E.9 states, "Ozone in the presence of NO will show significant losses even in the most inert probe material when the residence time exceeds 20 seconds. Other studies indicate that 10-second or less residence time is easily achievable."[1] Although 20-second residence time is the maximum allowed as specified in 40 CFR 58, Appendix E, it is recommended that the residence time within the sampling system be less than 10 seconds. If the volume of the sampling system does not allow this to occur, then a blower motor or other device (such as a vacuum pump) can be used to increase flow rate and decrease the residence time. The residence time for a sample manifold system is determined in the following way. First the total volume of the cane (inlet), manifold, and sample lines must be determined using the following equation:

$$\textit{Total Volume} = Cv + Mv + Lv \qquad \textit{Equation 1}$$

Where:

Cv = Volume of the sample cane or inlet and extensions
Mv = Volume of the sample manifold and moisture trap
Lv = Volume of the instrument lines from the manifold to the instrument bulkhead

The volume of each component of the sampling system must be measured individually. To measure the volume of the components (assuming they are cylindrical in shape), use the following equation:

$$V = \pi * (d/2)^2 * L \qquad \textit{Equation 2}$$

Where:
V = volume of the component, cm^3
$\pi = 3.14$
L = Length of the component, cm
d = inside diameter of the component, cm

Once the total volume is determined, divide the total volume by the total sample flow rate of all instruments to calculate the residence time in the inlet. If the residence time is greater than 20 seconds, attach a blower or vacuum pump to increase the flow rate and decrease the residence time.

Laminar Flow Manifolds: In the past, vertical laminar flow manifolds were a popular design. By the proper selection of a large diameter vertical inlet probe and by maintaining a laminar flow throughout, it was assumed that the sample air would not react with the walls of the probe. Numerous materials such as glass, plastic, galvanized steel, and stainless steel were used for constructing the probe. Removable sample lines constructed of FEP or PTFE were placed to protrude into the manifold to provide each instrument with sample air. A laminar flow manifold could have a flow rate as high as 150 L/min, in order to minimize any losses, and large diameter tubing was used to minimize pressure drops. However, vertical laminar flow manifolds have many disadvantages which are listed below:

- Since the flow rates are so high, it is difficult to supply enough audit gas to provide an adequate independent assessment for the entire sampling system;
- Long laminar flow manifolds may be difficult to clean due to size and length;
- Temperature differentials may exist that could change the characteristics of the gases, e.g., if a laminar manifold's inlet is on top of a building, the temperature at the bottom of the building may be much lower, thereby dropping the dew point and condensing water.

For these technical reasons, EPA strongly discourages the use of laminar flow manifolds in the national air monitoring network. It is recommended that agencies that utilize laminar manifolds migrate to conventional manifold designs that are described below.

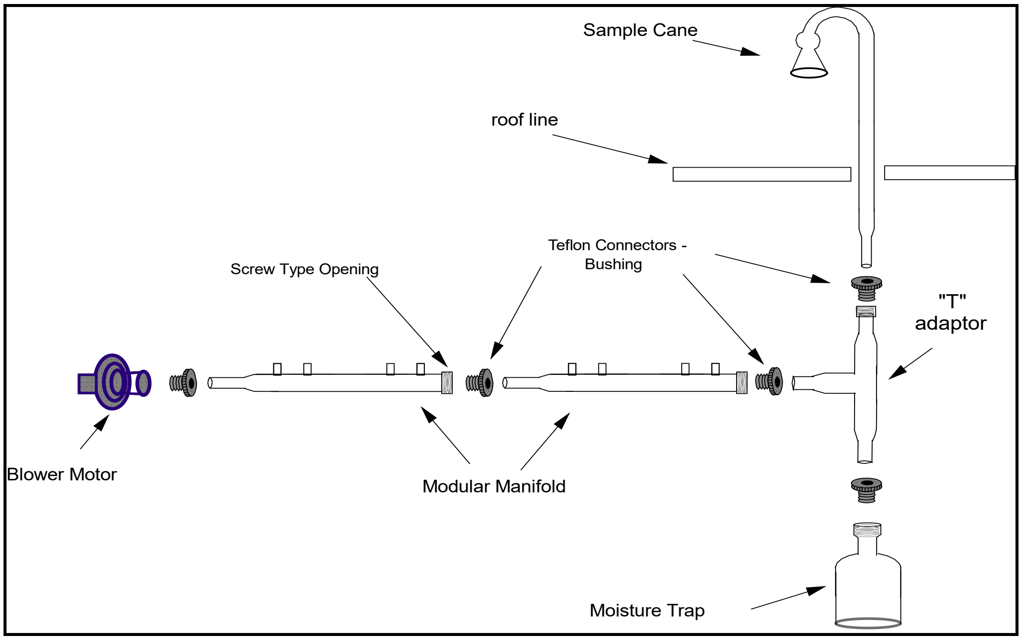
Sampling Lines as Inlet and Manifold: Often air monitoring agencies will place individual sample lines outside of their shelter for each instrument. If the sample lines are manufactured out of Polytetrafluoroethylene (PTFE) or Fluoroethylpropylene (FEP) Teflon®, this is acceptable to the EPA. The advantages to using single sample lines are: no breakage and ease of external auditing. In addition, rather than cleaning glass manifolds, some agencies just replace the sampling lines. However, please note the following caveats:

1. PTFE and FEP lines can deteriorate when exposed to atmospheric conditions, particularly ultraviolet radiation from the sun. Therefore, it is recommended that sample lines be inspected and replaced regularly.
2. Small insects and particles can accumulate inside of the tubing. It has been reported that small spiders build their webs inside of tubing. This can cause blockage and affect the response of the instruments. In addition, particles can collect inside the tubing, especially at the entrance, thus affecting precursor gas concentrations. Check the sampling lines and replace or clean the tubing on a regular basis.
3. Since there is no central manifold, these configurations sometimes have a "three-way" tee, i.e., one flow path for supplying calibration mixtures and the other for the sampling of ambient air. If the three-way tee is not placed near the outermost limit of the sample inlet tubing, then the entire sampling system is not challenged by the provision of calibration gas. It is strongly recommended that at least on a periodic basis calibration gas be supplied so that it floods the entire sample line. This is best done by placing the three-way tee just below the sample inlet, so that calibration gas supplied there is drawn through the entire sampling line.
4. The calibration gas must be delivered to the analyzers at near ambient pressure. Some instruments are very sensitive to pressure changes. If the calibration gas flow is excessive, the analyzer may sample the gas under pressure. If a pressure effect on calibration gas response is suspected, it is recommended that the gas be introduced at more than one place in the sampling line (by placement of the tee, as described in item #3 above). If the response to the calibration gas is the same regardless of delivery point, then there is likely no pressure effect.

Conventional Manifold Design - A number of "conventional" manifold systems exist today. However, one manifold feature must be consistent: the probe and manifold must be constructed of borosilicate glass or Teflon® (PFA or PTFE). These are the only materials proven to be inert to gases. EPA will accept manifolds or inlets that are made from other materials, such as steel or aluminum, that are lined or coated with borosilicate glass or the Teflon® materials named above. However, all of the linings, joints and connectors that could possibly come into contact with the sample gases must be of glass or Teflon®. It is recommended that probes and manifolds be constructed in modular sections to enable frequent cleaning. It has been demonstrated that there are no significant losses of reactive gas concentrations in conventional 13 mm inside diameter (ID) sampling lines of glass or Teflon® if the sample residence time is 10 seconds or less. This is true even in sample lines up to 38 m in length. However, when the sample residence time exceeds 20 seconds, loss is detectable, and at 60 seconds the loss can be nearly complete. Therefore, EPA requires that residence times must be 20 seconds or less (except for NOx). Please note that for particulate matter (PM) monitoring instruments, such as nephelometers, Tapered Element Oscillating Microbalance (TEOM) instruments, or Beta Gauges, the ambient precursor gas manifold is not recommended. Particle monitoring instruments should have separate intake probes that are as short and as straight as possible to avoid particulate losses due to impaction on the walls of the probe.

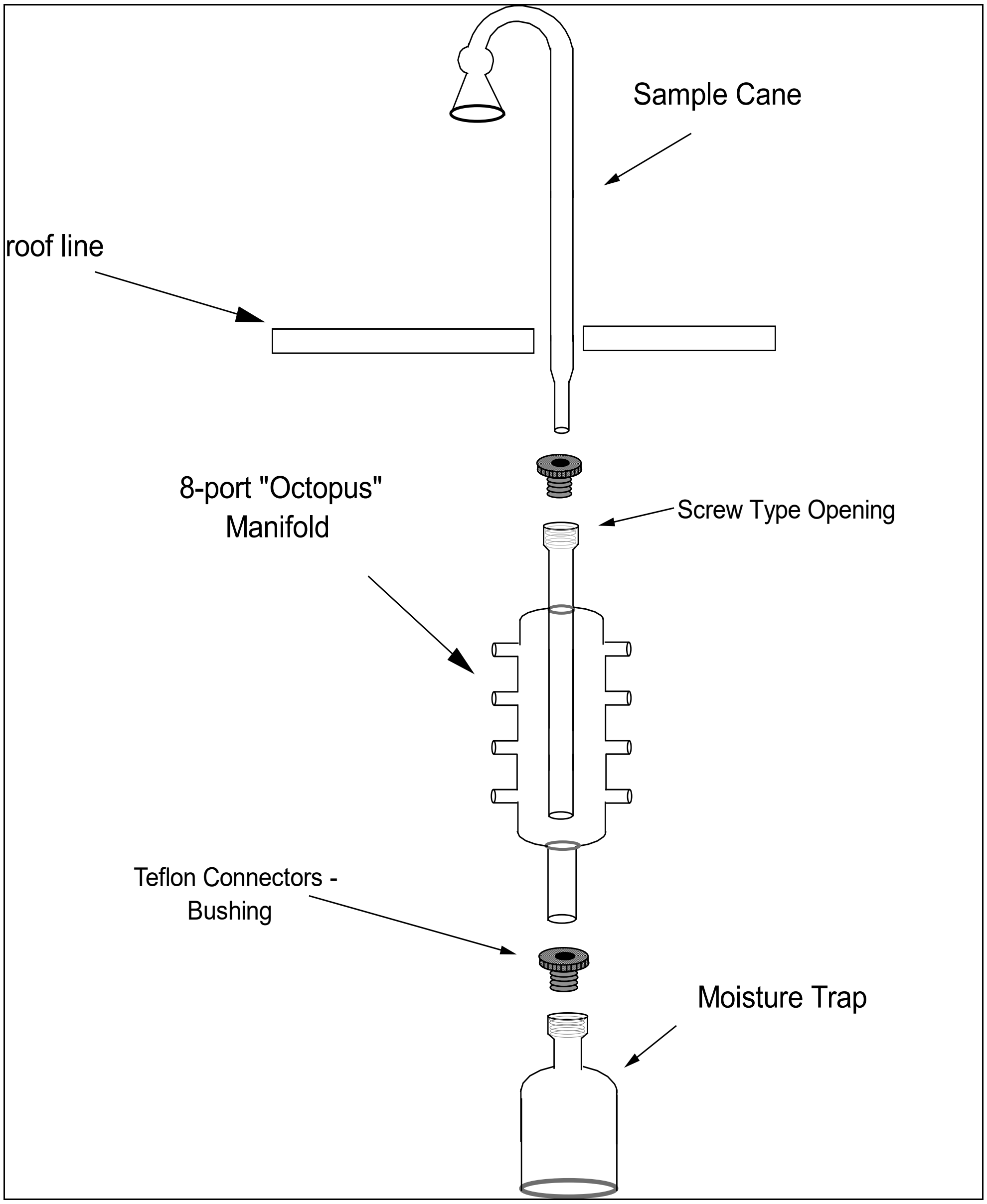
T-Type Design: The most popular gas sampling system in use today consists of a vertical "candy cane" protruding through the roof of the shelter with a horizontal sampling manifold connected by a tee fitting to the vertical section (Figure 1). This type of manifold is commercially available. At the bottom of the tee is a bottle for collecting particles and moisture that cannot make the bend; this is known as the "drop out" or moisture trap bottle. Please note that a small blower at the exhaust end of the system (optional) is used to provide flow through the sampling system. There are several issues that must be mitigated with this design:

- The probe and manifold may have a volume such that the total draw of the precursor gas analyzers cannot keep the residence time less than 20 seconds (except NOx), thereby requiring a blower motor. However, a blower motor may prevent calibration and audit gases from being supplied in sufficient quantity, because of the high flow rate in the manifold. To remedy this, the blower motor must be turned off for calibration. However, this may affect the response of the instruments since they are usually operated with the blower on.
- Horizontal manifolds have been known to collect water, especially in humid climates. Standing water in the manifold can be pulled into the instrument lines. Since most monitoring shelters are maintained at 20-30 ^{o}C, condensation can occur when warm humid outside air enters the manifold and is cooled. Station operators must be aware of this issue and mitigate this situation if it occurs. Tilting the horizontal manifold slightly and possibly heating the manifold have been used to mitigate the condensation problem. Water traps should be emptied whenever there is standing water.



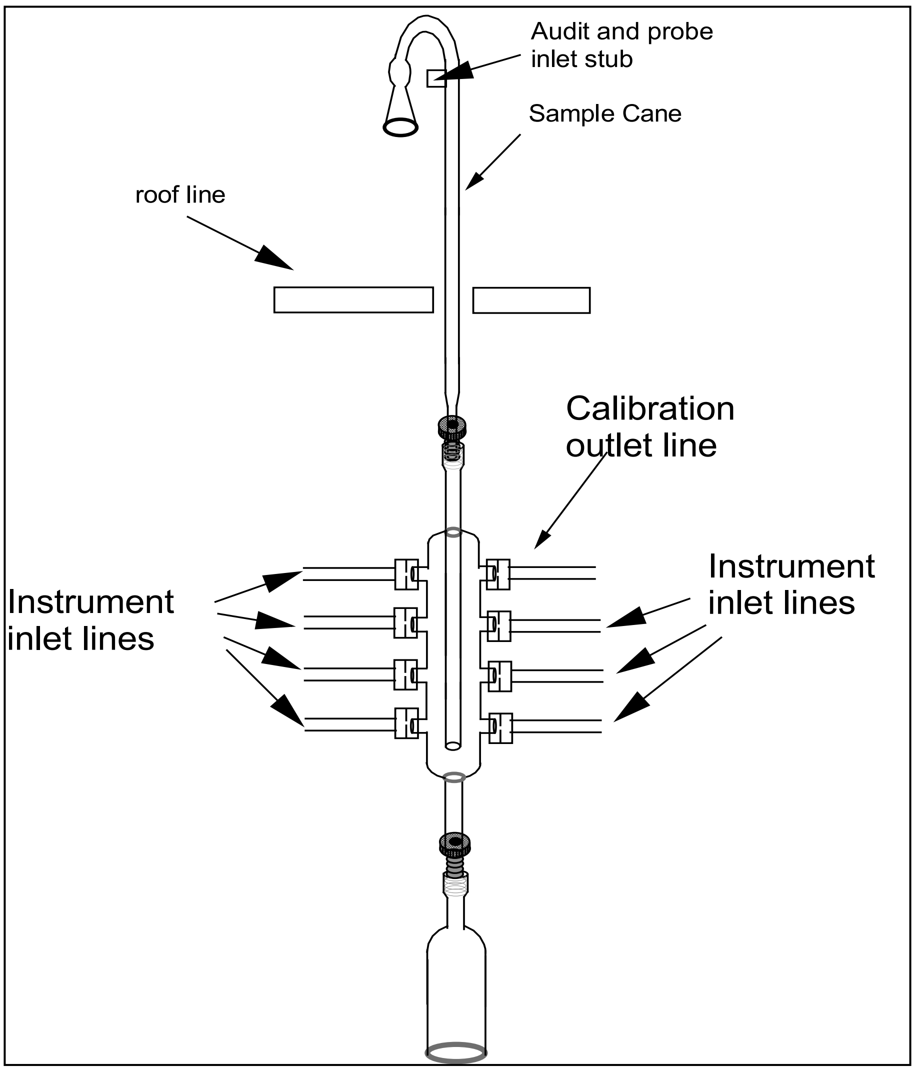
Appendix E, Figure 1. Conventional T-Type Glass Manifold System

California Air Resources Board "Octopus" Style: Another type of manifold that is being widely used is known as the California Air Resources Board (CARB) style or "Octopus" manifold, illustrated in Figure 2. This manifold has a reduced profile, i.e., there is less volume in the cane and manifold; therefore, there is less need for a blower motor. If the combined flow rates of the gas analyzers are high enough, then an additional blower is not required.

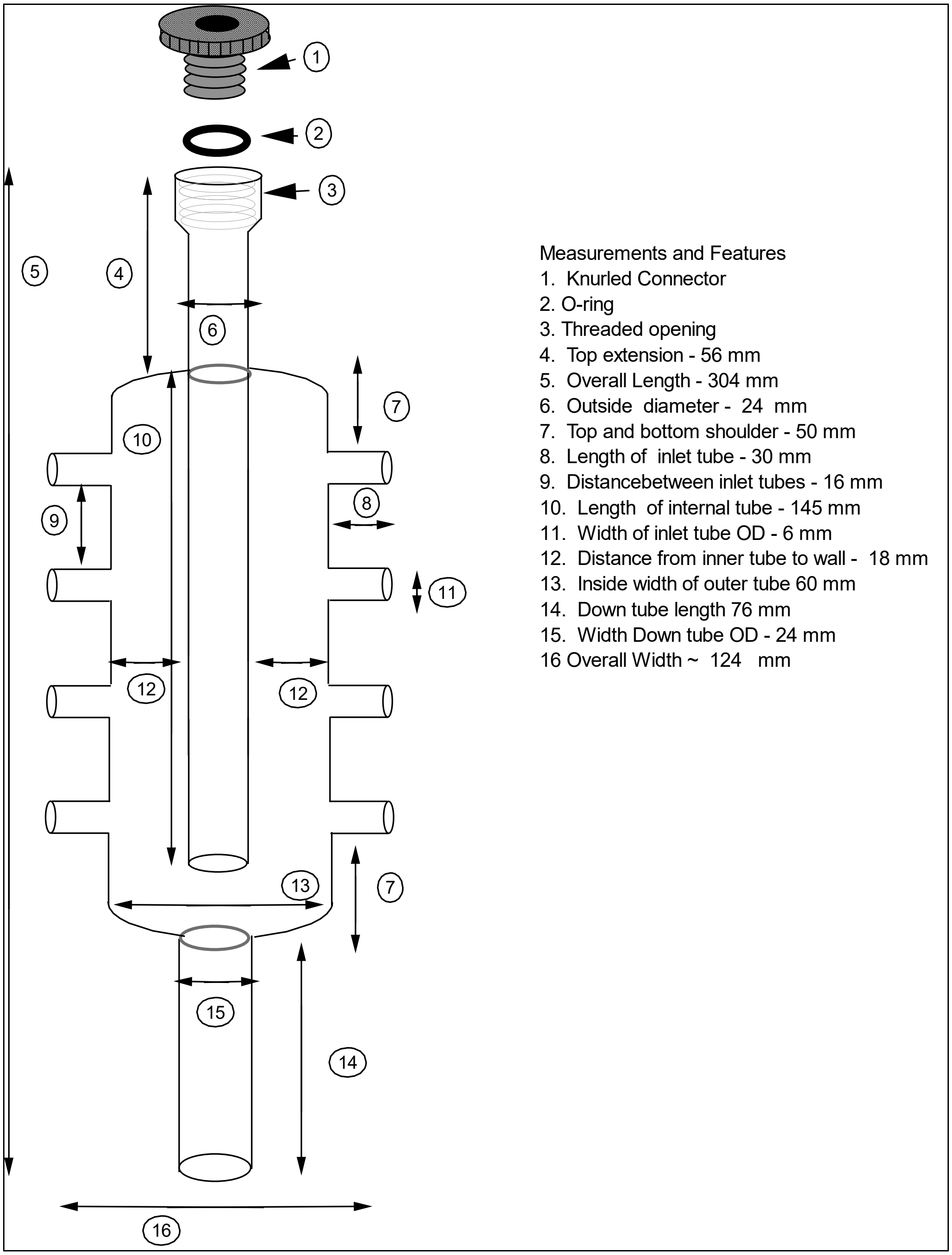


Appendix E, Figure 2. CARB or "Octopus" Style Manifold

Placement of Tubing on the Manifold: If the manifold employed at the station has multiple ports (as in Figure 2) then the position of the instrument lines relative to the calibration input line can be crucial. If a CARB "Octopus" or similar manifold is used, it is suggested that sample connections for analyzers requiring lower flows be placed towards the bottom of the manifold. Also, the general rule of thumb states that the calibration gas delivery line (if used) should be in a location so that the calibration gas flows past the analyzer inlet points before the gas is evacuated out of the manifold. Figure 3 illustrates two potential locations for introduction of the calibration gas. One is located at the ports on the "Octopus" manifold, and the other is upstream near the air inlet point, using an audit or probe inlet stub. This stub is a tee fitting placed so that "Through-the-Probe" audit line or sampling system tests and calibrations can be conducted.



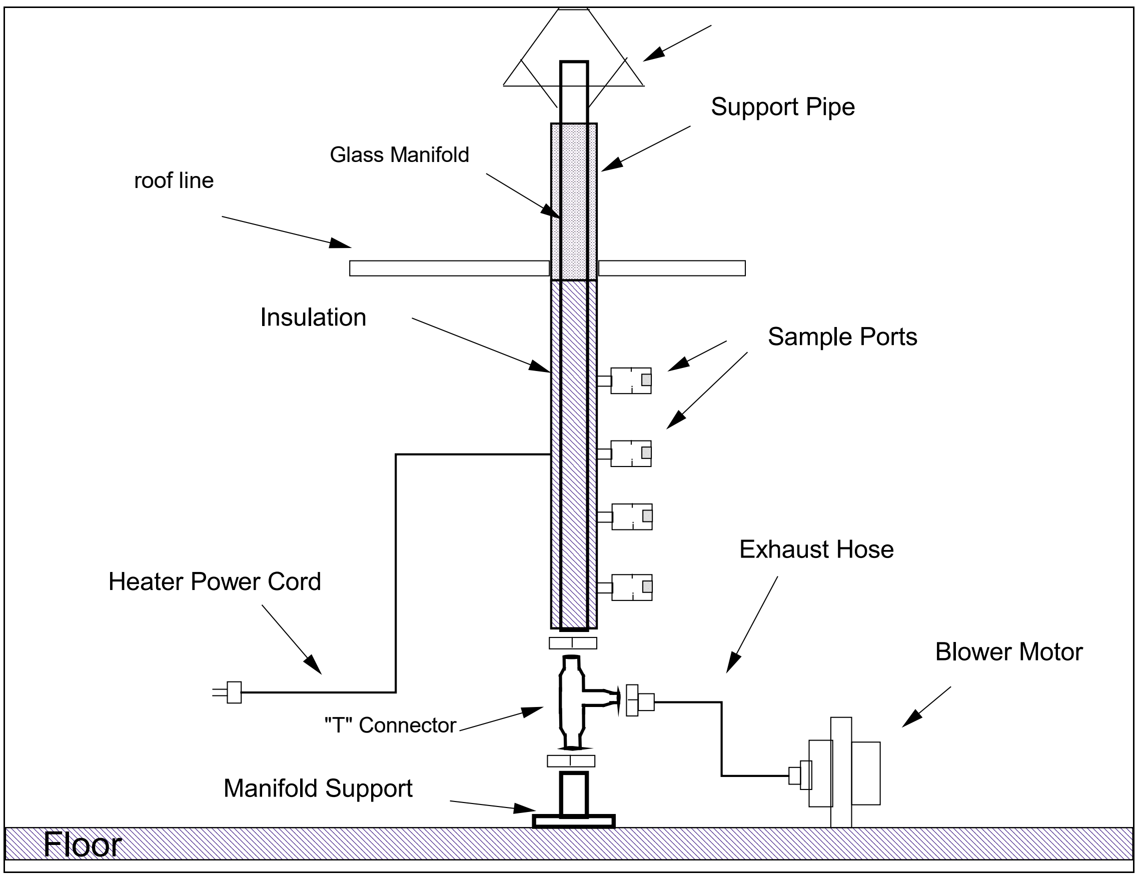
Appendix E, Figure 3. Placement of Lines on the Manifold



Appendix E, Figure 4. Specifications for an 'Octopus" Style Manifold

Figure 4 illustrates the specifications of an Octopus style manifold. Please note that EPA-OAQPS has used this style of manifold in its precursor gas analyzer testing program. This type of manifold is commercially available.

Vertical Manifold Design: Figure 5 shows a schematic of the vertical manifold design. Commercially available vertical manifolds have been on the market for some time. The issues with this type of manifold are the same with other conventional manifolds, i.e., when sample air moves from a warm humid atmosphere into an air-conditioned shelter, condensation of moisture can occur on the walls of the manifold. Commercially available vertical manifolds have the option for heated insulation to mitigate this problem. Whether the manifold tubing is made of glass or Teflon®, the heated insulation prevents viewing of the tubing, so the interior must be inspected often. The same issues apply to this manifold style as with horizontal or "Octopus" style manifolds: additional blower motors should not be used if the residence time is less than 20 seconds, and the calibration gas inlet should be placed upstream so that the calibration gas flows past the analyzer inlets before it exits the manifold.



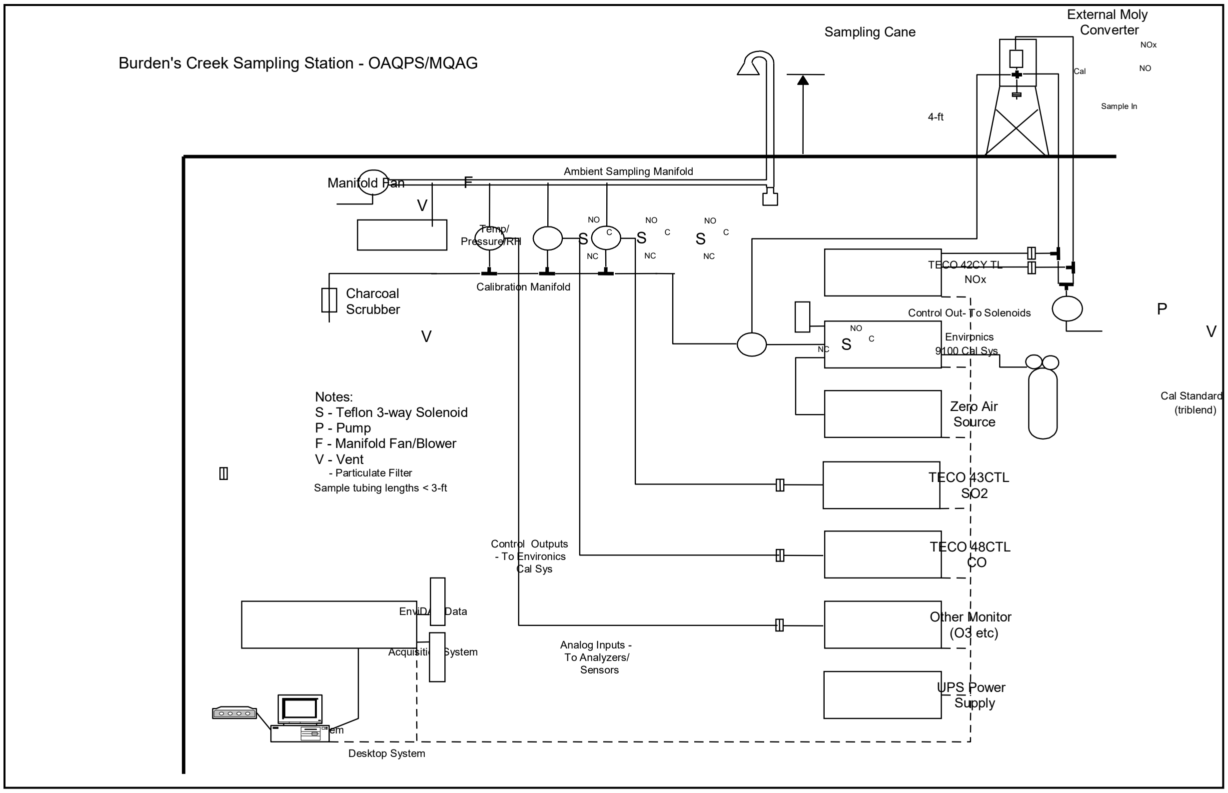
Appendix E, Figure 5. Example of Vertical Design Manifold

Manifold/Instrument Line Interface: A sampling system is an integral part of a monitoring station, however, it is only one part of the whole monitoring process. With the continuing integration of advanced electronics into monitoring stations, manifold design must be taken into consideration. Data Acquisition Systems

(DASs) are able not only to collect serial and analog data from the analyzers, but also to control Mass Flow Calibration (MFC) equipment and solid state solenoid switches, communicate via modem or Ethernet, and monitor conditions such as shelter temperature and manifold pressure. As described in Chapter 6, commercially available DASs may implement these features in an electronic data logger, or via software installed on a personal computer. Utilization of these features allows the DAS and support equipment to perform automated calibrations (Autocals). In addition to performing these tasks, the DAS can flag data during calibration periods and allow the data to be stored in separate files that can be reviewed remotely.

Figure 6 shows a schematic of the integrated monitoring system at EPA's Burden Creek NCore monitoring station. Note that a series of solenoid switches are positioned between the ambient air inlet manifold and an additional "calibration" manifold. This configuration allows the DAS to control the route from which the analyzers draw their sample. At the beginning of an Autocal, the DAS signals the MFC unit to come out of standby mode and start producing zero or calibration gas. Once the MFC has stabilized, the DAS switches the analyzers' inlet flow (via solenoids) from the ambient air manifold to the calibration manifold. The calibration gas is routed to the instruments, and the DAS monitors and averages the response, flagging the data appropriately as calibration data. When the Autocal has terminated, the DAS switches the analyzers' inlet flow from the calibration manifold back to the ambient manifold, and the data system resets the data flag to the normal ambient mode.

The integration of DAS, solenoid switches, and MFC into an automated configuration can bring an additional level of complexity to the monitoring station. Operators must be aware that this additional complexity can create situations where leaks can occur. For instance, if a solenoid switch fails to open, then the inlet flow of an analyzer may not be switched back to the ambient manifold, but instead will be sampling interior room air. When the calibrations occur, the instrument will span correctly, but will not return to ambient air sampling. In this case, the data collected must be invalidated. These problems are usually not discovered until there is an external "Through-the Probe" audit, but by then extensive data could be lost. It is recommended that the operator remove the calibration line from the calibration manifold on a routine basis and challenge the sampling system from the inlet probe. This test will discover any leak or switching problems within the entire sampling system.

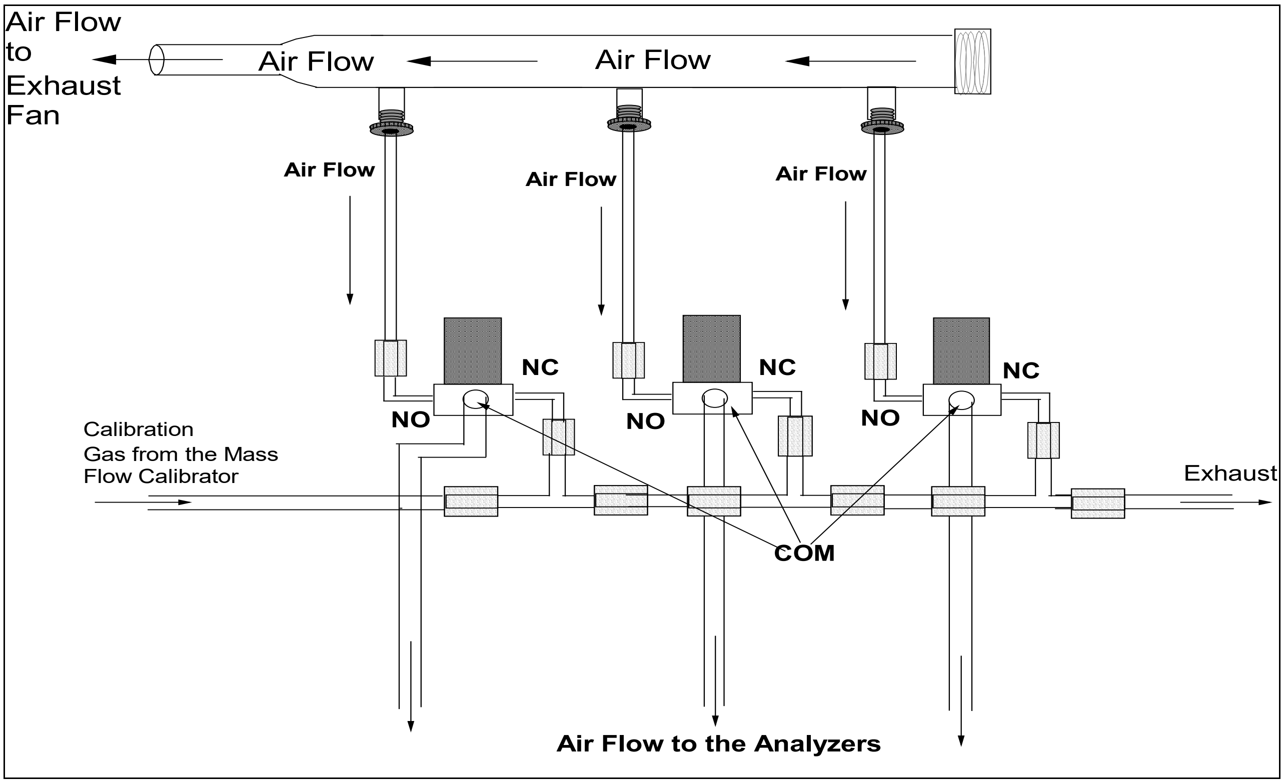


Appendix E, Figure 6. Example of a Manifold/Instrument Interface

Figure 7 shows a close up of an ambient/calibration manifold, illustrating the calibration manifold – ambient manifold interface. This is the same interface used at EPA's Burden's Creek monitoring station. The interface consists of three distinct portions: the ambient manifold, the solenoid switching system and the calibration manifold. In this instance, the ambient manifold is a T-type design that is being utilized with a blower fan at the terminal. Teflon® tubing connects the manifold to the solenoid switching system. Two-way solenoids have two configurations. Either the solenoid is in its passive state, at which time the ports that are connected are the normally open (NO) and the common (COM). In the other state, when it is energized, the ports that are connected are the normally closed (NC) and the COM ports. Depending on whether the solenoid is 'active' or not, the solenoid routes the air from the calibration or ambient manifold to the instrument inlets. There are two configurations that can be instituted with this system.

1. Ambient Mode: In this mode the solenoids are in "passive" state. The flow of air (under vacuum) is routed from the NO port through the solenoid to the COM port.
2. Calibration Mode: In this mode, the solenoids are in the "active" state. An external switching device, usually the DAS, must supply direct current

to the solenoid. This causes the solenoid to be energized so that the NO port is shut and the NC port is now connected to the COM port. As in all cases, the COM port is always selected. The switching of the solenoid is done in conjunction with the MFC unit becoming active; generally, the MFC is controlled by the DAS. When the calibration sequences have finished, the DAS stops the direct current from being sent to the solenoid and switches automatically back to the NO to COM (inactive) port configuration. This allows the air to flow through the NO to COM port and the instrument is now back on ambient mode.



Appendix E, Figure 7. Ambient – Calibration Manifold Interface

Reference

1. Code of Federal Regulations, Title 40, Part 58, Appendix E.9[102]

[102] https://www.gpo.gov/fdsys/granule/CFR-2012-title40-vol6/CFR-2012-title40-vol6-part58-appE

Appendix F

Example Procedure for Calibrating a Data Acquisition System

DAS Calibration Technique

The following is an example of a DAS calibration. The DAS owner's manual should be followed. The calibration of a DAS is performed by inputting known voltages into the DAS and measuring the output of the DAS.

Most DAS system work on a 1, 5 or 10 volt range, i.e., the full output of voltage equals the maximum measurable concentration of the input equipment. In the case of a 0 - 1000 ppb range instrument, 1.00 volts equals 1000 ppb. Accordingly, 500 ppb equals 0.5 volts (500 milivolts). To get the DAS to be linear throughout the range of the instrument being measured, the DAS must be tested for linearity.

class=WordSection2>

1. The calibration begins by obtaining a voltage source and an ohm/voltmeter. Identify what type of voltage system the DAS is (1, 5, or 10 volt)

2. Place a wire lead across the input of the DAS multiplexer. With this "shorted" out, the DAS should read zero.

3. If the output does not read zero, adjust the output according to the owner's manual.

4. After the background zero has been determined, it is time to adjust the full scale of the system. Attach the voltage source to a voltmeter. Adjust the voltage source to the full volts, again either 1, 5 or 10. Connect the output of the voltage source to the DAS multiplexer. The DAS should read the set maximum concentration value. Adjust the DAS voltage A/D card accordingly. Adjust the output of the voltage source to 25% of total volts (.25, 1.25, or 2.5). The DAS output should read 25% of the maximum concentration value. Adjust the analog/digital card or settings in the DAS accordingly. In addition to testing the full scale of the DAS, you would also test at zero, a low point, and a few mid points along the scale. It may be necessary to adjust the DAS to allow the high and low points to be as close to the source voltage as possible. In some cases, the linearity of the DAS may be in question. If this occurs, the data collected may need to be adjusted using a linear regression equation. The critical range for many instruments is in the lower 10 % of the scale; it is critical that this be linear.

6. Every channel on a DAS should be calibrated. In some newer DAS systems, there is only one A/D card voltage adjustment which is carried throughout the multiplexer. This usually will adjust all channels. It is recommended that DAS be calibrated once per year.

Appendix G

Ambient Air Data Sources

The following information provides descriptions of various websites that help to display data in a number of ways and well as web addresses for a number of the major data bases.

Following these descriptions is an information sheet that provides a description of the types of information that can be found in most of these data systems.

Ambient Air Data Sources

The following provide access to data systems, maps, and information through the following, non-exhaustive list of websites:

Data Evaluation Tools

- **Air Data** - https://www.epa.gov/outdoor-air-quality-data - The AirData site provides reports and maps of air pollution data for the entire United States based on criteria that you specify. The site provides access to generate maps, graphs, and data tables dynamically; some tools require password protected access. *Tools on this page are intended for both the general public and more experienced air quality professionals.*

- **AirCompare** - https://www3.epa.gov/aircompare/ - This is a tool which provides local air quality information. AirCompare searches EPA air quality databases to pull information about pollutants reported under the Air Quality Index (AQI) – and to translate it into charts that show simply whether the previous year's air quality was healthy, unhealthy or unhealthy for specific groups more susceptible to pollution. The tool also can provide a multi-year snapshot of a county's air quality, based on a particular health issue.

- **Air Explorer** - http://www.epa.gov/airexplorer/ - Air Explorer is a collection of user-friendly visualization tools for air quality analysts. The tools generate maps, graphs, and data tables dynamically. *This area is primarily intended for air quality analysts and communications specialists. It provides summary information from the Air Quality System.*

- **AirNow** – https://airnow.gov -The U.S. EPA, NOAA, NPS, tribal, state, and local agencies developed the AirNow Web site to provide the public with easy access to national air quality information including current fire conditions. AirNow offers daily air quality forecasts as well as real-time air quality conditions for most cities across the US as well as over 15 embassies and consulates, and provides links to more detailed State and local air quality information.

- **AirNow Tech** - https://www.airnowtech.org/ - AirNow-Tech is a password-protected website for air quality data management analysis, and decision support. AirNow-Tech is primarily used by the federal, State, Tribal, and local air quality organizations that provide data and forecasts to the AirNow system, as well as researchers and other air data users. AirNow Tech also provides tools such as DART (Data Analysis and Reporting Tool) which is a web-based application that provides data validation and analysis of air pollutant data collected as part of the ozone precursor, particulate matter, and air toxics monitoring networks.

- **Air Trends** - https://www.epa.gov/air-trends Air Trends provides national and local air quality trends information. Data tables and reports document EPA's assessment of trends in terms of air quality, emissions, and meteorological changes over time. *This area is primarily intended for the general public. It provides summary information from the Air Quality System.*

- **Air Markets Program Data** – https://ampd.epa.gov/ampd/ - Provides a web-based interface to view unit, facility, emissions, and allowance data collected as part of EPA's emissions trading programs. In addition, AMPD provides interactive maps, charts, reports, and pre-packaged datasets.

- **Greenhouse Gas Emissions** - https://www.epa.gov/ghgemissions - Provides information and data on emissions of greenhouse gases to Earth's atmosphere, and also the removal of greenhouse gases from the atmosphere, including the official national inventory of U.S. greenhouse gas emissions. Governments at the federal, state and local levels prepare emissions inventories, which track emissions from various parts of the economy such as transportation, electricity production, industry, agriculture, forestry, and other sectors.

- **DATAFED** http://www.datafed.net/-.The goals of the DataFed site are to facilitate the access and flow of atmospheric data from providers to users, support the development of user-driven data processing value chains, and participate in specific application projects. Tools provided by DataFed include browsers and analysis tools for distributed monitoring data. DataFed also serves as data gateway for user programs (web pages, GIS, science tools). Currently DataFed is focused on the mediation of air quality data.

- **EJ Screen** - https://www.epa.gov/ejscreen - EJSCREEN is an environmental justice mapping and screening tool that provides EPA with a nationally consistent dataset and approach for combining environmental and demographic indicators. EJSCREEN users choose a geographic area; the tool then provides demographic and environmental information for that area.

- **National-Scale Air Toxics Assessment (NATA)** - https://www.epa.gov/national-air-toxics-assessment - The National-Scale Air Toxics Assessment is EPA's ongoing comprehensive evaluation of air toxics in the U.S. These activities include expansion of air toxics monitoring, improving and periodically updating emission inventories, improving national- and local-scale modeling, continued research on health effects and exposures to both ambient and indoor air, and improvement of assessment tools.

- **Ambient Monitoring Data Analysis System (AMDAS) -** http://www.environ.org/amdas - AMDAS is a PC-based, user-friendly, menu driven program that provides air quality analysts and managers with easy "point and click" access to air quality data for browsing, preparing tabular and graphical summaries, and performing statistical analyses. AMDAS currently includes features specifically designed for the analysis of meteorological and air quality data contained in EPA's Aerometric Information Retrieval System (AIRS). AMDAS can be used to analyze meteorological data, routine air quality data (i.e., hourly ozone, oxides of nitrogen, carbon monoxide, etc.), speciated VOC and carbonyl compound data (i.e., PAMS data), and atmospheric particulate matter data, including PM10 and PM2.5 total mass and speciated sample data.

Databases

- **Air Quality System (AQS)** - https://www.epa.gov/aqs - The Air Quality System is EPA's repository of ambient air quality data. AQS stores data from over 10,000 monitors; 5000 of which are currently active. State, Local and Tribal agencies collect the data and submit it to AQS on a periodic basis. This area is primarily intended for those in the state, local and tribal agencies and within EPA who load data into the AQS database or use data from this database for analysis.

- **AQS Data Mart** - https://aqs.epa.gov/aqsweb/documents/data_mart_welcome.html - The AQS Data Mart is a database containing all of the information from AQS. It has every measured value the EPA has collected via the national ambient air monitoring program. It also includes the associated aggregate values calculated by EPA (8-hour, daily, annual, etc.). The AQS Data Mart is a copy of AQS made once per week and made accessible to the public through web-based applications. The intended users of the Data Mart are air quality data analysts in the regulatory, academic, and health research communities. It is intended for those who need to download large volumes of detailed technical data stored at EPA and does not provide any interactive analytical tools.

- **CASTNET** - http://www.epa.gov/castnet/ - CASTNET is a long-term environmental monitoring network with 95 sites located throughout the U.S. and Canada. It is managed and operated by the EPA in cooperation with the National Park Service, Bureau of Land Management, and other federal, state, and local partners including six Native American tribes that operate CASTNET sites on tribal lands. The network was established under the 1991 Clean Air Act Amendments to assess the trends in acidic deposition due to emission reduction programs such as the Acid Rain Program (ARP), NOx Budget Trading Program (NBP), the Clean Air Interstate Rule (CAIR), and the Cross-state Air Pollution Rule (CSAPR).

- **Emission Inventory System** - https://www.epa.gov/air-emissions-inventories/emissions-inventory-system-eis-gateway - The EIS Gateway, the first component of the Emissions Inventory System (EIS), was developed to provide registered EPA, State, local and Tribal users with access to emissions inventory data. Registered EPA, State, local and Tribal users can access facility inventory and emissions data for sources in their jurisdiction.

- **Envirofacts** – https://www3.epa.gov/enviro - Envirofacts is a repository that provides access to multimedia topical searches including air, toxics, water, facilities, and others. It pulls data from other databases, and is touted as "your one-stop source for environmental information. Multiple spatial search options, data downloads, apps and widgets are available.

- **Federal Land Manager Environmental Database -** http://views.cira.colostate.edu/fed/ This website provides access to an extensive database of environmental data and an integrated suite of online tools and resources to help assess and analyze the air quality and visibility in Federally-protected lands such as National Parks, National Forests, and Wilderness Areas.

- **National Emissions Inventory** - https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei The National Emissions Inventory (NEI) is a comprehensive and detailed estimate of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants from air emissions sources. The NEI is released every three years based primarily upon data provided by State, Local, and Tribal air agencies for sources in their jurisdictions and supplemented by data developed by the US EPA.

- **IMPROVE Monitoring Data** - http://vista.cira.colostate.edu/Improve/ - The IMPROVE monitoring network consists of aerosol, light scatter, light extinction and scene samplers in a number of National Parks and Wilderness areas. The webpage provides access to data and tools; however, for full access, utilize the Federal Land Manager Environmental Database listed above or the VIEWS webpage below.

- **Toxics Release Inventory (TRI) Program** – https://www.epa.gov/toxics-release-inventory-tri-program The Toxics Release Inventory (TRI) tracks the management of certain toxic chemicals that may pose a threat to human health and the environment. U.S. facilities, including tribal facilities, in different industry sectors must report how much of each chemical is released to the environment and/or managed through recycling, energy recovery and treatment.

- **VIEWS** - .http://views.cira.colostate.edu/web/ - VIEWS is a website and database system designed to provide easy access to a wide variety of air quality data through an interactive suite of query, visualization, and analysis tools. Ground-based measurements from dozens of monitoring networks, air quality modeling results, emissions data, and NASA satellite data are available from the integrated database.

- **MADIS -** http://madis.noaa.gov/ - MADIS ingests data from NOAA data sources and non-NOAA providers, decodes the data then encodes all of the observational data into a common format with uniform observational units and time stamps. Quality checks are conducted and the integrated data sets are stored along with a series of flags indicating the results of the various QC checks. MADIS provides several methods for users to access the data to meet their needs. Users can request data from July of 2001, which is when MADIS was first available to the public, to the present.

Air Quality Data Systems

System	Level of Detail					Time	Substances					Outputs			Audience		
	Raw	Daily	Annual	AQI	QA	Time range of most detailed data	Ozone + PM2.5	Other Criteria	Toxics	PM2.5 Speciation	Other	Tabular Data	Maps	Charts / Plots	Public	Specialists / Analysts	Researchers
AirData: Reports and Visualizations		●	●	●	●	1980 - Present	●	●	○	○		●	●	●	●	●	
AirData: Pregenerated Files	●	●	●	●		1980 - Present	●	●	●	●	●	●				●	●
AirNow				●		Present	●						●		●	●	
AirNow API	●	●		●		1999 – Present	●	●	○		○	●	●			●	
Air Trends			●			1980 – 2016	●	●	○	○	○		●	●	●	●	
AQS	●	●	●	●	●	1957 - Present	●	●	●	●	●	●				●	
AQS API	●					1957 - Present	●	●	●	●	●	●				●	●
CASTNET	●		●			1987 - Present	○				●	●	●			●	●
IMPROVE	●	●	●		●	1988-2016	●			●	●	●	●	●	●	●	●
AirCompare			●	●		2007 – 2016	●	●				●	●		●		
NATA			●			1996,1999, 2002, 2005, 2011			●			●	●			●	

Appendix H

National Ambient Air Quality Standards (NAAQS) Table

NAAQS TABLE

Pollutant		Primary/Secondary	Averaging Time	Standards	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb) [1]		primary and secondary	Rolling 3-month average	0.15μg/m3	Not to be exceeded
Nitrogen Dioxide (NO_2) [2]		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb	Annual Mean
Ozone (O_3) [3]		primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 $\mu g/m^3$	Annual mean, averaged over 3 years
		secondary	1 year	15.0 $\mu g/m^3$	Annual mean, averaged over 3 years
		primary and secondary	24 hours	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2) [4]		primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

[1] In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.

[2] The level of the annual NO2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

[3] Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

[4] The previous SO2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO2 standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Appendix J

Statistical Measurements

Statistical Measurements

This section describes ways to summarize basic characteristics of the dataset using common statistical measures. Some useful examples include: measures of central tendency, such as the mean or median; measures of relative standing, such as percentiles; measures of dispersion, such as range, variance, standard deviation, coefficient of variation, or interquartile range; measures of distribution symmetry or shape; and measures of association between two or more variables, such as correlation. These measures can be used for description and communication about the dataset.

Mathematical formulas that allow the user to calculate descriptive statistics using a simple calculator or computer spreadsheet program are provided in this section. Data analysts that want to perform advanced statistical procedures may consider investing in a statistical software package. Resources for those interested in learning more are provided at the end of this section. The definitions and procedures outlined in the next sections are primarily taken from the EPA document *Guidance for Data Quality Assessment – Practical Methods for Data Analysis*[103].

Central tendency -

The most common estimates for central tendency in environmental data are the mean and median. The **mean** may be considered to be the "center of gravity" of the dataset. It is calculated as a basic arithmetic average. The **median** is the value which falls directly in the middle of the data when the measurements are ranked in order from smallest to largest. Thus ½ of the data are smaller than the sample median and ½ of the data are larger than the sample median. Unlike the mean, the median is not influenced by a small number of extreme values.

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[103] https://www.epa.gov/sites/production/files/2015-06/documents/g9-final.pdf

Appendix J, Formula 1. Measuring central tendency

Let $X_1, X_2, \ldots, X_n$ represent the n data points.

Sample Mean: The sample mean $\bar{x}$ is the sum of all the data points divided by the total number of data points (n):

$$\bar{X} = \frac{1}{n} \sum_{i=1}^{n} X_i$$

Sample Median: The sample median ($\tilde{X}$) is the center of the data when the measurements are ranked in order from smallest to largest. To compute the sample median, list the data from smallest to largest and label these points $X_{(1)}, X_{(2)}, \ldots, X_{(n)}$ (so that $X_{(1)}$ is the smallest, $X_{(2)}$ is the second smallest, and $X_{(n)}$ is the largest).

If the number of data points is odd, then $\tilde{X} = X_{([n+1]/2)}$

If the number of data points is even, then $\tilde{X} = \frac{X_{(n/2)} + X_{([n/2]+1)}}{2}$

Relative Standing (Percentiles) -

It may be useful to know the relative position of one or several observations in relation to all of the observations. Percentiles are one such measure of relative standing that may also be useful for summarizing data. A percentile is the data value that is greater than or equal to a given percentage of the data values. For example, the data point which is the 25th percentile is greater than or equal to 25% of the data values and is less than or equal to 75%. Important percentiles usually reviewed are the quartiles of the data: the 25th, 50th, and 75th percentiles. The 50th percentile is also called the sample median (previously described), and the 25th and 75th percentiles are used to estimate the dispersion of a data set (next section).

Appendix J, Formula 2. Calculating percentiles

Let $X_1, X_2, \ldots, X_n$ represent the n data points. To compute the p^{th} percentile, y(p), first list the data from smallest to largest and label these points $X_{(1)}, X_{(2)}, \ldots, X_{(n)}$ (so that $X_{(1)}$ is the smallest, $X_{(2)}$ is the second smallest, and $X_{(n)}$ is the largest). Let t = p/100, and multiply the sample size n by t. Divide the result into the integer part and the fractional part, i.e., let nt = j + g where j is the integer part and g is the fraction part. Then the p^{th} percentile, y(p), is calculated by:

If g = 0, $y(p) = (X_{(j)} + X_{(j+1)})/2$

otherwise, $y(p) = X_{(j+1)}$

Example: The 90^{th} and 95^{th} percentile will be computed for the following 10 data points (ordered from smallest to largest) : 4, 4, 4, 5, 5, 6, 7, 7, 8, and 10 ppb.

For the 95th percentile, t = p/100 = 95/100= .95 and nt = (10)(.95) = 9.5 = 9 + .5. Therefore, j = 9 and g = .5. Because $g = .5 \neq 0$, $y(95) = X_{(j+1)} = X_{(9+1)} = X_{(10)}$ = 10 ppm. Therefore, 10 ppm is the 95^{th} percentile of the above data.

Measures of Dispersion-

Measures of central tendency are more meaningful if accompanied by information on how the data spread out from the center. Measures of dispersion in a data set include the range, variance, sample standard deviation, coefficient of variation, and the interquartile range. These measures are all described below and formulas provided.

The easiest measure of dispersion to compute is the sample ***range***. For small samples, the range is easy to interpret and may adequately represent the dispersion of the data. For large samples, the range is not very informative because it only considers (and therefore is greatly influenced) by extreme values.

The sample ***variance*** measures the dispersion from the mean of a data set. A large sample variance implies that there is a large spread among the data so that the data are not clustered around the mean. A small sample variance implies that there is little spread among the data so that most of the data are near the mean. The sample variance is affected by extreme values and by a large number of nondetects. The sample standard deviation is the square root of the sample variance and has the same unit of measure as the data.

The ***coefficient of variation (CV)*** is a unitless measure that allows the comparison of dispersion across several sets of data. The CV is often used in environmental applications because variability (expressed as a standard deviation) is often proportional to the mean.

When extreme values are present, the ***interquartile range*** may be more representative of the dispersion of the data than the standard deviation. This statistical quantity does not depend on extreme values and is therefore useful when the data include a large number of nondetects.

Appendix J, Formula 3. Calculating measures of dispersion

Let $X_1, X_2, \ldots, X_n$ represent the n data points.

Sample Range: The sample range (R) is the difference between the largest value and the smallest value of the sample, i.e., R = maximum - minimum.

Sample Variance: To compute the sample variance (s^2), compute:

$$s^2 = \frac{\sum_{i=1}^{n} X_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} X_i\right)^2}{n-1}$$

Sample Standard Deviation: The sample standard deviation (s) is the square root of the sample variance, i.e.,

$$s = \sqrt{s^2}$$

Coefficient of Variation: The coefficient of variation (CV) is the standard deviation divided by the sample mean (Section 2.2.2), i.e., $CV = s/\bar{X}$. The CV is often expressed as a percentage.

Interquartile Range: Use the directions in Section 2.2.1 to compute the 25th and 75th percentiles of the data (y(25) and y(75) respectively). The interquartile range (IQR) is the difference between these values, i.e.,
IQR = y(75) - y(25).

Trends analysis-

EPA uses trend analysis to assess year-to-year changes in ambient air quality and pollutant emissions. Annual Trends Reports are EPA's "report card" on the status of air quality and emission reductions. Annual trends reports and special studies dating back to 1994 are available at https://www.epa.gov/air-trends. Some methods used in these reports will be useful to tribal agencies.

The data analyst needs a reasonably long and complete dataset to distinguish a genuine trend from other kinds of data variability. A suspected trend in data may not be a “real” trend, but a function of data variation caused by weather conditions or other factors. For example, because higher temperatures cause more formation of some pollutants, like ozone and formaldehyde, a year with warmer temperatures may have higher concentrations of these pollutants, regardless of any possible changes in precursor emissions. Thus the measurements in one year may be higher than the previous year, but we cannot reliably say that there is an upward trend in ambient concentrations.

Although it is tempting to calculate trends based on two or three years of data, more years are needed to calculate a meaningful trend. For dispersion modeling, meteorologists recommend using between 3 and 5 years of data to assess the "baseline" condition. With this in mind, we suggest the following:

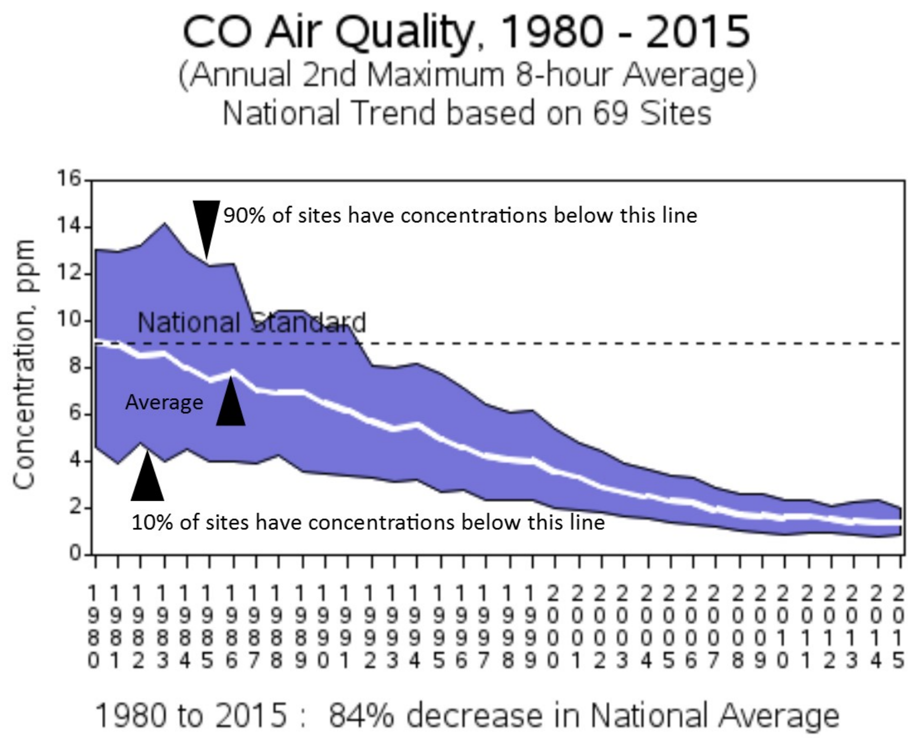
- 1 to 3 years of monitoring data – do not use for trend analysis
- 4 to 5 years of monitoring data – consider trend results to be preliminary
- 6 or more years of monitoring data – adequate dataset for trend analysis

If there are enough years of data available, then it is also important to confirm that each year has adequate data completeness. Multi-year trends can only be calculated if each year has a valid summary statistic (e.g. annual mean) based on sufficient data. The issue of data completeness was previously discussed in the section on data quality objectives and data validation.

Assuming that there are enough complete years of monitoring, then an annual air quality statistic can be determined for each individual year of air monitoring and then a trend may be evaluated for multiple years.

Percent change-

Actual ambient concentrations have little meaning to the general public and a change in concentration (for example a "0.04 ppb decline over 8 years") is even more abstract. For this reason, EPA most often explains trends in terms of a percent change over time. The example below (Fig. 7.1) shows the trend calculation and graph format most widely used in trend reports. The main trend statistic is the combined annual average of multiple monitoring sites. The figure also shows the 90th and 10th percentiles of all site averages for each year.



Appendix J, Figure 1. CO air quality

Appendix J, Formula 4. Percent change over multiple years of monitoring

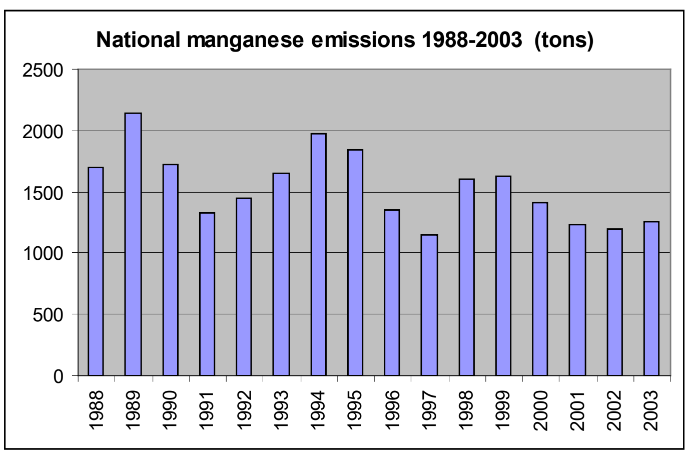
$$P = \left[\frac{(c_F - c_S)}{c_s}\right] \times 100$$

Where C_S = concentration at the start; C_F = concentration at the finish of the time period. A positive P indicates an upward trend and a negative value indicates a downward trend.

In the carbon monoxide example above,

$$P = \left[\frac{(9.1ppm - 1.4ppm)}{9.1ppm}\right] \times 100 = -84\%$$

There are some important pitfalls to the percent change approach to trends. The main concern is that if the dataset has strong year-to-year variability, then the existence of a positive or negative trend is dependent on which years are chosen as the start and finish. Figure 7.2 below shows national annual total manganese emissions as reported to the Toxics Release Inventory (TRI). The percent change in emissions between 1988 and 2003 is –26%. However, the downward trend is magnified if we look only at 1989 through 1997 (–88%); the trend is relatively flat if the time period is 1993–1999 (–2%); the trend reversed if we look at 1991 to 1999 (+19%). For this reason it is preferable to use the percent change method for a dataset with smooth trends. Highly variable datasets should be evaluated by using a moving average (described below) or with a more rigorous statistical method, such as linear regression or using non-parametric methods.



Appendix J, Figure 2. Example dataset with variable data

<u>National Air Toxics Trend Site (NATTS) method</u>

Trends within the new NATTS network are figured based on six (6) years of annual average concentrations for key HAPs, specifically benzene, 1,3-butadiene, arsenic, chromium, acrolein, and formaldehyde. The trend is calculated by finding the percent difference between the mean of the first three annual concentrations and the mean of the last three annual concentrations. This is a variation on the percent change method described above.

Appendix J, Formula 5. NATTS trend method

First the annual average concentration (Xi) is found for each year i = 1, 2, 3, 4, 5 & 6. Then the mean (X) for the first three years and the mean (Y) for years 4 through 6 is calculated:

$$X = \frac{X_1 + X_2 + X_3}{3} \text{ and } Y = \frac{X_4 + X_5 + X_6}{3}$$

The downward trend (T) is the percent decrease from the first 3-year period to the second.

$$T = \frac{X - Y}{X} \cdot 100$$

According to the data quality objectives (DQOs) for the NATTS program, a trend of at least 15 percent is considered a significant decrease. A tribal agency may wish to adopt this protocol for their own monitoring program or adapt it as needed through consultation with quality assurance experts. The Technical Assistance Document for the NATTS program is available at: https://www3.epa.gov/ttnamti1/files/ambient/airtox/NATTS%20TAD%20Revision%203_FINAL%20October%202016.pdf.

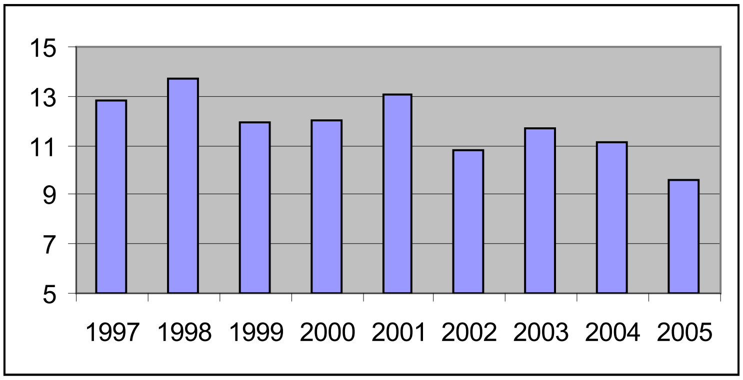
Moving average-

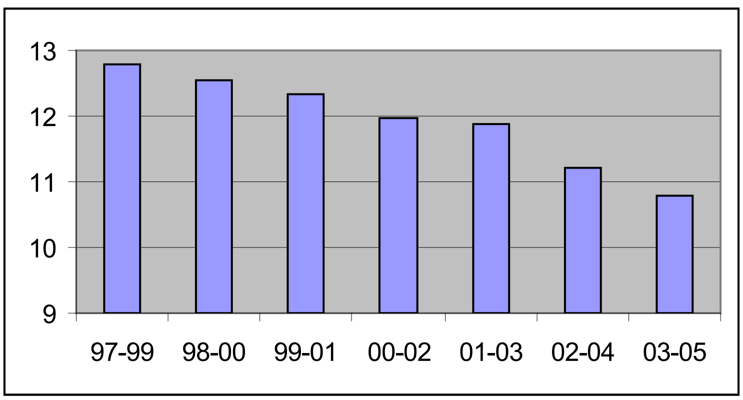
A dataset with considerable year-to-year variability may be smoothed out by calculating a moving average. Instead at looking at annual averages that rise and fall with each year, we look at 3-year, 4-year, or 5-year averages which are less subject to variability swings.

The example graphs in Figure 7.3 below shows data graphed first as annual averages and then as a moving 3-year average. The first figure shows annual averages from 1997 to 2005; the second shows the combined average for 1997 through 1999, then 1998-2000, 1999-2001, and so forth. The downward trend in data is more evident in the second figure.

Year	Mercury wet deposition (µg/m^2)
1997	12.8
1998	13.7
1999	11.9
2000	12.0

2001	13.1
2002	10.8
2003	11.7
2004	11.1
2005	9.6





Appendix J, Figure 3. Data trend presented with annual average and moving average

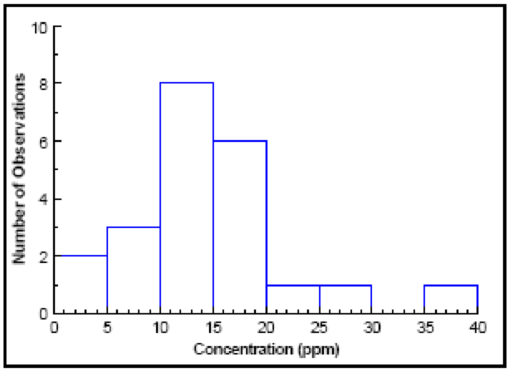
Data visualization

Simple graphing techniques are useful to describe the dataset and communicate monitoring results. Graphs can be used to identify patterns and trends in the data. Graphical representations include displays of individual data points, statistical quantities, temporal data, spatial data, and two or more variables.

Detailed instructions on how to produce these graphics are provided in Section 2 of the previously mentioned *Guidance for Data Quality Assessment – Practical Methods for Data Analysis*[104].

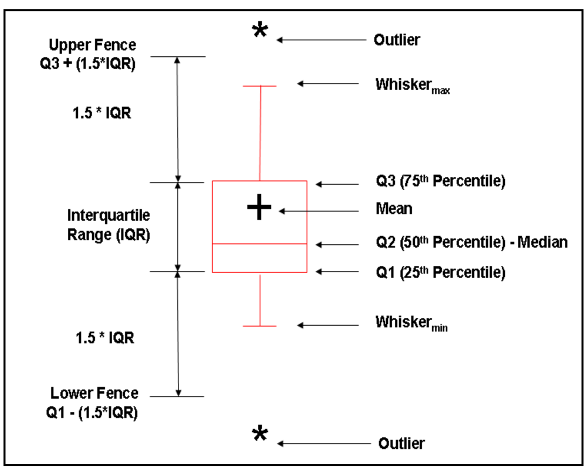
Histogram/Frequency Plots -

Two of the oldest methods for summarizing data distributions are the frequency plot (Fig. 4) and the histogram. Both the histogram and the frequency plot use the same basic principles to display the data: dividing the data range into units, counting the number of points within the units, and displaying the data as the height or area within a bar graph.



Appendix J, Figure 4. Example of a frequency plot

Box and Whisker Plot -



App. J, Figure 5. Box and whisker plot

A box and whisker plot or box plot (Fig. 5) is a schematic diagram useful for visualizing important statistical quantities of the data. A box and whiskers plot is composed of a central box divided by a line and two lines extending out from the box called whiskers. The length of the central box indicates the spread of the bulk of the data (the inter-quartile range, 25th to 75th percentile), while the length of the whiskers show how stretched the tails of the distribution are. The sample median is displayed as a line through the box and the sample mean is displayed using a '+' sign. Any unusually small or large data points are displayed by a '*' on the plot.

Scatter Plot -

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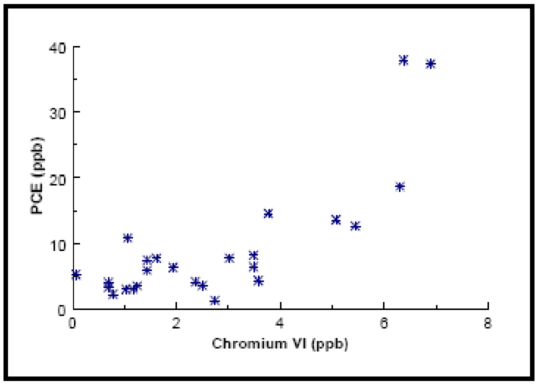
[104] https://www.epa.gov/sites/production/files/2015-06/documents/g9-final.pdf



App. J, Fig. 6. Example of a scatter plot

For data sets consisting of paired observations where two or more variables are measured for each sampling point, a scatter plot (Fig. 6) is a powerful tool for analyzing the relationship between two or more variables. Both potential outliers from a single variable and potential outliers from the paired variables may be identified on this plot. A scatter plot also displays the correlation between the two variables. Scatter plots of highly linearly correlated variables cluster compactly around a straight line.

Time Plot -

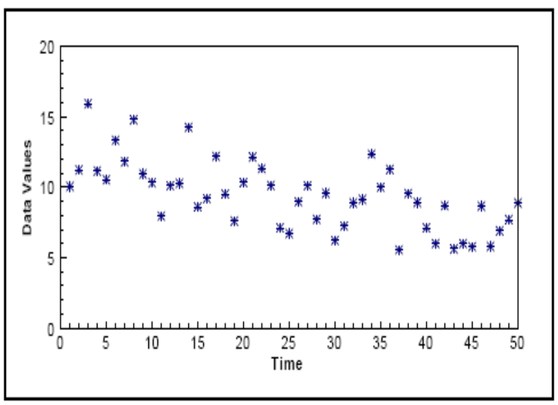


Figure 7.7. Example of a time plot

One of the simplest plots to illustrate a large amount of information is a time plot. A time plot (Fig. 7) is a plot of the data over time. This plot makes it easy to identify large-scale and small-scale trends over time. Small-scale trends show up on a time plot as fluctuations in smaller time periods. For example, ozone levels over the course of one day typically rise until the afternoon, then decrease, and this process is repeated every day. An example of a large-scale trend is a multi-year decrease in air pollution resulting from effective air quality control programs. For example, the annual average concentration of NO_x at a particular monitoring site may decline over the course of several years as a result of emissions controls at local industries and the introduction of cleaner cars.

References, Tools, and Resources

EPA courses -

EPA's Air Pollution Training Institute[105] (APTI) provides technical air pollution training to state, tribal, and local air pollution professionals, although others may benefit from this training. The curriculum is available in classroom, telecourse, self-instruction, and web-based formats. If you want to receive Continuing Education Credits (CEU) for the course, you must be a Registered APTI user. Examples of some courses are described below.

Introduction to Environmental Statistics

This series of online lectures was developed for USEPA by the University of Illinois at Chicago School of Public Health, Environmental and Occupational Health Sciences Division. This course provides a basic understanding of how to interpret monitoring data and how to analyze environmental data. Originally produced in 2004, the first three videos of the series were updated in 2012..

- Module 1: Interpreting Your Monitoring Data
- Module 2: Sampling and Analytical Limitations & Sample Detection Limits
- Module 3: Quality Assurance Quality Control
- Module 4: Analysis of Trends
- Module 5: Language of Data Graphing
- Module 6: Censored Values and Extreme Values
- Module 7: Fundamentals of Trajectory Analysis

Beginning Environmental Statistical Techniques SI:473A

The course gives students a ""conversational"" knowledge of statistics so they can understand the statistics in journal articles and reports, do some basic statistical calculations and analyses of their own, or listen to a statistician and understand what he or she is saying. The basic statistical principles and methods presented in the course can be applied in many fields including medicine, business, science, or other fields. The course serves as background material for APTI courses that require statistics, such as *Analysis of Ambient Measurements* and classroom course *Statistical Analysis for Ambient Measures*.

[105] https://www.apti-learn.net/LMS/EPAHomePage.aspx?m=1&n=0

Training Courses on Quality Assurance and Quality Control Activities-

EPA Quality Staff develops a variety of traditional training courses on quality assurance (QA) and quality control (QC) activities and the EPA quality system. The website[106], which is currently being updated, provides training materials on such subjects as *Introduction to Data Quality Assessment* and *Introduction to Quality Assuracne Project Plans.*

Other tools and resources

Statistics books:

An Internet or Amazon[107] search will provide countless numbers of books and e-books covering specific and various statistical methods.

Other agencies and organizations have resources that provide information, tools, and guidance that tribal air quality professionals can use to verify and visualize their data. A small example includes the following:

- DataPlot[108] (National Institutes of Science and Technology) is a free, public-domain, multi-platform software system for scientific visualization, statistical analysis, and non-linear modeling.
- StatPages[109] (by John C. Pezzullo) contains links to online calculators, free statistical software, online statistics books, tutorials, and related resources

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106 https://www.epa.gov/quality/training-courses-quality-assurance-and-quality-control-activities#intro_dqa

107 https://www.amazon.com/

108 http://www.itl.nist.gov/div898/software/dataplot/homepage.htm

109 http://statpages.info/javasta2.html

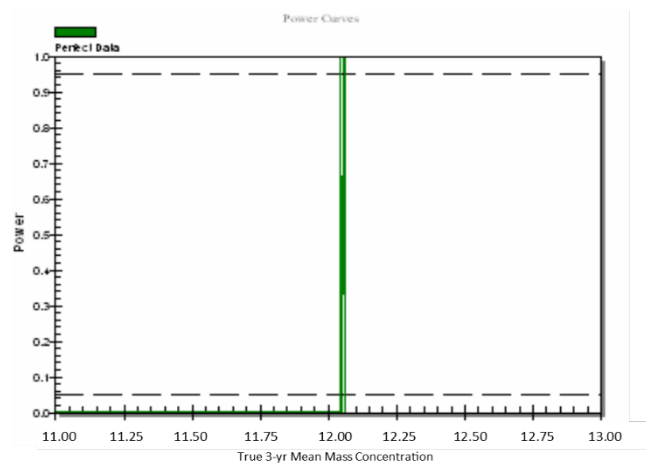
Appendix K

Using the Data Quality Objectives Companion Tool V2.0

The following information is for understanding and utilizing the DQO Companion Tool Version 2.0 available at https://www3.epa.gov/ttn/amtic/dqotool.html. Although the tool functions as intended, it should be noted that the tool has not been updated since 2004 and referenced standards in the tool documentation have changed. These documents include a user manual and *Read_Me* file and are part of the zipped package.

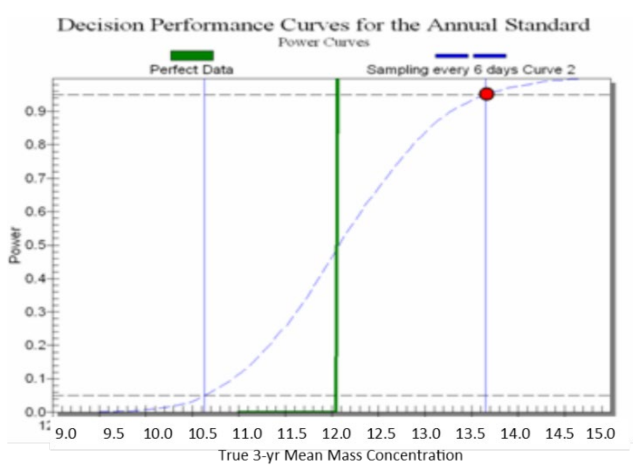
A Practical Example of Monitoring Tradeoffs That Affect a Decision

During the development of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS), EPA wanted to know how different sampling frequencies, data completeness and different levels of precision and bias would affect a decision maker's ability to make correct decision choices. In order to give decision makers a tool that would allow them to play "what-if" scenarios, the EPA developed a software tool that allows certain variables to change, in order to see what effect the change had on the decision makers' ability to make a comparison to the NAAQS. The following provides an example of the $PM_{2.5}$ Data Quality Objective Tool. This tool is available on the Ambient Monitoring Technology Information Center (AMTIC) Website https://www.epa.gov/amtic.



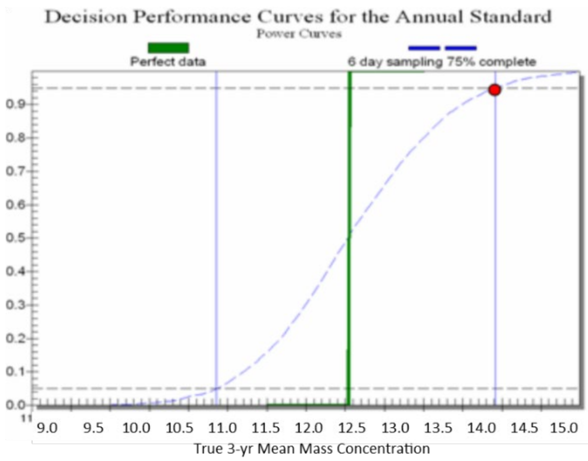
Appendix K, Figure1. Decision curve representing "perfect" data

The software uses historical $PM_{2.5}$ data to generate data values for a "typical" $PM_{2.5}$ site. The action limit is the NAAQS value which is 12.0 ug/m³. A curve on either side of the action limit represents the probability of making an incorrect attainment decision. The first graph (Figure 1) represents a site that is monitoring every day, has a complete data set (100%) and has no bias or imprecision. Therefore, it's considered "perfect" data and the green line represents that any 3-year $PM_{2.5}$ average above 12 would always be declared non-attainment and any 3-year $PM_{2.5}$ average less than 12 would be declared in attainment. In other words, the data are perfect representations of reality and allow the decision makers to always make the correct decision.



Appendix K, Figure 2. Decision curve with 1-in-6 day sampling

Figure 2 demonstrates what would happen if instead of sampling every day, the sampler was on a 1-in-6 day schedule (which is acceptable). The dashed blue line represents a true concentration. However, because the tribe is not sampling every day, even though the true 3-year concentration might be greater than 12.0 ug/m^3, a mistake can be made (there is a probability) that the site is declared in attainment (less than 12.0) when it is in truth non-attainment. The red dot represents a true concentration. Following the red dot over to the Y axis, it falls on the 95% probability (power) line. What this says is that 95% of the time one will declare that the 3-year average is greater than 12.0 ug/m^3 (action limit) when the true concentration is greater than or equal to 14.2 ug/m^3 when sampling at a 1-in-6 day interval. However, as one moves down the blue dashed line to a concentration that is closer to the action limit there is greater probability of making a mistake.



Appendix K, Figure 3. Decision curve with 1-in-6 day sampling and 75% complete.

The last graph (Figure 3) demonstrates what would happen if a monitoring organization sampled on a 1-in-6 day schedule but collected only 75% of the data (which is acceptable). The blue vertical lines gets a little wider meaning that one would be 95% sure that the 3-year average is greater than 12.0 ug/m^3 if the true value was greater than or equal to 13.7 ug/m^3. These graphs do not include any measurement errors like imprecision and bias which would make the blue vertical lines wider. The tool allows this uncertainty to be incorporated into the decision making process.

The example demonstrates that when tribes are developing a monitoring program, there are tradeoffs that need to be discussed in order to produce the best quality information within the budgets available. In the above example, the final decision might be that instead of going to every day sampling, the monitoring agency decides to implement 1-in-3 day sampling and maintain a completeness objective of 85%. The tradeoff is spending less money by not sampling everyday (sacrificing some accuracy), but collecting enough data (increasing completeness) to make the decision maker comfortable that the data collected represents the air quality status.